Brief Overview of Cotton Biotechnology

(Work Presented at Plenary and Parallel Sessions of WCRC—2)

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Dr. Kater Hake of Delta and Pine Land Company, USA, presented a paper at the Technical Seminar on the biotechnology work presented at the World Cotton Research Conference—2, but he decided not to include his paper in this publication. However, summaries presented by Dr. Stewart and Dr. Momtaz in the concluding session of the WCRC—2 are included here.

Part 1 (James McD. Stewart)

Biotechnology, rather than being a discipline, is a convenient way to designate the set of technical procedures and tools that are arrayed to achieve genetic objectives that may be exceedingly difficult by traditional approaches. The concept of biotechnology is passing from the realm of potential to that of actual accomplishment. In so doing, the fruits of biotechnology pass from under the parental umbrella to that of the traditional disciplines of breeding and genetics, crop management, entomology and such. Thus, many of the presentations and discussions of this conference dealt with the successes and problems associated with transgenic genotypes that are now being widely cultivated in the U.S. and Australia, and which are rapidly expanding in many areas of the cotton producing world.

It was interesting to note that Dr. Fitt, in his plenary presentation on the Future of Integrated Pest Management, placed transgenic cotton at the center of his diagram of the future to which all other inputs would feed. Dr. Barbosa included in his opening address a discussion of various aspects of Bt and herbicide tolerant cotton. He made the point that the popularity of Bt cotton negatively impacted research into other sources of resistance to insect pests. Perhaps this is reflected in the low number of presentations reporting research on new genes for cotton. Dr. Perlak provided a synopsis of the history of genes that have been used in commercial production. In addition, he provided a partial list of genes reported in the literature to have been inserted into cotton. Dr. Momtaz has summarized additional genes reported by the group from the Chinese Academy of Sciences.

Dr. Triplett provided an overview of the ovule culture system developed by C.A. Beasley and his co-workers, and the many lines of basic research and information that flowed from the availability of that system. She also touched on research on genes involved in the determination of fiber wall structure. Unfortunately, because of the time limitations, she was unable to dwell on some of the interesting molecular work that she and others are contributing to the understanding of fiber structure.

An area of biotechnology that has rapidly moved from basic concept to application is the use of molecular markers in genotype fingerprinting, genome mapping and marker assisted selection. This is indicated by the assumption of this area by the cotton geneticists as a component of their discipline. Perhaps notable for the conference was the paucity of reports involving molecular genetics other than the use of molecular markers. Mrs. Asad from Pakistan reported on the use of antisense RNA technology in the search for engineered resistance to the cotton leaf curl virus. The Australian work on the molecular structure of RNA viruses was particularly interesting. Dr. Nepomuceno presented his work at the University of Arkansas on the application of molecular techniques to identify genes differentially expressed across contrasting genotypes in response to water stress.

While we are aware of other molecular work on cotton, the scientists have not chosen the world conference as a medium to disseminate their results. One of the exciting developments for the future in the United States is the award of a multi-million dollar grant to Dr. Thea Wilkins and a team of collaborators to identify and map the genes expressed during fiber elongation. While the ultimate impact of this project on cotton remains to be seen, we can anticipate a significant increase in our knowledge of the genes important in fiber elaboration.

The majority of cotton scientists agree that the application of the tools of biotechnology holds great potential, both in the immediate development of products and in the acquisition of basic understanding of gene expression. This understanding will provide the applied developments of the future. By WCRC-3 we will, no doubt, see many more positive developments derived from biotechnology and passed on to other disciplines for verification.

Part 2 (Osama A. Momtaz)

A wide area of cotton biotechnology research work was presented and discussed during the sessions. Development of transgenic cotton with different traits for pest resistance, herbicide tolerance, and stress tolerance beside molecular investigation to locate molecular markers for fiber quality and yield have been presented and discussed.

Developing countries producing cotton such as Argentina, Egypt, Mexico, Pakistan, Uzbekistan, and South Africa did overcome technical hurdles for transformation and regeneration of different cotton varieties and in technical advancement with other countries already commercializing transgenic cotton varieties (BOLLGARD and INGARD) such as Australia, China and

the USA.

Advances in identifying and isolating appropriate genes and transforming them into cotton to introduce and improve economic traits were presented at the conference. In China, cowpea trypsin inhibitor, soybean trypsin inhibitor, pea lectin, and Bt genes have been transformed into cotton and produced 12 new Chinese cotton varieties for introducing pest resistance.

Problems with existing transgenic varieties were also presented. In Australia, studies on INGARD cotton with the Bt gene showed that variety background, tannins, endogenous plant factors, and environmental factors, play a role in down-regulating, silencing, post-transcriptional regulation and efficacy of the Bt gene and protein functions in the field.

Development of stress tolerant cotton using traditional breeding as well as biotechnological advancement have been proposed. RAPD, AFLP, RFLP, etc., molecular marker technologies to map multi-adversity resistance genes against all different stress factors such as pest and disease resistance, abiotic tolerant, etc., as well as map-based cloning of an indicated multiple gene family were also proposed. In China, development of abiotic salt stress tolerant cotton varieties via a regenerating stress tolerant somatic mutant was presented. In Egypt, development of abiotic stress tolerant cotton varieties via introducing genes responsible for carbohydrate and amino acid accumulation is in progress after overcoming transformation and regeneration problems in Egyptian cotton varieties.

Finding different alternatives to deal with developing insect resistance to transgenic cotton having a Bt gene was reported by different scientists. Modifying the Bt gene as well as IPM programs and cultivation practices are in progress. Introducing new proteins to compete with Bt was also presented. New competitive protein, specific to lepidopteran insects, was reported to recombinant polyhydron virus, a new technology for insect control. New technology for insect control using insect RNA viruses from the Tetravinideae family, which contains 18 viral genes specific to lepidopteran, will be competing and adding important factors to cotton integrated pest management programs across the world.

New technologies using recombinant DNA technology in identifying and isolating genes regulating fiber quality and yield, reducing variety development time, increasing polyester within cotton fiber and oil-free gossypol development are new areas of progress and improvement in world wide cotton production and quality via biotechnology.

In conclusion, during the WCRC-2 in Athens, cotton biotechnology research discussed solutions, problems, and promises for development of transgenic cotton varieties carrying different cotton economic traits to increase cotton production and refine its quality worldwide.