- Campaigns have been launched to control migrant populations of boll weevil involving all the farmers in a given region, thus reducing the required number of insecticide applications. In some regions, such as Sur del César, these campaigns have successfully reduced the number of applications against the boll weevil from ten or more to almost two.
- Less expensive generic products with higher marginal returns have been used to control weeds and pests.
- Lint quality has improved thanks to the introduction into the country of varieties with excellent intrinsic quality properties, such as DP Opal, and the increased use of domestic varieties. Selection of the former was done in conjunction with the industry and based on a determination of lint quality parameters in line with the type of yarn to be produced. Thus, all materials that did not meet the established parameters were eliminated. These varieties have the added advantage of performing better in ginning, raising lint yields from 34% 36% by region, to 39% or more when averaged in with the new varieties.

Current Status and Prospects of Transgenic Egyptian Cotton

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The Egyptian cotton culture and industry started to develop in the 1820s. Improving cotton varieties cultivated in different locations in the delta region and newly reclaimed areas was considered a national priority in 2002. The aim is to increase the profitability of cotton production, and meet the competitive edge with other crops with a major task to increase the total cotton cultivated area in newly reclaimed land in Egypt with maximum cotton quality and quantity production level per hectare.

The target of the cotton biotechnology program is to use advanced recombinant DNA technology to preserve cotton germplasm quality, increase its productivity by resisting biotic factors and tolerating environmental conditions (heat, salt and drought) for the sensitive varieties focusing on producing high quality fiber and maintaining fiber quality and quantity when cultivated in newly reclaimed areas. In coordination with the Cotton Research Institute, new hybrids have been tested in order to select varieties for the improvement of heat and salt stress tolerance using recombinant DNA technology. The Agricultural Genetic Engineering Research Institute (AGERI), the Cotton Research Institute (CRI) of the Agricultural Research Center and the Ministry of Agriculture will supervise final field-testing of the new transgenic cotton hybrids. The following steps have been studied to fulfill this goal:

- Identification and isolation of abiotic stress tolerance genes responsible for heat and salt stress tolerance.
- Development of an eukaryotic vector carrying the indicated gene and selectable marker.
- Creation of an Egyptian cotton transformation system for proven constructs and elaboration of a regeneration system for *Gossypium barbadense* target varieties.

The next step will be molecular studies on transgenic cotton plants at different levels (in the controlled environment, greenhouse and confined field-testing).

The main goal of the cotton biotechnology program at AGERI is to develop new biotechnological approaches to control insects with minimal use of insecticides, a step in this direction is to produce transgenic Egyptian cotton varieties that resist insects and tolerate abiotic stress (heat, salt and drought). Genes, which have the potential to improve cotton quantity and quality, must be identified, manipulated, and genetically engineered into a genotype that cotton breeders can effectively utilize. Identification of genes resistant to insects, and to adverse growing conditions like high temperature, soil salinity and drought and their incorporation into new varieties will have a direct impact on the productivity of the plant. With the transformation process becoming more successful, genetic engineering is going to be a major thrust in cotton research and production.

Main achievements of the program:

1- In vitro regeneration and transformation of Egyptian cotton varieties.

2- Study of key proteins and their genes responsible for salt, drought, heat stress tolerance, and insect resistance (multiple adversity resistant genes).

3- Development of transgenic Egyptian cotton varieties, resistant to insects, using Bt genes molecules, CryI(A)b and CryI(A)c with targeted activities for the pink bollworm.

4- Study properties and biochemical functions of key factors responsible for fiber initiation and development for fiber quality maintenance and improvement.

5- Isolation and purification of megabase size DNA and construction of Egyptian megabase DNA bacterial artificial chromosome (BAC) libraries to be used in gene family identification and map-based cloning.

6- Development of transgenic cotton tolerant to abiotic stress via carbohydrate accumulation via overexpression of manitole dehydrogenase gene and fructane synthase gene for manitole and fructan accumulation and also, via amino acid accumulation using over expression of Delta-1-Pyrroline-5-Carboxylate Synthase gene.

Additional progress in these areas is likely to be achieved in a shorter period of time than before due to new developments in gene identification and transformation technologies. Genomic technologies associated with structural, functional and bioinformatics are being developed under the AGERI biotechnology program targeting the most needed economic traits for Egyptian cotton such as fiber quality, earliness and multiple adversity gene families associated with host plant resistance. Using new AGERI genomic laboratory facilities and BAC libraries that are developed, screening for these traits is carried out. Several genes for stress resistance and fiber modification are being tested in various laboratories. New genes for insect and herbicide resistance are being sought. A strategy to modify fiber using metabolic pathway engineering to produce aliphatic polyester compounds is under development. Particle bombardment technology has been developed to introduce and test genes in elite varieties of cotton, without the need for regeneration or other tissue culture practices and backcrossing. These developments will lead to improved agronomical and fiber traits in cotton and enable the industry to expand its market share.

Impact of Transgenic Cotton on the International Cotton Trade

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Introduction

This paper is presented at the invitation of the International Cotton Advisory Committee, and the material presented documents the reported experiences of the international cotton trade in addition to relying on the available scientific literature documenting the use of insect resistant cotton seeds and Roundup Ready cottons.

Discussion

The controversy generated by the transgenic modification of fruits, vegetables, and feed crops has not affected the international trade in cotton. While some questions were raised by environmental activists in England and Germany at the onset of the use of insect resistant (Bt) and herbicide tolerant (Roundup Ready) cottons in 1996 and 1997, the cotton industry has effectively communicated to the environmental and political communities and to the consumer through sound scientific evidence of benefits to the soil, fauna, beneficial insects, birds, fish, wild life, and the ground and surface water through a substantial reduction in the use of pesticides.

The other important attributes of the new genetic varieties are the significant reductions in costs achieved through reduced use of pesticides and the increase in yields. In 2002, about 25-30% of total world production is transgenic cotton. Based on the increase in the use of the new seeds it is estimated that by 2005 approximately 50 percent of the total world production will make use of the new genetic varieties and the level should encompass two-thirds of production by 2008[1]. The benefits of the new varieties come at a critical time, as they will allow small producers in Africa, China, India, and Brazil to reduce their production costs and be more competitive with producers from the developed nations. The needed breakthroughs have come in two categories, insect resistance and weed control.

Insect Resistant Cotton

Since the transgenic cotton carrying the insect-resistant Bt gene was commercialized in the United States in 1996 the research data[2] documents that Bt cotton has provided 95 percent control of the tobacco budworm; 90 percent control of the cotton bollworm (pre-bloom) and 70 percent control of the cotton bollworm (bloom); and 99 percent control of the pink bollworm. More importantly, yield losses were suppressed. The adoption of Bt varieties was extremely rapid in states that experienced resistance problems (Arizona, Alabama, Georgia, Florida). After a year of very high budworm populations and damage in 1995, growers in Alabama adopted the new technology at an extremely rapid rate, planting over 60% of total acreage to Bt varieties in 1996. The results were astounding and Bt cotton is credited with saving the cotton industry in