Genetic Manipulation of Turfgrasses

Though turfgrass is not food, fiber, or animal feed, it affects millions of lives in various ways, including physical and mental health and social wellbeing. Turfgrasses limit soil erosion, conserve water, filter air and water-borne pollutants, reduce heat buildup in urban areas, and provide safer playing surfaces. In the United States 50 million acres of turf are managed as golf courses, athletic fields, home lawns, road-sides, cemeteries, and parks, with a value of $57.9 billion dollars annually. The turfgrass industry faces challenges such as water shortage, rising cost of energy, limited labor resources, and environment-related restrictions on the use of fertilizers, herbicides, fungicides, and pesticides. A sustainable approach is to develop cultivars that tolerate stresses and perform well under different conditions.

Molecular biology and biotechnology allow speedy modification of plants. Texas AgriLife Research scientists have an integrated multidisciplinary approach to develop new and improved Resource Efficient cultivars of major turfgrasses requiring lower inputs (water, pesticides, fertilizers) using plant breeding.

Traditional Breeding

Turfgrasses is a cyclical process of germplasm acquisition, recombination, segregation, selection, and evaluation. Traditional as well as molecular breeding require time and effort to sort through the germplasm base and assemble and develop advanced-generation germplasm lines with the desired traits. After the first cultivar release, additional releases with further improvements follow rapidly, as many undesirable gene combinations have been eliminated. Texas AgriLife Urban Solutions Center has released many cultivars that have dominated the marketplace.

Tissue Culture of Major Turfgrasses

An efficient plant tissue culture system is the basis for genetic engineering of turfgrass species. Researchers will establish standardized plant callus initiation and maintenance, as well as plant regeneration protocols. Initially focused on zoysiagrass and creeping bentgrass, research will be expanded to include other grasses.

Genetic Transformation for Value-Added Traits and Varietal Improvement

Genomic and cellular tools allow scientists to genetically modify and/or engineer turfgrass species for characteristics like tolerance to environmental stress (drought, salinity, extreme temperatures), resistance to insects and pathogens, competitiveness against weeds, and nutrient uptake efficiency. Tissue culture and genetic transformation for zoysiagrass and creeping bentgrass are in the advanced stages at the Texas AgriLife Research Center Dallas.

Concerns about the ecological impact of transgenic plants have resulted in the cautious use of this technology. Some concerns are that cross-pollination with a wild relative may result in the introduction of the transgene into perennial weedy species, “auper-weeds.” Efforts on genetic modification of turfgrasses have been limited to laboratories and greenhouses and are yet to be commercially exploited.

http://AgriLifeResearch.tamu.edu
Establishing a Gene Containment System

Practical and regulatory considerations necessitate adoption of gene-containment approaches for both pollen and seed. AgriLife Research scientists plan to develop a gene containment system to suppress or eliminate the migration of transgenes across populations through pollen flow and seed dispersal. Some elite transgenic lines of zoysiagrass and creeping bentgrass have been transformed with a gene containment system; transformed plants of creeping bentgrass are being evaluated in field trails.

Marker-assisted Breeding

Traditional methods of selective breeding are based on visual assessment of phenotypic characteristics that are easy to identify and score, but these may be masked or altered by environmental effects. Molecular techniques for analyzing variations present in DNA enable breeders to quickly choose superior plants through the development of molecular markers and identification of quantitative trait loci. Marker-assisted breeding/selection programs identify and isolate specific native genes controlling agronomically important traits and associated molecular markers to tag and track native genes. To achieve this, scientists will use synteny, which is based on the co-linearity of genetic markers wherein information generated in major monocots such as rice, wheat, sorghum, and barley will be used to recruit molecular markers in turfgrasses.

Screening for Major Biotic and Abiotic Stresses

AgriLife Research scientists are creating biotic and abiotic stress screening techniques for accurate phenotyping of the transgenic and nontransgenic material for insects and mites, diseases, and drought and salinity tolerance.

Texas AgriLife Urban Solutions Center Dallas

The Texas AgriLife Urban Solutions Center in Dallas has many strengths, including those outlined here:

- **Germplasm Repository**  The Texas AgriLife Urban Solutions Center has an extensive collection of genetically diverse zoysiagrass (*Zoysia spp.*) plants (ca. 900 unique accessions), the largest collection in existence. Other turfgrass species in the germplasm repository are St. Augustinegrass, creeping bentgrass, and Texas bluegrass.

- **Knowledge in Turfgrass Breeding and Genetics**  Turfgrasses, mostly being open-pollinated and higher polyploids, are genetically complex. Scientists at the Texas AgriLife Urban Solutions Center have broad knowledge and extensive experience in diverse scientific disciplines involved in turfgrass development.

- **Turfgrass Genetic Transformation**  AgriLife Research’s efforts to develop genetically modified turfgrasses are in mature phases of development and follow a systematic and comprehensive approach at the molecular level by utilizing proven techniques in identification, isolation, insertion, and implementation to capture genetic traits of interest.

- **Turfgrass Market**  Texas AgriLife Urban Solutions Center Dallas has released many cultivars that have dominated the marketplace and are widely used, worldwide.

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