Turfgrass Genetic Engineering and Functional Genomics

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We developed a very reliable system of genetic engineering for turfgrass, transferred multi-gene in plants, and tested transgenic plants for herbicide and disease resistance. A genetic engineering system for creeping bentgrass transformation was initially developed using a marker *gus* gene to determine successful gene incorporation. Then, herbicide (bialaphos or glufosinate) resistant turfgrass was generated using herbicide resistant *bar* gene in transformation experiments. Extensive studies using bialaphos and glufosinate discovered that these herbicides also have fungicidal properties. It was found that herbicidal spray on herbicide resistant transgenic creeping bentgrass could prevent simultaneously the growth of weeds as well as the fungal infection caused by *Rhizoctonia solani* (brown patch) and *Sclerotinia homoeocarpa* (dollar spot). Furthermore, a chitinase gene (antifungal protein) isolated from a Dutch elm disease resistant American elm (*Ulmus americana*), cloned and characterized in our laboratory, was also transformed into creeping bentgrass. Expression of the chitinase gene in creeping bentgrass is expected to promote disease control against fungal pathogen via chitin degradation. It was concluded that bialaphos may provide a means for the simultaneous control of weeds and fungal pathogens in turf areas with transgenic bialaphos-resistant creeping bentgrass, and in combination with the efficient transformation system, chitinase gene may be used to provide significant protection against fungal infections in grasses.

The ongoing research is to develop insect resistant, cold resistant, and discover drought tolerance and disease resistant genes via Microarray robotics techniques.

A recently developed highly powerful technology "DNA Microarray" is being used to identify large number of plant genes with a wide variety of functions such as genes for developmental regulation, genes controlling plant morphology, abiotic stress-induced genes and genes for disease and insect resistance. This technology has the potential to be highly effective for discovering those actual turfgrass genes that function under induced conditions for tolerance to abiotic stress factors, diseases, etc.

There are two fold uses for these novel bentgrass genes, i.e., one, as actual turfgrass defensive genes, these genes can be used to genetically engineer susceptible turfgrasses; second, these novel genes can be used as molecular probes to track their presence in other turfgrasses in breeding programs. In case of turfgrass, one can discover a relatively large numbers of turfgrass stress related genes using molecular genetics data bases discovered in other plants such as *Arabidopsis*, rice or maize. It is decided to identify the genes in bentgrass whose expressions are induced by drought or by *R. solani* or *S. homoeocarpa*. These genes will be isolated from bentgrass cDNA libraries and characterized. Identified genes as being potential candidates for drought tolerance or disease resistance will be used for future studies in developing disease resistant turfgrass via genetic engineering.

Dr. Sticklen's team is the only team at Michigan State University (MSU) that performs molecular genetics of turfgrass. After discovery of the proposed genes, we will establish collaboration with MSU turfgrass breeders, pathologists, and physiologist for using those genes in transformation studies, in turfgrass breeding program, in stress physiology studies, and in pathology studies.

PUBLICATIONS:

1. Chai, B., Hajela, R. K., Green, D., Vargas, J. M., Warkentin, D., Sabzikar, R., Maqbool, S. B., **Sticklen, M. B.** 2001. Engineering fungal resistance in creeping bentgrass (*Agrostis palustris* Huds.) with a chitinase-like cDNA clone from Dutch elm disease resistant triploid elm (*Ulmus Americana)* NPS-3-487. Molecular Breeding (Submitted).

2. Chai, B. and **Sticklen, M. B.** 1998. Application of biotechnology in turfgrass improvement. Crop Sci. 38:1320-1338.

3. Hajela, R. K., Graham, L. S., and **Sticklen, M. B.** 1993. Nucleotide sequences of a cDNA encoding a chitinase like polypeptide from American elm (Ulmus americana). Announcement Section. Plant Mol. Biol. 23:915.

4. Warkentin D., Chai, B., Liu, C. A., Hajela, R. K., Zhong, H. and **Sticklen, M. B.** 1998. Development of transgenic creeping bentgrass (*Agrostis palustris* Huds.) for fungal disease resistance. In: M. B. Sticklen and M. Kenna (eds). Turfgrass Biotechnology: Cellular and Molecular Genetic Approaches to Turfgrass Improvement. Ann Arbor Press. pp. 153-161.

5. Zhong, H. and **Sticklen, M. B.** 1993. Transgenic plants of turfgrass (*Agrostis palustris Huds*) from microprojectile bombardment of embryogenic callus. Plant Cell Rep. 13:1-6.

6. Zhong, H., Liu, C. A., Vargas, J., Penner, D. and **Sticklen, M. B.** 1998. Simultaneous control of weeds, dollar spot, and brown patch diseases in transgenic creeping bentgrass. In: M. B. Sticklen and M. Kenna (eds). Turfgrass Biotechnology: Cellular and Molecular Genetic Approaches to Turfgrass Improvement. Ann Arbor Press. pp. 203-210.