Biotechnology And Turfgrass Research: A Glimpse Into The Future

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USED IN GOLF course applications, biotechnology holds great promise for improving plants, especially turfgrass. Simply stated, plant biotechnology involves the interaction of various biological sciences to create technologies that can genetically improve plants, multiply superior genotypes, create new methods for plant pest control, and enhance plant nutrition.

Some of the more important problems of golf course turf are related to the available sites. The challenge is to develop superior turfgrasses that can be managed for quality condition even with adverse weather conditions, poor soil, subsurface problems, and low water quality. Turf varieties are needed that will perform well with minimal irrigation as well as adapt to the unique topography created by the golf course design. Yet, turfgrasses must withstand the wear of golf carts and demanding conditions of play. These problems, coupled with high maintenance standards and the need to control operational costs, place a burden on the golf course superintendent and maintenance staff, as well as on golf course architects and green committees.

New approaches, made possible by scientific advances in plant biotechnology, provide opportunities to solve some of these problems. By maintaining healthy relations with the U.S. Golf Association and the Golf Course Superintendents Association of America, research scientists in biotechnology laboratories can better understand how to create the new plant materials and products to improve golf course quality and management.

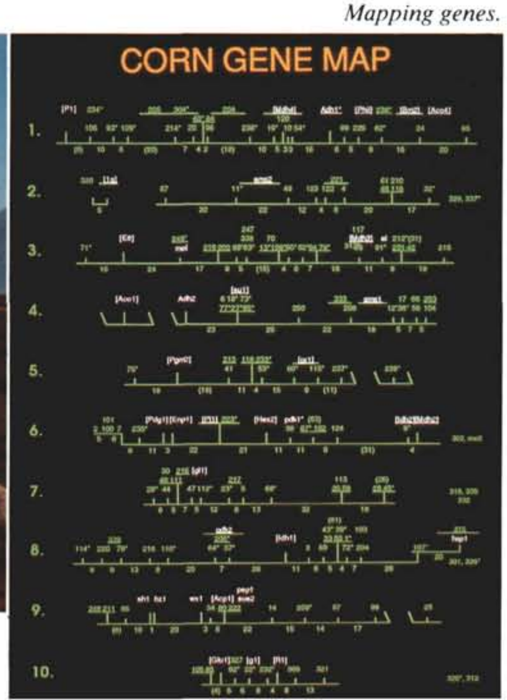
Tissue Culture Technology

Plants with superior genetic qualities can be multiplied by cloning to produce millions of plants of identical genetic constitution. *Figure 1* shows an elite red rose that has been multiplied *in vitro* to produce a potted plant capable of flowering just a few months after being initiated in the tissue culture process. Using the same cloning process, it is possible to multiply selected grass genotypes to produce a superior parental population for seed production.

Taking the technology one step further, it is possible to select somatic variants for stress tolerance in a cell-

This new golf course will be seeded to six different grasses. Tough sites need better plants.

Mapping genes.



suspension culture containing the appropriate balance of growth hormones, energy, and nutrient minerals. Somatic variants can be developed that are resistant to salinity, drought, and temperature stress. The *in vitro* selection process involves placing varying intensities of stress-creating materials into the growth-promoting culture solution to eliminate cells that are less tolerant to the stress factor and regenerating whole plants from the surviving cells.

Molecular Biology Technology

It is now possible to apply DNA restriction fragment length polymorphism (RFLP) technology to accelerate plant breeding by developing molecular markers for desired traits and using the markers to follow these traits in subsequent segregating generations. Selection of superior genetic combinations can be guided by laboratory research in combination with a computer data base and field observations. The RFLP patterns can also serve as a fingerprint to identify specific plant genotypes and thus protect patented turf varieties from infringement by those who would misrepresent them as their own, or substitute a lower quality material in place of the patented variety. NPI has recently shown that the RFLP technology can be used to differentiate among Lofts Seed Company's perennial ryegrass proprietary varieties. Thus, the RFLP technology is a means of protecting patented turfgrass varieties as well as providing quality control to assure buyers that they will receive the quality features they expect when they buy a named turf variety. The RFLP technology also serves to locate the genes (DNA) for superior qualities to be transferred into desired plant varieties.

Chemicals are already on the market, and new ones are being developed to control plant growth and maturity as well as turf growth and color. However, with new techniques now being developed in biotechnology, many desired growth characteristics, such as dwarf size and stoloniferous habit, may be transferred to existing varieties by recombinant DNA methods.

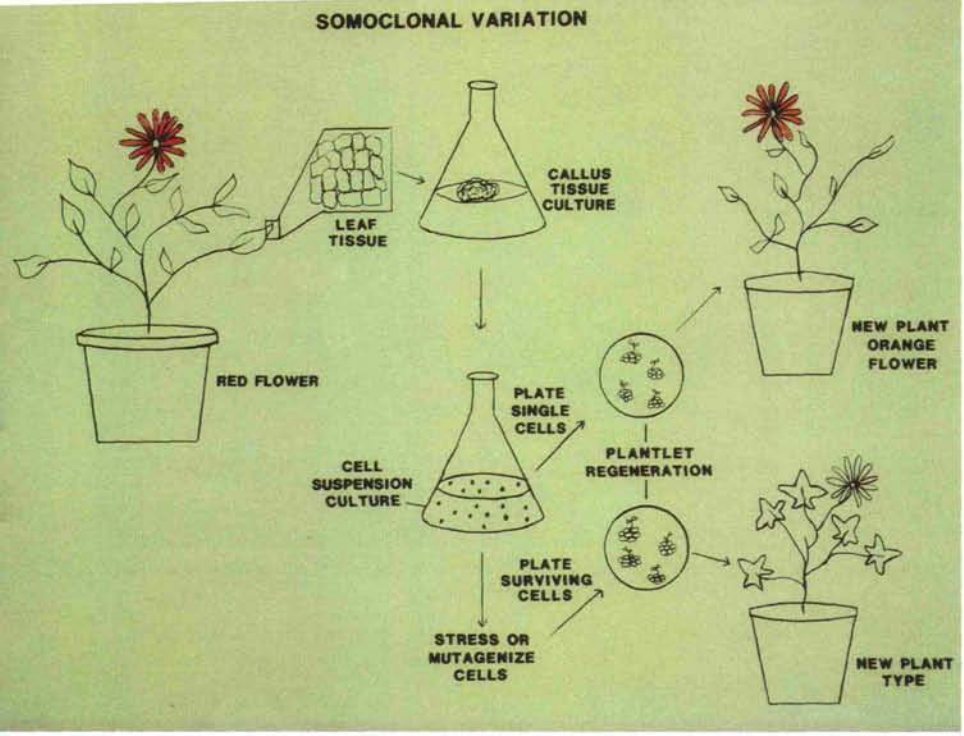
Soil Inoculants and Biological Fertilizers

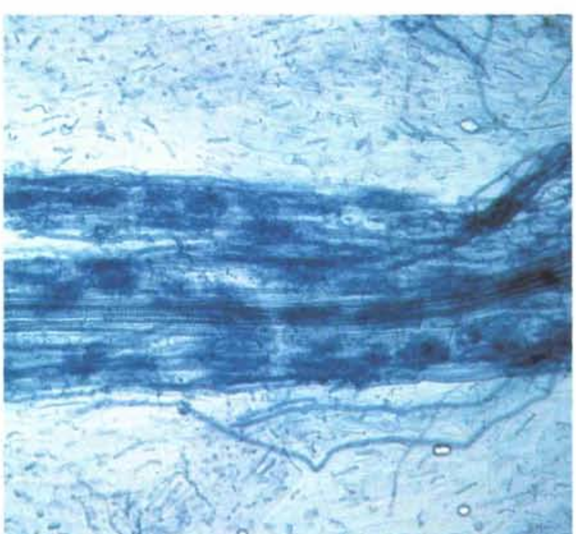
The plant biotechnology industry is looking forward to new methods of manipulating biological nitrogen fixation and phosphorus nutrition in turfgrass species as a means of reducing

(Below) In-vitro cloning of an elite rose. (Bottom, left) The final product — a living, potted rose in its own package. (Bottom, right) Tomato breeding for high solids, insect resistance and stress tolerance.

Opposite page: (Top, left) Genetic improvement via somatic variation and selection; how it's done. (Top, right) A chrysanthemum variant. (Center, left) A natural, high-salinity selection. In-vitro tissue culture does the same thing in less time. (Center, right) Mycorrhizae mycelium in the soil provides an additional system for water and nutrient uptake. (Bottom, left) A microscope view of root with mycelium growing into it. (Bottom, right) A citrus seedling bed showing non-inoculated versus inoculated plants.

Figure 1.


SOMOCLONAL VARIATION
LEAF TISSUE
CALLUS TISSUE CULTURE
RED FLOWER
NEW PLANT ORANGE FLOWER
PLATE SINGLE CELLS
CELL SUSPENSION CULTURE
PLANTLET REGENERATION
PLATE SURVIVING CELLS
STRESS OR MUTAGENIZE CELLS
NEW PLANT TYPE



(Above, left) Root system with and without mycorrhizae.

(Above, right) Natural chemicals in plants may give protection from insects.

(Left) A larva that has eaten a natural chemical has its ability to molt disrupted.

maintenance costs and improving turf quality. An inoculant of endomycorrhizae, a beneficial root symbiont that enhances phosphorus uptake, improves water use, and aids in disease resistance is just coming on the market. The extensive hyphae of endomycorrhizae proliferate in the soil in the immediate vicinity of most plant roots and grow into the cortex cells of the root system. Thus, the mycorrhizae serve as an adjunct to root hairs in providing an additional conduit system for nourishing a plant. Current tests with tree seedlings, shrubs, and herbaceous plants show that inoculation with the NPI mycorrhizal product, Nutri-LinkTM, produces a seedling plant twice the size and vigor of non-inoculated plants. Because turf grasses are also able to interact with endomycorrhizae, the new product should find application in selected golf course management situations where fungicides are not used in excess.

Biological Pesticides

New strategies will be available soon to control plant pests biologically with naturally-produced plant chemicals that are insect specific and pose no human safety problems. One example is azadirachtin, a chemical extracted from the neem tree, a native of India. Ingested in small quantities, the chemical serves as an antifeedant, but when it is eaten in larger quantities, the chemical disrupts the synthesis of chitin, the material used by the insect to produce its exo-skeleton. The chemical functions, therefore, as an insecticide by preventing the insect from reaching its next stage of growth and stopping further consumption of plant material. It has no effect on human physiology and will be safe in human environments.

Research is underway in many commercial biotechnology laboratories to transfer genes from the bacteria *Bacillus thuringiensis* (Bt) into plants that will prompt them to produce their own natural systemic insecticide.

Current research and development in plant biotechnology may sound like something out of the future, but each of these ideas is being developed in plant biotechnology laboratories here in the United States. In fact, many are subjects of research projects in NPI laboratories.

The question of applying biotechnology techniques to serve the needs of golf is a matter or priorities. At present the major agricultural crops provide a significant incentive for application of biotechnology to create improved plants and products that can reduce the costs of production. Although biotechnology research costs are high, many are being paid by investors in the biotechnology companies who believe new agricultural products will return a profit from their investments. In the future it will be possible to apply biotechnology techniques to the solution of turfgrass problems once the process of learning how to use them has gone through the first cycle. However, a few well-placed projects at the present time, costing no more than the price of irrigating a golf course in the Southwest, could immediately encourage research applications to develop plants and products useful for golf courses.