Milestones of the USGA Turfgrass and Environmental Research Program

For decades, USGA research funding has provided the means for turfgrass scientists to achieve noteworthy accomplishments.

BY GREEN SECTION STAFF

In any endeavor, it is necessary to look back periodically and evaluate progress. Although the United States Golf Association has been funding turfgrass research since the 1920s, today's golf courses reflect a level of management not even imaginable at that time. Huge advancements have been made in both the technology and science of turfgrass management. That progress is due directly to a key role the USGA has played funding research for several decades. When assessing the progress of the USGA Turfgrass and Environmental Research Program over the last 30 years, several notable accomplishments stand out.

WATER CONSERVATION

The USGA has been a leader in supporting university research to determine how much water our major golf course turfgrasses use. The amount of water a turfgrass uses each day or week is the combination of what evaporates from the soil and what moves (or transpires) through the plant. This combined amount is called evapotranspiration or ET. In the 1980s and '90s, research supported by the USGA started the process of determining ET rates for turfgrasses used on golf courses (see Table 1).

Today, work continues on how turfgrasses respond to periods of drought and the minimum amount of water needed to maintain quality playing conditions. For example, scientists at Oklahoma State University and Texas A&M University have demonstrated that bermudagrass can survive on 60 percent of estimated ET during the summer. Maintaining turfgrass quality and performance using a fraction of the daily or weekly ET is an important water conservation method.

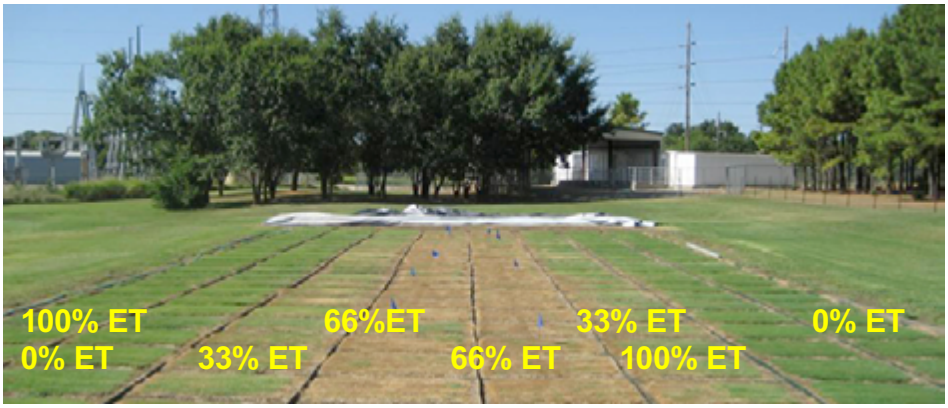

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Table 1. Relative Ranking of evapotranspiration rates for the most commonly used cultivars of the major cool- and warm-season turfgrasses*

Relative Ranking	ET Rate (mm/day)	ET Rate (in./week)	Cool-Season	Warm-Season
Very low	< 6.0	< 1.7		Buffalograss
Low	6.0 -7.0	1.7 to 2.0		Bermudagrass hybrids Centipedegrass Bermudagrass Zoysiagrass, Meyer Blue Grama
Medium	7.0 - 8.5	2.0 to 2.3	Hard fescue Chewings fescue Red fescue	Bahiagrass Seashore paspalum St. Augustinegrass Zoysiagrass, Emerald
High	8.5 - 10.0	2.4 to 2.8	Perennial ryegrass	
Very high	> 10.0	> 2.8	Tall fescue Creeping bentgrass Annual bluegrass Kentucky bluegrass Italian ryegrass	

*Grown in their respective climatic regions of adaptation and optimum culture regime. Cultural or environmental factors that cause a drastic change in leaf area or shoot density of a given species may result in a significant shift in its relative ranking compared to the other species.

Adapted from Beard et al. January 1989. Green Section Record.

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Inland saltgrass is native to the Western United States and survives with infrequent rainfall and soils high in salts. The research at Colorado State University has developed several lines of inland saltgrass with both salt and drought tolerance.

Dr. Paul Raymer, University of Georgia, continues to breed for improved cultivars of seashore paspalum that can be used on salt-affected golf courses. (Photo courtesy of University of Georgia).

The USGA has provided leadership working with scientists to provide important publications on water quality and quantity issues for turfgrasses, and since the 1970s, the USGA has encouraged the adoption of recycled water use for golf course irrigation. In the 1993, the USGA cooperated with allied golf associations on the book Wastewater Reuse for Golf Course Irrigation. More than 15 percent of golf courses now use some form of recycled water, which will continue to be an important source of water for golf courses in the future. When managed correctly, recycled wastewater can provide excellent playing conditions.

PESTICIDE AND NUTRIENT FATE

This USGA-funded research effort was the first extensive self-examination of golf's impact on the environment. What has the research told us? The research shows that under most conditions, the small amounts of pesticides and nutrients that move from golf course turf and soils were found at levels below the health and safety standards established by the U.S. Environmental Protection Agency (EPA).

The fate and transport research provided extremely valuable information and resulted in several important publications. The first comprehensive book was published in the early 1990s on Golf Course Management and Construction: Environmental Issues. After ten years of research, the USGA and American Chemical Society (ACS) published a summary of research results in The Fate and Management of Turfgrass Chemicals. In 2008, the USGA cooperated with the Council for Agricultural Science and Technology

Results of numerous USGA-funded nutrient and fate studies have shown that best management practices can greatly minimize the amount of pesticide and nutrients reaching surface waters surrounding the golf course.(Photo courtesy of Dr. Kevin King, USDA Agricultural Research Service).

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With mounting pressure to ban pesticides, the USGA support of integrated pest management (IPM) projects leads to more effective management of diseases such as dollar spot, shown above. This research demonstrated that IPM could reduce pesticide use while providing quality playing conditions and, more important, demonstrated a no-pesticide program resulted in damaged putting greens.

(CAST) on the book Water Quality and Quantity Issues for Turfgrasses in Urban Landscapes, which summarizes pesticide and fertilizer fate and includes chapters on turfgrass water usage. The USGA is still working cooperatively with universities and the U.S. Department of Agriculture on nitrogen and phosphorous runoff, as well as quantifying the amounts of these nutrients that move through subsurface drain tiles and methods to reduce the amount released into surface waters.

TURFGRASS INFORMATION CENTER AND TGIF

The Turfgrass Information File (TGIF) is hosted at the Turfgrass Information Center located in the Michigan State University Library in East Lansing, Michigan. This important resource allows the industry access to the largest collection of turfgrass information in the world — both the physical collections and electronic database. This important resource has more than 200,000 records, with more than a million database searches conducted annually. More than 50 percent of the records are linked to the full-text item on the internet, including the Green Section Record that was accessed more than 3,000 times per day in 2011. There are more than 60 university subscribers worldwide that use TGIF, and ten organizations (e.g., Golf Course Superintendents Association of America, Sport Turf Managers Association, Turfgrass Producers International, and others) have agreements for their members to access TGIF.

PUTTING GREEN CONSTRUCTION

Putting green construction research provided new information about alternative methods of construction, testing procedures (which led to a soil laboratory certification program), the effects of poor irrigation water on putting green rootzones, as well as testing a wide range of organic and inorganic amendments. The results provided valuable information and resulted in a revision of the USGA's Recommendations for a Method of Putting Green Construction in 2004. The changes help to make the construction of USGA greens less expensive and less complicated. The reader is encouraged to visit the Course Care section of the USGA website to view the recommendations in their entirety.

TURFGRASS BREEDING

Throughout the history of the Green Section, turfgrass breeding research with universities and the U.S. Department of Agriculture has led to improvements in the major turfgrasses used on golf courses. For example, the USGA has sponsored research in Georgia since 1946 and at Rutgers University since 1960. In 1983, the USGA significantly increased funding for turfgrass research, and due to heat and drought across the country, an emphasis was placed developing grasses that tolerate periods of extreme heat and drought, as well as warm-season grasses that are better adapted to cold temperatures. Major improvements in creeping bentgrass, perennial ryegrass, and Kentucky bluegrass resulted due to financial support from the USGA. New bermudagrasses such as Riviera and Patriot have better cold tolerance and earlier green-up in the spring. New zoysiagrass cultivars were developed that established faster to help speed up sod production (see Table 2).

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Table 2. Summary of turfgrass cultivars developed by universities receiving USGA funding.

Turfgrass	University	Cultivars or Varieties
Creeping Bentgrass *Agrostis stolonifera var. palustris*	Texas A&M University University of Rhode Island Pennsylvania State University Rutgers University	Crenshaw, Cato, Mariner, Century, Imperial, Backspin Providence Pennlinks Heat-tolerant and dollar-spot-resistant parental lines under development
Colonial Bentgrass *Agrostis tenuis*	DSIR-New Zealand and University of Rhode Island	BR-1518
Bermudagrass *Cynodon dactylon* *C. dactylon X C. transvaalensis*	New Mexico State University Oklahoma State University University of Georgia	NuMex Sahara, Sonesta, Primavera, Princess Two seeded types: Yukon, Riviera Three vegetative types: Patriot, Northbridge, Latitude 36 Tifton 10, Tifsport, Tifeagle, Tifgrand
Buffalograss *Buchloe dactyloides*	University of Nebraska	Four vegetative varieties: Legacy, Prestige, 609, 315, 378 Three seeded varieties: Cody, Tatanka, Bowie Vegetative NE 95-55 under evaluation
Alkaligrass *Puccinellia sp.*	Colorado State University	Ten improved families developed
Blue grama *Bouteloua gracilis*	Colorado State University	Elite, Nice, Plus, Narrow populations developed
Fairway Crested Wheatgrass *Agropyron cristatum*	Colorado State University	Narrow-leafed and rhizomatous populations developed
Curly Mesquitegrass *Hilaria belangeri*	University of Arizona	Fine and Roadside populations developed and made available for further improvement
Annual bluegrass *Poa annua var. reptans*	University of Minnesota Pennsylvania State University	DW-184 (MN#184) Several promising lines, but nothing released due to seed production problems
Zoysiagrass *Zoysia japonica* *Z. matrella*	Texas A&M University	Diamond, Cavalier, Crowne, Palisades
Inland Saltgrass *Distichlis spicata*	Colorado State University University of Arizona	Vegetative A-49, A-50, A-138 considered for release Seeded varieties being developed
Seashore Paspalum *Paspalum vaginatum*	University of Georgia	Vegetative Seaisle 2000, Seaisle I, Seaisle Supreme Seeded Seaspray More seeded and vegetative cultivars nearing release

In April 2010, *National Geographic* published a special issue on water that stated, "A humble turfgrass has won the golf trifecta, earning raves from duffers and greenkeepers as well as environmentalists." They were referring to seashore paspalum, which has rapidly gained acceptance for use on golf courses with poor-quality irrigation water. USGA-sponsored development of improved seashore paspalum cultivars is a positive step in addressing the need for turfgrasses that can grow in warm, coastal climates with irrigation water high in salts.

WILDLIFE LINKS

The Wildlife Links Program was conducted by the USGA in cooperation with the National Fish and Wildlife Foundation. This cooperative program funded more than 20 projects conducted by wildlife biologists. More important, the research provided a better understanding of how pollinators, birds, fish, reptiles, and mammals use golf courses and their surrounding habitats. Much of this work led to important scientific publications and books to help golf course superintendents interested in improving the wildlife habitat on their golf facilities. Bird Conservation on Golf Courses, Making Room for Native Pollinators, and Wildlife Links: Improving Golf's Environmental Game are just a few of the publications that resulted from this research effort.

INTEGRATED TURFGRASS MANAGEMENT

Several outstanding studies were funded regarding the stress tolerance of turfgrasses to drought, heat, cold, and salinity. This research provided information on how plants survive

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Several strategies for biological control of turfgrass pests were investigated including the ability of parasitic wasps to control populations of scarab beetle larvae (grubs). (Photo courtesy of Dr. Daniel Potter, University of Kentucky).

periods of stress, as well as identifying techniques that plant breeders used to improve grasses for stress tolerance. Cultural practice research helped to improve the firmness and playability of golf surfaces through thatch management and sand topdressing programs. Potential biological pest controls to help reduce the use of pesticides were evaluated, and some biological control strategies were introduced to the golf course industry. In addition, several studies were conducted to develop Integrated Pest Management (IPM) strategies for turfgrass disease and insect problems. Implementation of proven IPM programs often reduces pesticide usage, making the golf course environmentally sustainable and more economical to maintain.

TURFGRASS BIOTECHNOLOGY

Valuable advances have been made in the area of turfgrass biotechnology. The USGA has been a leader in supporting land-grant universities in an effort to learn more about genetic modification techniques, marker-assisted selection, genetic maps, and gene sequencing. In 1998, *Turfgrass Biotechnology: Cell and Molecular Genetic Approaches to Turfgrass Improvement* summarized conventional and molecular plant breeding and physiology. The hope was that this basic research effort would provide valuable tools and information for university and commercial turfgrass breeders in the future. For instance, the discovery of how genes control drought tolerance and pest resistance would help produce better turfgrasses for golf that require fewer inputs such as irrigation water and pesticides.

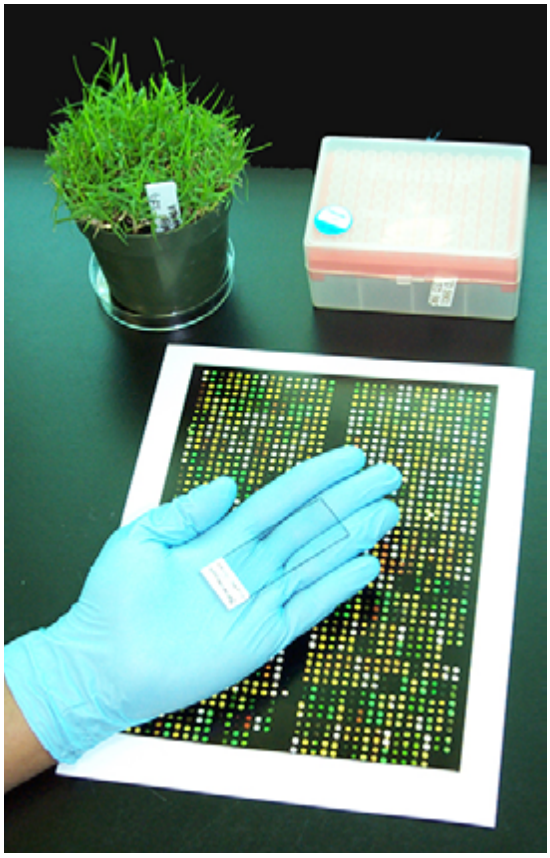
USGA PUBLICATIONS

The USGA provides research information and advice free to the public through the internet. Articles on the Course Care section of USGA website or in the Green Section Record, USGA Research Summaries, and USGA Turfgrass and Environmental Research Online (or USGA TERO) keep golf course superintendents and other interested turfgrass managers, as well as the academic community, abreast of the results from studies funded by USGA. There are more than 240 articles available in USGA TERO. The articles have a short summary at the beginning and links to records of other popular trade and scientific publications contained in the Turfgrass Information File.

FUTURE EXPECTATIONS

By funding the research necessary to achieve these and other milestones, the USGA has led the way in providing the outstanding playing conditions on today's golf courses — the primary factor for the enjoyment of millions of golfers worldwide. Those conditions are a direct result of the hundreds of USGA research projects conducted over nearly a century. Although the future will demand a high level of course conditioning using fewer inputs, USGA-funded research will continue to provide the knowledge to make that possible.

The USGA research program will continue a rigorous evaluation of natural resource and energy consumption, as well as supporting the development of new turfgrass cultivars and the integration of new technologies. Best management practices that are economically sound and maintain a balance between established practices and environmental sustainability will be developed. The primary focus will be on turfgrass and environmental research efforts on pesticide and nutrient fate, protection of water quality, and water conservation.



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