

EXECUTIVE SUMMARY TO THE USGA - NOVEMBER 1990

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Superior salt and water deficit-tolerant turfgrass lines are needed for marginal planting sites, or irrigated sites where salt build-up is likely to occur. Effective selection of stress-tolerant genotypes is extremely complicated in the field due to environmental interactions that sometimes mask stress tolerance traits. Controlled environments can provide a more uniform test environment, to permit efficient germplasm prescreening and selection prior to scale-up for field evaluations.

As part of this turfgrass research program, comparative, parallel studies to elucidate multiple symptoms of salt tolerance in warm and cool season turfgrasses have been completed in both solution culture and whole plant microculture. Plants are monitored from the small plug or seedling stage through an extended test period, to elucidate adaptations in both the root and shoot zone to increasing salt levels over time. Video image analysis uses a video camera and microcomputer to capture detailed, quantitative spatial [height, shoot area, root length and area] and spectral [visual density, color index] data on grass performance, and since the technique is completely non-destructive, plants can be effectively monitored as they adapt over time. The turfgrass responses to salt stress in both the in vitro and in vivo culture systems have shown excellent correlation, and have aided identification of key growth responses to stress, levels of salt that induce growth reductions, and timing before stress symptoms are evident. The objective visual data collected rapidly through image analysis has proven to be in strong agreement with conventional growth analysis of the treatments (the latter requires destructive sampling and dry weight measurement of plants). The experiments initiated in 1988 and 1989 were repeated in late 1989 and 1990 to provide additional replication of the experimental system data.

In whole plant microculture, additional tests have separated the response characteristics of grasses when "shocked" by transplant to salt-supplemented sites, and when gradually adapted to those same salt concentrations. Evaluation of the recovery of the in vitro grass samples from salt stress is evaluated after they are transplanted back to non-salinized control media. The microculture stress-tolerance screens can be conducted on a smaller scale than field or greenhouse tests, do not require the high maintenance of growth chambers, and can be rapidly accomplished on a year-round basis. The tests will next be extended to novel selections which have been first screened for salt tolerance at the cell level, then regenerated into whole plants. This intermediate whole plant microculture step is an effective prescreen to determine whether cell-level traits are actually expressed in whole turfgrass plants.

ANNUAL RESEARCH REPORT TO THE USGA - NOVEMBER 1990

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SUMMARY OF ACCOMPLISHMENTS, 1990

Parallel Screening Tests for Selected Turfgrasses Completed

Greenhouse stock plants from 3 turfgrass species (bermudagrass, bentgrass, and St. Augustinegrass) were successfully adapted for solution culture and whole plant microculture (WPMC) test environments. The growth and developmental responses (spatial and spectral changes in quality) and physiological adaptations to saline stress were constantly monitored over the course of each screening test using non-destructive video imaging methods. These completed tests were able to accurately separate salt tolerant and susceptible grass selections using some of the same measurement parameters (including osmotic adjustment) used in field or greenhouse tests by other researchers. Additional detailed and quantitative analysis of foliage color and plant density were also provided. Rigorous cross-comparison of conventional growth analysis data (including DW, RGR, R/S ratio, etc.) and the non-destructive imaging data have conclusively demonstrated that the latter can be effectively substituted during turfgrass evaluations, to increase test efficiency and follow the gradual development of symptoms. Image analysis of growth responses also followed the same trends as osmotic adjustment of turfgrass leaf cells under saline stress. Root growth responses and color change induced under salinized conditions were more distinctive in the in vitro tests than in solution culture, and usually observed earlier in the salt tests, at lower levels of salt. These results indicate that salt sensitivity in vitro (at least in terms of roots and color) is more acute than in nature.

Bermudagrass was less easily adapted to culture in vitro than other grass species tested. In order to establish vegetative stands in microculture, a low level of cytokinin was initially used to stimulate proliferation. After several rounds of subculture, the bermudagrass populations adapted to culture and could be successfully used in salt adaptation, salt shock, and recovery tests.

Results from these comprehensive screening tests were presented this year as part of two invited presentations entitled "Alternative Strategies for Salt Tolerance Selection", at Purdue University (March, 1990) and Eastern Illinois University (April, 1990).

Adaptations to Enhance WPMC Screening Tests

In order to further evaluate the efficacy of WPMC for turfgrass prescreening, some adjustments in methodology were implemented after the above germplasm comparisons. Since the root growth was sometimes more stunted in vitro at high salt levels than in solution or greenhouse tests, some alternatives to the traditional agar or gelrite-solidified tissue culture media were tested. For example, sterile screens mounted on posts were inserted into tissue culture vessels filled with liquid salinized growth media. Solidified medium mimics natural soil (salt must diffuse to roots), whereas salts are more rapidly delivered to the root zone in liquid culture. Roots in liquid culture did not encounter any resistance from a solidification agent, but were less easy to evaluate due to the presence of the screens. Alternatively, use of a lower gelrite concentration provided a softer matrix for root growth, and maintained the ease of root zone evaluations.

Future Goals:

Now that the merit of the whole plant microculture screen has been demonstrated with identified, field selected salt tolerant and susceptible grass genotypes, testing of novel selections from in vitro cell culture can be implemented. Although salt-tolerance in callus cultures has been heavily researched in several non-turf crops, often those same salt tolerance traits are not evident under field conditions in whole plants. Cell level screens are advantageous since the selection is very rapid and numerous salt-tolerant lines can be isolated, but scale-up to field testing is extremely inefficient, since regenerated plantlets must be vegetatively bulked-up or cross-bred before sufficient populations are available for replicated field testing. Since many of the putative salt tolerant cell lines will not demonstrate whole plant tolerance to salt, tremendous expense may be incurred, and time consumed, to complete this phase of the research. We plan a 2-phase screening system, including selection of putative salt-tolerant cell lines in callus cultures and plant regeneration, followed by rescreening regenerated plantlets in whole plant microculture. The intermediate whole plant microculture screen (with all of the control and small scale advantages of in vitro culture) will weed out undesirable lines and isolate only whole plants that still demonstrate stress resistance traits. These can be advanced to greenhouse or field tests with a high degree of confidence that salt tolerance will be expressed in vivo. Again, the system features visible root and shoot zones throughout the course of the test, the ability to evaluate quantitatively without disturbing growth, the ability to test a greater range of salt formulations and concentrations without the expense and limitations of field, greenhouse, or growth chamber plots, and the ability to evaluate both the adaptation of grasses to gradual salt buildup, and the shock response of turfgrasses transplanted directly from standard to saline medium.

This procedure is easily adapted to screening for other stress tolerance characteristics. We have already completed preliminary work evaluating water-deficit tolerance and disease resistance using whole plant microcultures, and again evaluating the complex responses of the whole plants with video image analysis. The work is designed to lead to selection of low-maintenance, stress tolerant lines, towards realization of minimal cultural systems in turfgrass maintenance.

Current project status:

A student with a strong turfgrass and plant physiology background was recruited last year to expand on this project and to begin a program in September, but unfortunately decided at the last minute not to attend UI. This created a temporary "hole" in the project. This year's experiments have been completed by the PI, with partial technical support from a college research scholars program. We have been fortunate to attract the talents of another new student (funded from a different source), and are currently striving to recruit a new, motivated and dedicated individual to devote research efforts to this project exclusively.

ANNUAL PROJECT REPORT

1989-90

USGA TURFGRASS INFORMATION FILE

Turfgrass Information Center
Michigan State University Libraries

In the spring of 1984, the USGA and Michigan State University signed an agreement whereby the MSU Library would design and develop a computer-based bibliographic database to provide access to published materials reporting the results of research that affects turfgrass and its maintenance. The project began on March 1, 1984. At the end of the 1990 project year on January 31, 1991, the project will have been funded to the amount of \$484,326. This report will highlight the current statement of goals and objectives in effect for the period of this report, with comments, reports of accomplishments and anticipated results in italics.

GOALS AND OBJECTIVES

The purpose of the USGA Turfgrass Information File is to provide efficient and effective access to all published and processed materials reporting the results of research affecting turfgrass and its maintenance. The access will be provided for the research community, for practitioners (such as golf course superintendents), for extension-type services, and for commercial concerns.

Four goals, with their associated objectives, have been identified as necessary for the successful implementation of the Project. These are detailed below:

1. Michigan State University will acquire, maintain, and preserve all appropriate printed and processed materials reporting on research related to turfgrass growth, development, and maintenance.

Michigan State continued to acquire, with university funds, as necessary, all pertinent information on turfgrass research. It is imperative that we receive, on a regular basis, any materials published by institutions, projects, etc. For the rare and unusual titles, the O. J. Noer Foundation continues to provide financial support.

- 1.1 A Librarian will devote part-time each week to the acquisition of materials for the turfgrass collection.

Collection development continues to be a part-time activity of the Project Manager with cooperation from the Science Libraries collection development faculty.

- 1.2 Communication will be maintained with researchers and practitioners to assist in acquiring the variety of materials for the collection and for inclusion in the Project's bibliographic files.

As file users have become better acquainted with database objectives and usefulness, and solicitation efforts have increased, materials have been contributed for processing and addition to the file. Such contributions are particularly important for annual progress reports, theses and dissertations, and unpublished manuscripts. Getting on, and staying on, all relevant mailing lists is sometimes a difficult task. We must all continue to emphasize that it is in the best interests of the discipline, each research institution, and individual researchers to have their citations represented in the database and collection.

- 1.3 Preservation of the O. J. Noer Collection, including binding and microfilming where appropriate, will be undertaken using funds other than those provided by the USGA or received in payment for services rendered by the Turfgrass Information Center (TIC).

No part of the collection requires microfilming at this time. Binding of monographs and serials is a continuing function of the Science Library.

2. Construction of the online index to the turf science literature (USGA TGIF) will continue, including both currently published literature and gradual retrospective processing back to 1972 in order to compliment the Beard Bibliography. TIC will include specific references from pre-1972 sources when such materials are particularly important.

The USGA Turfgrass Information File (USGA TGIF) continues to be constructed and searchable in an Alpha Micro multi-user microcomputer, using the internationally recognized STAR database management software. Addendum I, "Production Statistics," details records added to the file between May 1, 1989 and April 30, 1990. The total of 3,276, well above the intended project annual target and recent rates of production, reflects increased reliance on hourly student labor, particularly for data entry. By October 1990, over 19,000 records were in the bibliographic database.

- 2.1 All turf research monographs and separate reports currently acquired and selected for the O. J. Noer Collection will be indexed, abstracted, and entered into the Project's online retrieval system.

All recent and most historic monographs in the collection have been added to the database, with limited subject access based primarily on chapter headings. A proposed separate database, an interfiled index of "standard turf reference works," could provide detailed access to the limited number of turf books. A file of this type is more appropriate for this material than a bibliographic database such as USGA TGIF. It could be constructed within STAR and alongside USGA TGIF,

given the necessary copyright clearance. In any case, the report literature will always have a higher priority for addition to USGA TGIF.

- 2.2 All turf research articles in the 130 or so primary research journals (e.g. Agronomy Journal, Plant Disease, Crop Science, etc.), technical periodicals (e.g. California Turfgrass Culture, USGA Green Section Record, Journal of the Sports Turf Research Institute, Golf Course Management, etc.), and annual compilations (e.g. Agronomy Abstracts, Proceedings of the Michigan Turfgrass Conference, etc.) will be reviewed regularly to identify relevant articles for addition to the file.

Current published literature is added to the file after processing by TIC staff; older materials are being added to the file on a systematic basis. Emphasis continues on the completion of the 1972-1990 conference proceedings and annual research reports. Skeletal records for trade press articles will continue to be necessary due to competing demands on the limited staff time available.

- 2.3 On a quarterly basis the files and bibliographies of the National Agricultural Library, Commonwealth Agricultural Bureau, FAO, Biological Abstracts, and others will be reviewed and/or computer searched for omissions and for other titles that do not usually report turfgrass research. Articles so identified will be added to the file.

In addition, citation tracing of currently published refereed turfgrass material adds to the comprehensiveness of the file. These file-building techniques have resulted in USGA TGIF citations originating from more than 1,300 different serial sources. In addition, the new availability of CD-ROM versions of AGRICOLA, Medline, and Cambridge Life Sciences Collection within the MSU Science Libraries strengthens our ability to do cost effective citation verification in research reported outside the mainstream turf culture literature.

- 2.4 Simultaneously, index, and as appropriate, abstract golf course maintenance literature, estimated to be about 300 citations per year. Science literature will take priority over retrospective indexing of maintenance literature.

The maintenance literature is added as it "crosses our desk;" it is not sought out for addition to the file in and of itself. Interest in access to this material is particularly high among golf course superintendents and students.

3. Michigan State University will make the online index (USGA TGIF) available to support research, education, and management needs.

- 3.1 Information, including subscriber packets and brochures, will be made available to interested parties.

Subscriber packets and brochures are distributed to callers, visitors, and at conferences by TIC, in addition to USGA Green Section distribution.

- 3.2 For subscribers, software will be made available to enable an IBM PC or compatible microcomputer with modem to directly access the file, along with documentation to guide remote searching.

VuePort, the PC software necessary to dial into the Alpha Micro and STAR, is distributed to subscribers, along with the Dial-Up User's Manual. Projected revisions to the software, online system structure and capabilities, and documentation will dominate much of the 1990-1991 work plan.

As detailed in Addendum II, "Subscription Statistics," a total of 117 subscribers supported TIC efforts between August 1988 and April 1990. Just over half were superintendents.

- 3.3 Respond to written, telephone, and electronic mediated search requests within 48 hrs. with a printed bibliography.

A total of 235 mediated searches were conducted between May 1, 1989 to April 30, 1990. Addendum III, "Offline Search Statistics," details the distribution of these queries by user type and method of contact, as well as summarizing mean mediated search size and document delivery.

- 3.4 Make available for distribution a first public edition of the Turfgrass Thesaurus, to aid search strategy construction.

The milestone first public edition of the Thesaurus will be available early in the new year. This has been a primary activity of the Graduate Assistant working on the project. The Thesaurus, a necessary element to provide long-term stability to file structure, details inter-relationships between some 10,000 keywords related to turf culture. It's primary job is to automate, as much as possible, the indexing process used in building USGA TGIF. In time, it may become a standard turf reference work in and of itself, available both online alongside USGA TGIF and in a printed form.

- 3.5 Promotion of USGA TGIF will begin to the identified primary initial target user groups: turf researchers and golf course superintendents.

Continuing promotional efforts involved presentations, mailings, and published articles. Booth space within the Green Section to demonstrate USGA TGIF at the International Golf Course conference and Show (2/90, Orlando) resulted in hundreds of inquiries, discussions, and training opportunities. We were also

directly represented at the North Central Turf Expo (12/89) and the Michigan Turfgrass Conference (1/90).

During the year, 4 issues of The Sward, TIC's newsletter were issued. This communication channel to subscribers and other users will become increasingly important in the future.

4. Michigan State University will provide loans and/or appropriate photocopies to all users who have reason to need access to the Noer collection.

- 4.1 Respond within 48 hrs. to most requests for copies, within legal restrictions.

Monographic requests have been handled per normal Interlibrary loan arrangements. Photocopy requests are a service offered as a part of the supplementary services fee schedule, with discounted rates for subscribers. Photocopy requests supplied totaled 302 items.

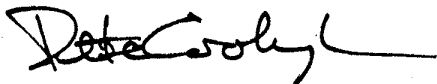
NOTES AND OBSERVATIONS

1. "Download Topics"

A prototype debut of five sample topics was made at the Orlando GCSAA conference. Following endorsement by the site review team in May, implementation and expansion of this new portion of the online system proceeded. It continues to grow in both size and scope, and we will begin to make these short-form bibliographies available in printed versions shortly.

2. "Back" to Print

Several of our efforts this coming year will result in printed products as spin-offs from the production of USGA TGIF and associated files. These include The Turfgrass Thesaurus, the beginnings of The Turfgrass Index, and the Current Bibliographies series (Download Topics in print). There is some irony in our having existed "with no print equivalent" for several years. It is a case of "going back to the future."



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