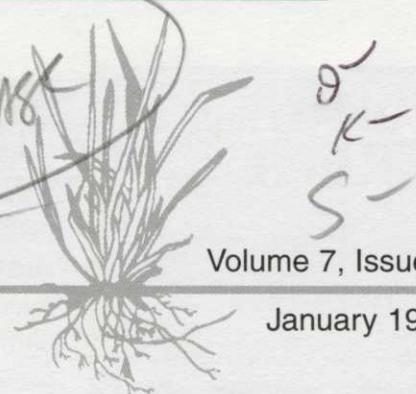


TurfGrass TRENDS



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Turf Research: Nature, Needs and Net Results

Eliot C. Roberts, Ph.D.

As we approach the year 2000, turfgrass research efforts in the United States have been underway for well over 100 years. In fact, this research has become the backbone of the whole turf management segment of the green industry. We have advanced in all technical aspects of turfgrass culture because of the science that supports the development of new fertilizers, soil conditioners and activators, equipment for grooming and irrigation, pesticides, and turfgrass cultivars. Without both public (primarily Land Grant University) and private (industry) research, the quality of landscape and sports turf would be much lower quality than we enjoy today. Research has been a major driving force, a critically important element, in advancing "know-how" as we are about to enter the 21st Century. Furthermore, the research we need is far from complete, not even after 100 plus years of scientific effort.

We all recognize that times are changing. Public perceptions of research, particularly in agricultural and related sciences, have changed and are continuing to change. Government funding is thought to be of greater need in other areas, especially those related to socioeconomic and humanistic concerns. As a result, limited funding becomes a serious liability at a time when costs of turfgrass research are on the increase.

Questions We Must Answer

- How do we need to grow grass?
 - How does grass grow?
- What is good turfgrass research?
 - How can we recognize the best in turfgrass science?
- Are some values from research of higher priority than others?
- How can researchers, who specialize in basic science, work more closely and effectively with turf managers, who are masters in the art of growing grass?

IN THIS ISSUE

- **Turf Research: Nature, Needs and Net Results1**

The Turfgrass Commodity

Research Strategies

Efforts, Needs and Challenges

Early, Present and Future Research

Basic, Applied and Synthesis Research

Benefits of Research Findings

Research Funding

- **Book Review: Redesigning The American Lawn . .10**

- **ASA Educational Materials12**

- **USGA Green Section Research Summaries . .13**

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The question of who will pay becomes one of major importance. How much public funding can be made available? How much industry funding can be passed along to the consumer of goods and services? There are no other sources and we must recognize that ultimately research costs fall to the consuming public, one way or another.

Because we live in a time when hard decisions need to be made, we all must understand what turfgrass research is all about, including the nature and politics of turf as a component of Landscape Horticulture. It's time, perhaps past time, to get serious about turfgrass research. Let us take the time to look at this topic from the broadest possible perspective.

The Turfgrass Commodity: Plant Characteristics and Management Needs

The turfgrass commodity is unique among plant kinds and thus presents some interesting prospects for research. Perhaps no other plant is cultured at a higher density (population of plants per unit area), often close to 800,000 per per 1,000 square feet. These plants compete with each other, with other plants, and with woody landscape plants whose roots intermingle with grass roots. They also compete with macro- and microorganisms. Some 45 quadrillion (15 zeros) per 1,000 square foot to a six-inch rootzone depth utilize nutrients essential for life processes. Thus, turfgrass is an excellent specimen for study of ecological principles.

In addition, turfgrasses are defoliated (pruned) regularly. This might be daily

on a golf green or weekly on a home lawn. No other plant is trimmed this regularly. Furthermore, the intensity of trim varies from 1/3 inch on a golf green to as high as three inches on a home lawn. Different grasses tolerate clipping at different heights. For all of them, defoliation has a pronounced effect on the development of the root system. At times, grasses might become so severely weakened by close clipping that disease incidence is increased and loss of turf cover results. At other times, this weakness is manifested later in the season under adverse climatic conditions - too wet or too dry, too hot or too cold. In effect, persistence of a turf stand is directly related to energy reserves stored underground. Thus, relationships between mineral nutrition and organic nutrition within these plants can be studied effectively using turfgrasses as test specimens.

Further, because of the nature of turfgrass use involving traffic and play of the game requirements, it serves as an excellent plant to evaluate effects of soil compaction on soil air/water relationships in the rootzone. And, since turf quality is evaluated daily during the growing season, and even on through late fall, winter and early spring, this plant commodity serves well in monitoring plant responses throughout the entire year. This is unlike other agricultural or ornamental plants that are grown for yield at harvest time or for seasonal flower or foliage quality.

Finally, few other plant kinds are as intensively maintained as turfgrass. This applies especially to golf course and sports turf where foot traffic abrasion and soil compaction can be so detrimental on plant quality and persistence. As much as 70 percent of

Looking at Turfgrass From the Broadest Possible Perspective

- I. The Turfgrass Commodity - Plant characteristics and management requirements.
 - A. Team effort between plant scientists and turfgrass managers.
- II. Research Strategies - Purposes, needs, and applications.
- III. Efforts, Needs and Challenges
 - A. Early Research - where we have come from.
 - B. Present Research - where we are now
 - C. Future Research - where we are going
- IV. Knowledge Gained
 - A. From Applied Research
 - B. From Basic Research
 - C. From Research Synthesis
- V. Benefits
 - A. Values from research findings for a.) industry, b.) grounds managers, c.) public education, d.) environmentalists, e.) fortifying political correctness.
- VI. Research Funding

turfgrass quality can be accounted for by proper irrigation practices. Also having a profound influence on turfgrasses are use of fertilizers, biological activators, soil conditioners, surfactants and pesticides. Practices, such as mowing, aerification, thinning and grooming add to an ultimate realization of high quality in the sward.

These plant characteristics and management requirements make desirable a close working relationship between the turf research scientist and the professional turf manager. Either party acting alone will be less effective than when a team approach is followed. Golf course superintendents across the country have increasingly recognized this in recent years.

Research Strategies Purposes, Needs and Applications

Consequently, research planning and implementation is a task for joint attention by scientists and practitioners. Difficulty arises when either group attempts to see the entire picture from a single perspective. First, we should look at the purpose or purposes of conducting turfgrass research.

Together, we need to increase emphasis on developing a research strategy.

Purposes - There's an old saying that speaks much truth, "If it's not broken, don't fix it." The purpose of turfgrass research should never be to fix something that is not broken. Research is conducted for the purpose of preventing a breakdown or in order to strengthen a weakness in management that has resulted in turf failure in the past. The most positive and longest lasting purposes of research are often genetic in nature. For example, to improve disease or insect resistance genetically is superior to developing a new pesticide that organisms could become resistant to in time. This is not to say that pesticide research is not valid. It is indeed necessary and a high priority issue.

Testing and demonstration research fulfills an important purpose. How else can we know if trial and error based testimonials are worth anything? What works under one set of conditions might not work under another. Subjecting turf responses to an analysis of variance and reporting results in least significant differences might not make good advertising copy, but it does provide a clear picture of which differences are real and which are wishful thinking.

Product development research has a highly useful purpose - only through emphasis in this area do we realize mechanical improvements and more effective chemicals that can make turf management easier and result in higher quality. Like basic research, product development studies might not have clear-cut objectives at the start, but as pieces of information relate to one another, a precise understanding of the purpose of this work becomes real.

Needs - It is relatively easy to come up with a laundry list of research wants. But, how many of these are really needed? Where are the probabilities of a breakthrough most likely? These are the areas that might well be explored first in meeting current needs. And, just because a topic has been under investigation for the past 50 years, doesn't mean that new technology or a new approach cannot be put to good use in making a significant advancement. This particularly applies well to investigations of a longstanding nature that have to date yielded little in the way of positive results. Soil microbiology, seems to me, is ripe for major advancements now at the close of the 20th Century.

Application of Findings - In all likelihood, we already know far more about how to grow turfgrass than we put to good use. Does that mean we should slow down research efforts until our application successes catch up with the reserve of information on hand? Not at all. The probability exists that each new finding will help us better understand and apply knowledge already in existence. In other words, research must be backed up with education in order to increase usefulness of findings.

This was the original concept of Cooperative Agricultural Extension within the Land Grant University System. Now, with turfgrass research conducted at many institutions and locations, it's not clear how effective Extension Education is these days. Certainly Division C-5 of the American Society of Agronomy/Crop Science Society of America and the International Turfgrass Society, among other professional societies, are key educators in the practical applications of turfgrass findings. In addition, practical research digests for

turf managers, such as *TurfGrass TRENDS*, have important roles to play in this process.

Efforts, Needs and Challenges Past, Present and Future

At this point, there should be value in looking at turfgrass research from a historical perspective. In order to plan for the future, we need to know where we've been. Otherwise, we are likely to repeat past failures and missed opportunities.

Early Research - Most turfgrass research in the United States before World War II was an outgrowth of forage and pasture studies. However, the increasing popularity of golf provided incentive for specialized research that would be of benefit to the playability of golf course tees, fairways and greens. Application of research results was also directed towards lawns across the country and this spin-off caused an increasing realization of the true extent of the importance and value of the turfgrass commodity. Thus, these early trials and demonstrations concerned with adaptation of turfgrass varieties, weed control, and fertilization whetted the appetites of agronomists and horticulturists for better things to come.

Present Research - Following World War II, there has been realized a 50-year period of unprecedented progress and growth in turf research. Full-time turf specialists, trained in agronomy and horticulture, devoted major effort to teaching, research, and extension in nearly every state. These scientists affiliated with the American Society of Agronomy in order to share research methodology and the results of current experimentation. They worked as partners with golf course superintendents (once known as greenskeepers) to provide firm, practical foundations for their research endeavors. During this period, we have seen tremendous progress. Perhaps this impressive list of accomplishments might tend to indicate that the turf research mission has been completed and that there is little more to do. Not so. We should now look into the future to see what must come next.

Post-War Turfgrass Research Progress

- Development and standardization for use of selective herbicides
- Development and standardization of soil sterilization practices from a scorched earth technology to relatively fast acting chemical treatments for improved seed beds and turf renovation
- Development and standardization of soil aeration practices that have replaced the use of dynamite and spade forks. These include mechanical devices as well as chemicals to increase soil wettability.
- Development and standardization of fungicides, insecticides, and nematicides
- Development and standardization of new fertilizers, soil conditioners and biological activators
- Development and standardization of equipment for turf irrigation and grooming
- Development and evaluation of new grass cultivars engineered genetically to meet specific use requirements on lawns and sports turf
- Advances in our understanding of how grass grows, especially in relation to concepts of stress physiology
- Advances in our understanding of safe use and handling of pesticides and other chemicals essential in the turf management process.

Future Research - As we enter the 21st Century and start a second hundred years of turf research, where must emphasis be placed? We should consider briefly the following six topics for investigation: Socioeconomics, Computerization and Automation, Turfgrass Improvement, Turfgrass Stress Physiology, Soil Biology and Plant Ecology.

Socioeconomic Research

Socioeconomic studies investigate relationships between green industry products and services and consumer needs. These will result in an orderly maturation of industrial components with emphasis on public relations.

Within all areas of turfgrass specialization today exist many misunderstandings, old wives' tales, and just plain false teaching based on trial and error technology of years gone by. Science-based technology has made great inroads on many of these misconceptions and yet others still linger on. These can be found across the board, from the professional turf manager to the weekend home gardener. Some gainfully employed writers and educators perpetuate misconceptions and some of the products and practices. The net result of this situation is a loss of credibility within the turfgrass segment of the Green Industry. The value of lawns and sports turf and the benefits in terms of environmental quality are much greater than the

general public realizes. For the past 20 years, we have bemoaned this public relations problem, but have done little to correct it. Socioeconomic studies, designed to relate products and services with consumer needs in order to promote a better understanding of true value, are of critical importance now and will continue to be so well on into the 21st Century.

Computerization and Automation

Computerization and automation of turf management systems within limits is needed so that the "man" in management is not replaced. Turf culture should continue to be considered labor intensive.

There are too many uncontrollable variables in soil, plant, and environment to ever make turfgrass management a push-button, mechanical operation. Often, we note that it's the "man" in management who makes the system, whatever it is, work. However, in recent years, computerization and resulting automation have found a useful place in nearly all endeavors, including agriculture and turfgrass management.

There seems to be nearly no limit to what the computer can do in the improvement of turf quality. But, there have to be limits because computers can only do what we program them or tell them to do.

Increasing research effort is needed in order to expand what we already know into an information system that can help solve problems not yet thought of. And, we need to be aware that these problems do exist, although not fully identified to date. Our only fear is that, in an effort toward higher and higher technology, the little grass plant might suffer by making maintenance operations less labor intensive. After all, from golf turf to home lawns, a hands-on approach yields highest quality. At least for now, our hands provide the best in tender loving care.

Genetic Improvement

Genetic turfgrass improvement can result in higher quality with lower maintenance inputs. We need to further explore and utilize the grass genetic pool for the benefit of humankind.

In all areas of science, biochemical research is reaping big rewards. The more we understand the chemistry of biological systems, the better we can control adverse reactions or even prevent breakdowns that otherwise might be fatal. With turf, high quality is realized as long as growth conditions are favorable for the grass, or at least more favorable for it than for associated plants in the sward. But at times, when stress is placed on the plant, such as temperature and soil moisture extremes, turf quality can deteriorate rapidly. We know that these environmental stress conditions can present themselves unannounced throughout most of the year. At these times, we are faced with the greatest challenges as turf managers. In order to be prepared for these unexpected occurrences, we must have a better understanding of turfgrass biochemistry. Insights gained to date would seem to have only scratched the surface in terms of what there is we should know.

Microbiological Research

Soil biology studies are needed to better understand the microbiology of soil systems active in the rootzone of densely populated grass stands.

Among the earliest agricultural research projects, well over 100 years ago, were studies on the value of organic matter (manures) in crop production. And yet today, we still have not learned all the secrets related to soil organic matter and its decomposition to form humic acids and humus by soil macro- and microorganisms.

Microorganisms have a short life span, perhaps only a few minutes before they reproduce and die. In good, biologically active soil, there can be as many as 45,000,000,000,000,000 (quadrillion) microorganisms in the rootzone of 1,000 square feet of turf. In fact, the most productive agricultural soils worldwide are those that formed under the influence of prairie vegetation, where resulting levels of organic matter are near seven percent. Thus, we have a good understanding of the value of organic matter as a soil conditioner in the seedbed, but little appreciation of the value of humus and related bioactivators in the hardness and persistence of turf over time. For microbiologists looking for research challenges into the 21st Century, studies of microbiological activity in close association with turfgrass root systems as they grow, die off, and regrow, would be of significant interest and value.

Ecological Research

Plant ecological studies are necessary to build on our current understanding of the nature of competition within living systems. Ecological principles govern relationships between all living organisms, including all the surrounding biosphere and us. Therefore, ecological research of any kind is considered to be highly important.

Turfgrass ecology fits right in because the grass covered soil system on lawns, parks, roadsides, and golf courses is a major entity for the percolation of water to underground reservoirs. As water moves down through the soil profile, impurities and contamination are filtered out and biodegraded. In addition, grass roots stabilize the soil to help reduce wind and water erosion, thus helping to keep streams, ponds, lakes and rivers cleaner than they would otherwise be. Further, from the stand-

point of environmental education, our closest contact with the existence of natural ecological principles is right there in the lawn and under foot. In a real sense, all lawn or turf care really amounts to is the shifting of ecological forces so as to favor the little grass plant at any given time. When we do this, the turf benefits and so does the entire surrounding community. Thus, we dare not slacken our future turf research effort in this important area.

Knowledge Gained From Basic, Applied, and Synthesis Research

Throughout the past 100 years of turfgrass research, three major types of emphasis have been realized. These include applied, basic, and synthesis research. Each has value and only in the aggregate can we gain all the knowledge that scientific research can provide. I would suggest that scientists should continue to work in each of the following areas.

Applied - Applied research yields the most direct answers to most practical lawn and turf problems. Experimentation is designed for that purpose. Often the researcher has a hunch, based on previous knowledge and experience, that a certain approach will yield accurate information leading to a correct interpretation and resolution of the existing problem. Less often does the researcher shoot in the dark as a totally unbiased investigator. Usually basic research is less expensive to conduct and often grant-in-aid funding is available from concerns that might have a vested interest in the results. And applied research is ideally suited for cooperative effort between the turf scientist and turf manager-practitioner. Results of applied research are usually subjected to an analysis of variance so that real differences between products and/or treatment rates can be identified. Such procedures require that different entries or treatments be replicated.

Basic - Basic research is conducted without concern for the practicality of results obtained. This doesn't mean that practical applications

cannot be made, but only that information for information's sake is sufficiently important to justify the time and expense involved in the study. Often one basic investigation leads to another and another over a period of time and thus establishes the scientist as an expert in his particular field. The more complex the physiology or chemistry of the process under investigation, the more such studies lend themselves to a team approach.

Basic research often involves use of advanced technology, such that apparatus and standardization of methodology are not only expensive but also time consuming to master. From time to time, large competitive grants-in-aid are available for scientists with well-established reputations. In the final analysis, basic research is necessary to keep turfgrass science at the forefront with other leaders in the fields of agronomy and horticulture.

Synthesis - Research synthesis is featured in some fields of investigation where there are serious limitations on the generation of new data. In these instances, the experimentation and conclusions of a number of researchers are reviewed and new or varying conclusions are drawn by another investigator. These reports feed on one another and tend to polarize conclusions toward pro or con perspectives.

Significant benefits can be derived from these types of studies. The author, in an editorial capacity with The Lawn Institute from 1982 to 1992, regularly presented a "Threshing the Journals" feature in TLI's quarterly newsletter *Harvests*. From time to time, several reports with varying results would be reviewed in an attempt to relate environmental differences and/or research methodology in terms of explaining deviance of results among the reports. Such analysis should be helpful in understanding why a specific turfgrass rates higher in one location than in another. Or, why fungicides, insecticides, or herbicides yield varying levels of control in nationwide tests conducted at different locations around the country.

This library or office type research is relatively inexpensive to conduct and yet information gained can be of considerable value. In effect, we need not

be finished with research data filed away in publications and forgotten. Reprocessing and evaluation can lead to important new conclusions.

Benefits From Research Findings

In the final analysis, we must answer the question, "What are the benefits obtained from research findings?" Without benefits that are clearly identified and understood, we miss the mark in what we do. And, who among us benefits? How about the green or turf industry, or grounds managers, or environmentalists, or educators, or politicians, or all of the above including the general public?

Industry Benefits - Turf research benefits the Green Industry either directly or indirectly. Direct benefits result from new product development through increased sales or through more effective product use resulting in increased consumer satisfaction. In either instance, product acceptance is enhanced and public appreciation of the turf commodity is increased.

This latter benefit (increased public acceptance) must not be underemphasized as it has been in the past. For in a real sense, Green Industry products and services do not compete with each other for consumer dollars nearly as much as one might think. Consumer expenditures within the Green Industry compete more with non-Green Industry products and services. Funds devoted to improvements inside the house are not available for lawns and gardens. As we address research at the close of the 20th century, turf does not receive its fair share of consumer dollars.

Grounds Managers - Turf research benefits grounds managers from professionals to the weekend home gardener. New information generated through continuing research properly interpreted and in the hands of interested practitioners, brings about improved turf quality that results in increased satisfaction on the part of all whom enjoy out-of-doors sports, lawns, and gardens. These benefits are appreciated not only by athletes who play more safely on live turf, but also by spectators, tourists and local residents.

Educational Benefits - Turf research benefits those who teach and learn from courses in the plant sciences, including horticulture and agronomy. Education in the biological sciences not only presents various plant responses, but also provides detailed explanations for such responses. These types of information are only available and kept up to date through continuing research. Many teachers also conduct research projects with their students who have direct classroom benefits.

Environmental Benefits - Environmental concerns are the direct beneficiary of all turf research, so much so that specialization in the field of ornamental horticulture is now known as environmental horticulture. Landscape plants, including turf, offer both physical and psychological benefits. Physical improvements in the soil associated with grass roots result in improved infiltration and purification of rainwater. Also, less soil erosion is associated with sod ground covers. In addition, landscape beauty offers psychological benefits for those exposed to gardens and gardening. A relatively new field of specialization is horticultural therapy, created to help those suffering from both physical and mental disabilities. These and other environmental benefits should rank high on our list of reasons for maintaining an active turf research posture.

Political Correctness - Turf research benefits should be focused on the political correctness of current governmental practices. For example, the pesticide issue in recent years has been distorted by groups of activists interested in advancing their cause, irrespective of facts backed by research. Toxicology clearly indicates that it's "the dose that makes the poison."

But, political correctness often holds to zero tolerance. With increasing sensitivity of analytical chemical methodology, some determinations can now be made within the parts per quadrillion (PPQ) ranges. At this level, the probability of biological significance is extremely low. Despite this recognition, public perceptions inflamed by activist rhetoric lead to stances of political correctness. Adding more fuel to this already dangerous fire is a certain amount of "junk research" (poorly

conceived, utilizing inferior methodology and biased interpretation of results) that lacks scientific credibility from start to finish. Good, sound turf research will continue to be of benefit in influencing many diverse elements of political correctness.

Public Benefits - Finally, the public stands to benefit in all of this. Insofar as research results report the truth and this information is used throughout the Green Industry and made a part of practicing grounds management, environmental affairs, education, and the political process, the public will benefit, regardless of specific interest in lawns and sport turf.

Research Funding

Now, we're down to the bottom line, funding. Research is expensive to conduct and dissemination of information to all who can use new approaches and technology is also time consuming. Who pays the bill? Fifty years ago, funds were very limited. Then, increasing support came from agricultural experiment stations. This funding has now leveled off and in many locations has started to decrease. The United States Department of Agriculture has suffered major cuts in its research budget. The once extensive turf research effort has been reduced to a program of national variety trials based at Beltsville, MD.

Many feel that turf research, now and into the future, is in deep trouble. Grant-in-aid money has always been available from industry sources. It is adequate for result-demonstration type investigations, but inadequate for much in the way of basic research. Royalties from the release of new turf cultivars have been a significant help to those experiment stations involved in breeding and genetics.

Science foundations sponsor competitive bidding for grants-in-aid. Where these were once available primarily to agricultural experiment stations, where a land grant philosophy influenced research objectives, the tendency now is to open the competition to private colleges and universities, where politically-correct, hidden agendas often influence

the research conducted and the usefulness of the results. At times, third party research confuses issues to the point where we cannot be certain what studies are underway.

Government seems to feel that sufficient "seed" money has been invested in turf research during the past 50 years to enable this specialized area of agriculture to now stand on its own. They look at the sports turf and lawn care related industry as sufficiently mature to recognize the importance of turf research and to arrange for adequate funding. Within an industry as diverse as this, there is reasonable doubt that the level of funding required can be generated from industry alone.

More likely is a joint effort among various firms and associations to make research funds available through state and regional turfgrass conferences and show. Certainly associations, such as the Professional Lawn Care Association of America (PLCAA) and the Golf Course Superintendents Association of America (GCSAA), will remain active at the national level. Each of these groups will maintain committees to identify research needs and to allocate funding, as appropriate. A major effort to coordinate research activity nationally will be needed in some form. This is just another challenge for turf researchers in the years ahead.

With the growth of the industry currently and the increasing importance of the turfgrass commodity, turfgrass research needs will continue into the 21st Century. To realize an adequate effort to meet consumer and general public needs, the backing of a mature, public oriented Green Industry will be required. To this end, all of us involved must put our shoulders to the wheel.

Eliot C. Roberts was formerly executive director of The Lawn Institute. He served as chairman of the Department of Ornamental Horticulture at the University of Florida and the Plant and Soil Science Department at the University of Rhode Island, and turfgrass scientist at the Iowa State University and the University of Massachusetts. He now is a consultant with Rosehall Associates, 2080 Red Road, Sparta, TN 38583, (931) 277-3374.