

1982

## Spring 1982 Conference Issue


Nancy N. Ragsdale

William A. Torello

William B. Davis

Jack A. Paul

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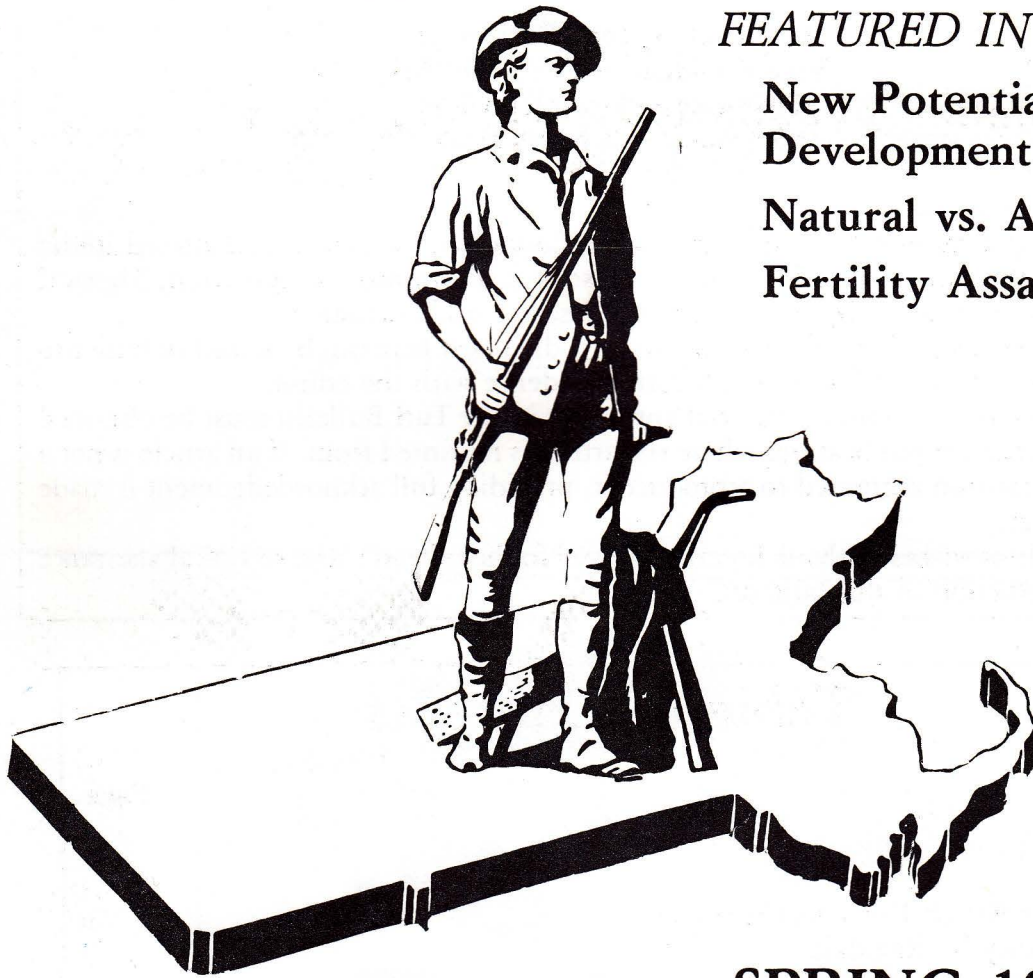
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# TURF

## BULLETIN

MASSACHUSETTS TURF  
AND LAWN GRASS COUNCIL

INCORPORATED



*FEATURED IN THIS ISSUE:*

New Potentials in Turfgrass  
Development

Natural vs. Artificial Turf

Fertility Assay of Sands

SPRING 1982  
CONFERENCE ISSUE

BETTER TURF THROUGH RESEARCH AND EDUCATION

EDITOR  
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Vol. 19, No. 1

Spring 1982

**Massachusetts Turf & Lawn Grass Council Officers**

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The Massachusetts Turf and Lawn Grass Council Incorporated is chartered under the laws of the Commonwealth of Massachusetts as a non-profit corporation. The turf council seeks to foster "Better turf through research and education."

More detailed information on the subjects discussed here can be found in bulletins and circulars or may be had through correspondence with the editor.

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The Editor wishes to thank Loretta J. Cassel for her research and technical assistance in the construction of this bulletin.

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## Turf Clippings

Gary S. Cameron and Jeffrey Houston, both Stockbridge School Turf Management majors, have received \$250.00 each in scholarship money from the Tuco-Upjohn company.

A recent publication in Plant Disease Reporter by D. L. Roberts and J. M. Vargas Jr. indicates they may have found a cause for the wilt symptoms of Toronto (C-15) creeping bentgrass. These researchers found bacteria in the xylem of roots, crowns, and leaves of this turfgrass. Until now the problem was simply known as the "C-15 problem" due to its unknown origin, but these researchers suggest calling the disease "bacterial wilt" of Toronto creeping bentgrass.

Cindy Lincoln, a 1981 graduate of Centre College of Kentucky, has begun her graduate studies at the University under the direction of Dr. Bill Torello. Tissue culture of turfgrass is Cindy's major topic of interest. She is working towards her Masters degree.

The University of Vermont has recently reported that sixteen of eighty-nine companies selling fertilizer in Vermont in 1979 failed to make grade. To make grade, a fertilizer must provide at least 95% of the guaranteed plant nutrients. The most common offense was in a 15-8-12 blend which was actually a 9-6-12. Some 10-10-10 was found to be 7-9-10.

The logo features the word "Scotts" in a white, italicized serif font, centered within a solid black oval.The word "ProTurf" is written in a bold, black, sans-serif font. A small registered trademark symbol (®) is located at the bottom right of the word.

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## How the RPAR Process Is Working

NANCY N. RAGSDALE

Pesticide Impact Assessment Coordinator, U.S. Department of Agriculture,  
Science and Education Administration, Cooperative Research, Washington, DC



RPAR (Rebuttable Presumption Against Registration) was originally envisaged as an expedient mechanism by which EPA could reregister pesticides as mandated by Congress. In this registration process, all known data are examined for indications that a given pesticide might have unreasonable adverse effects on human health or the environment. If such evidence is found, EPA issues an RPAR, and a time follows

during which the registrant and others may challenge the validity or applicability of the data. Furthermore, before a decision is made on the future of the pesticide, the adverse effects (risks) are weighed against the benefits derived from use of the pesticide.

The National Agricultural Pesticide Impact Assessment Program (NAPIAP), which is coordinated by the USDA and carried out in cooperation with the states and EPA, is a primary source of data on agricultural benefits and on exposure through agricultural use. The desired information, most of which must be sought on the state level, may be directly collected or, as is more often the case, assembled by teams of biologists and economists.

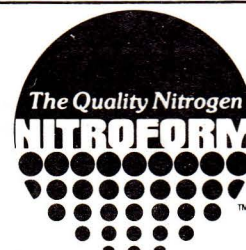
One would assume that since the RPAR process involves input from such a wide variety of interest groups, well-founded regulatory decisions would be made in a relatively short time and cause minimum dissatisfaction. Such has not been the case. The first major problem is the time factor. The process takes much longer than anticipated. According to my records, 24 RPARs have been issued (including some groups of pesticides) since NAPIAP became operational in 1977. Taking suspensions or cancellations out of the picture, the RPAR process has generated eight proposals of regulatory options and one final decision. What causes the delays?

First, contrary to what many had thought, the biological data necessary to development of economic impact assessments were not readily available. We are talking primarily about usage data—acres of given crop, acres treated with the specified pesticide, and what would happen if the pesticide were not available. Second, many questions are raised during the complex economic analysis that to a biologist seem quite obvious and thus have not been addressed in the biological portion of the assessment report. This means that after that portion is considered complete, the team members

must be contacted and recontacted to provide additional data. EPA has made some efforts to improve the data-gathering process through contracts. Generally, these have not created good working relations among the parties involved. In most cases, the data one person has trouble finding are just as difficult for someone else to locate. The irony of the situation is that invariably all parties converge on the same source for the information.

Another bottleneck is the limited number of economists relative to the number of biologists. This means that biological reports on some pesticides are put aside to wait their turn. This situation frequently leads to the need for some updating efforts on the part of the team biologists.

To top off a less-than-perfect situation, EPA is saddled with making numerous extrapolations from the risk data and then comparing what, for the most part, are hypothetical situations with the biological economic impact, which also contains quite a few extrapolations. Reaching decisions based on these extrapolations is definitely not preferred.



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The second major problem is the nature of the economic impact assessments. Because they are designed to address effects at the national level, the loss of a pesticide projected to have minor or moderate consequences can have serious impacts on local areas. This situation is likely with any pesticide used on crops not considered major and grown in diverse geographical areas with diverse pest problems. Closely related to this situation are minor or specialty crop uses, in which total loss resulting from inadequate pest control is not likely to seriously impact the nation's economy but may be catastrophic for a limited number of growers.

The final major problem is related to the concept of alternative pesticides. Pest control is a very dynamic situation: pest problems can change markedly from one growing season to the next. The pesticide that is second choice this year may be immensely beneficial next year. The growing field of pest management demands a variety of pest control measures, including pesticides; the greater the selection opportunities, the more flexibility available to design better pest control programs.

Let us focus on some possible solutions. There should be a sequence of events, not a group of simultaneous tasks. First, the basic question of whether the pesticide is a real risk needs to be examined. The data should be scrutinized and verified. If the data are not adequate, new research should follow, and no further activity in the RPAR process should take place until the results of that research are available. One cannot ignore that a lot of educated guesswork is involved in assessing the likelihood of adverse effects actually occurring. This area is in its infancy and will undoubtedly grow in sophistication in the near future. In addition to their fate in the environment, the mode of action of these chemicals must be determined. Along with this, the routes of exposure should be identified, as well as the metabolic breakdown. Then feeding studies can be put in their proper perspective and the guesswork lessened.

If adequate and valid data indicate potential risks, the second step is to examine the actual exposure situations existing through the use of the pesticide; this area has truly blossomed during the RPAR process, and EPA continues to place great emphasis on exposure in their decisions. The third step, taken if actual exposure constitutes a hazard, is determining if exposure can be reduced to an acceptable level.

When these three steps have been completed, there should be quite a few uses that, when label directions are followed, would not involve adverse effects. If some uses do, the fourth step should be taken—use benefits on a state-by-state basis. Arrangements could be made with states to provide information assembled into a report at the federal level and then reviewed by a team of experts from the state and federal levels. Both the biological and economic information in the report would be used in deciding whether the benefits justified the risks.

I believe that following these four steps would significantly improve the RPAR process. Changes such as these rarely occur overnight, but a concerted effort could produce real progress.



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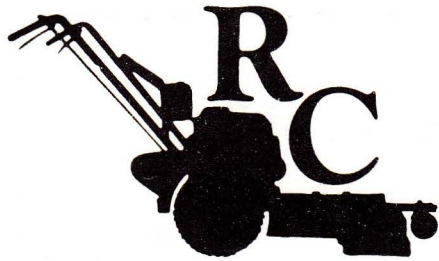
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# Cellular and Genetic Engineering Techniques Applied Towards the Improvement of Turfgrasses.

By Dr. William A. Torello

Genetic engineering has rapidly become one of the most promising areas of biology by revealing the nature and potential usefulness of the genetic code or gene. Genes from humans, animals, and plants have been transplanted into certain bacteria to study and decipher the genetic code as well as to biologically synthesize various drugs and useful compounds. The latest feat of genetic engineers has been to introduce human genes into plant cells. In related studies, scientists have transplanted certain plant genes into other species of plant cells. The primary objective of plant scientists working in this area have been to introduce or improve the processes of nitrogen fixation and photosynthesis between plant species.

The explosive advances in biology that have made the above possible are still accelerating, promising social and economic effects that are impossible to predict, but sure to be significant.

In view of these unlimited possibilities we have initiated several research projects at the University of Massachusetts aimed at improving turfgrasses through cellular and genetic manipulation. The improvement of disease resistance, drought tolerance, heat and cold tolerance, salt tolerance, and increased nutrient or fertilizer efficiency are but a few objectives that may be met using these techniques.

There are quite a number of techniques which may be employed to genetically alter turfgrass plants for increased environmental tolerances. The classical methods used by plant breeders entail crosses between plants by laboratory pollination techniques. These methods have been quite successful over the years but are extremely time-consuming (up to 15 years) and costly. Furthermore, pollinations are usually limited to crosses between cultivars or species of turfgrasses due to incompatibility problems. For example, this virtually eliminates possible crosses between Kentucky bluegrasses and red fescues or ryegrasses and bentgrasses. The use of certain tissue culture techniques has allowed scientists to overcome these restrictions. Cellular hybrids have been successfully produced between barley and soybean, corn and soybean, barley and carrot, as well as many other crosses too numerous to mention.

These techniques are currently being used at the University of Massachusetts to improve on several environmental characteristics of various turfgrasses. One method entails the selection of mutant cells which are grown in culture and subsequently thrive under adverse conditions such as

drought, heat, cold, and saline environments. Other methods for making interspecific and/or intergeneric crosses include haploid culture and protoplast fusion techniques.

The prerequisite for any tissue culture/genetic manipulation work is the successful growth of "callus" tissue. A callus is a group or clump of undifferentiated, actively dividing and growing cells. Callus tissue is produced by taking certain plant parts (termed "explants") such as root tips, seed embryos, or apical meristems from turfgrasses and placing them upon a highly specialized nutrient media. These "explants" are carefully surface sterilized to eliminate many bacteria or fungi before placement on the media. The synthetic media contains all essential nutrients as well as various vitamins and certain plant hormones (auxins, and cytokinins) to help in "initiation" and growth of the callus. If all nutritional and hormonal conditions are optimum, cells within the explant (or plant part) will divide, proliferate, and eventually form a 'clump' of undifferentiated turfgrass cells. This "callus" tissue can then be used to induce or select for various beneficial cellular mutations. Furthermore, these "undifferentiated" cells may be used to create "cellular crosses" whereby we bypass the normal or natural sexual processes of pollination which are extremely time consuming. This technique is termed "protoplast fusion".

During protoplast fusion experiments, single cells are isolated from a source of callus tissue (for instance Kentucky bluegrass tissue), and from the leaf mesophyll cells of another plant source (for instance centipede grass). The callus derived Kentucky bluegrass cells are clear, having no chlorophyll content while the leaf mesophyll cells from the centipede grass are green. Once isolated, these cells are stripped of their cell walls using various cell wall degrading enzymes thereby liberating the fragile "naked" protoplast from each plant source. After several other treatments these cells are mixed together in a solution containing a chemical (polyethylene glycol) which facilitates the "fusion" or combination of two or more cells. A successful fusion of a callus-derived cell and a green mesophyll cell yields a very light green colored hybrid cell. The important point of this fusion is the fact that the genes from both cells or plant types have been combined into one distinctly different hybrid cell. As such, the beneficial traits of one plant type have hopefully been transferred and contained in the cells of another plant type. Once cell fusion is complete, one is faced with the task of regenerating a whole plant out of a single "hybrid" cell.



The regeneration of a "plant" from a single cell is theoretically possible since all cells from a plant are considered to be "totipotent". This means that each cell within a plant contains the necessary genetic information to develop a whole new plant. This is, in essence; cloning. In practice, regeneration of a whole plant from a "naked" protoplast or "hybrid protoplast" is quite difficult. The first step requires transfer of the hybrid cell or protoplast to a complex synthetic nutrient media which contains the optimum levels of certain hormones to induce the protoplast to regenerate a cell wall. After this critical step, the hybrid cell is then induced to form a callus (clumb of undifferentiated cells.). Once formed, the callus is then transferred to a synthetic medium having the optimum hormonal concentration for root and shoot regeneration. The correct hormonal, light, and temperature levels can induce cells within the callus to differentiate into vascular tissue, cortical tissue, epidermal tissue and finally roots and shoots.

The end product of all this "manipulation" is hopefully a viable cross between two greatly different turf type grasses.

The regenerated plant may look like a bluegrass but containing the beneficial aspects of centipede grass such as drought tolerance, and nutrient efficiency. Conversely, the plant may look like centipede grass but have much better color and some other beneficial characteristics of bluegrass.

The main point of all this work is the possibility of making crosses which normally would be impossible using classical plant breeding techniques. Furthermore, the combination of crosses for any characteristic and from any plant source is limited only to the successful regeneration of a viable plant from a single cell.

The generation of new, beneficial plant types is not limited to protoplast fusion techniques. There are several other potentially useful techniques that allow similar results although approached from a different angle.

In conclusion, it is quite obvious that tissue culture/genetic engineering techniques show tremendous potential in improving turfgrasses for a variety of different factors. The important point to remember is that this area of science is still in its infancy.

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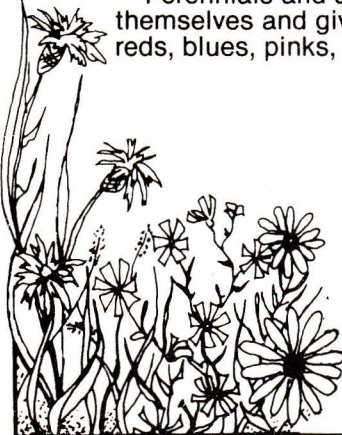
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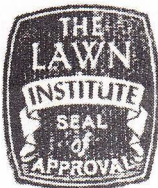
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**REGISTRATION**  
Lobby, Plaza Entrance

8:30 AM- 4:00 PM    Tuesday, March 2, 1982

8:00 AM- 4:00 PM    Wednesday, March 3, 1982

**TUESDAY, MARCH 2**

—Morning—

9:00 AM-12:45 PM    Industrial Show Open  
Exhibition Hall.    Snack Bar.

—Afternoon—

**GENERAL SESSION**  
Banquet Room

**Chairman: Dr. Joseph Troll**  
University of Massachusetts

1:00    **Welcome**  
Dr. Daniel I. Padberg, Dean  
College of Food & Natural Resources  
University of Massachusetts

1:15    **Protecting Your Future**  
Mr. Reg. F. Johnston, Asst. Vice Pres.  
Kidder Peabody & Co., Lowell, MA

2:00    **Estate Planning**  
Mr. Gilbert Kelling, Atty.  
Kelling, Joondeph, Shaffer, & Nagel  
Akron, OH

2:45 PM- 3:00 PM    **Break**

3:00    **Rusting On Your Laurels**  
Mr. James Arch, President  
James Arch & Associates  
Maitland, FL

3:45    **Weeds As I See Them**  
Mr. Paul R. Harder, Instructor  
Essex Agr. & Tech. Institute  
Hathorne, MA

4:30 PM- 6:30 PM    **Industrial Show Open**  
Exhibition Hall

**WEDNESDAY, MARCH 3**

**GOLF COURSE SESSION**  
Banquet Room

—Morning—

**Chairman: Prof. John M. Zak**  
University of Massachusetts

9:00    **Contour Mowing**  
Mr. Geoffrey S. Cornish  
Golf Course Architect, Amherst, MA

Mr. Bruce Cadenelli, Superintendent  
Hollywood Golf Course, Deal, NJ

Ms. Rachel Therrien, Landscape Designer  
Westchester Country Club, Rye, NY

9:45    **Irrigation Systems:**  
**Conservation and Efficiency**  
Mr. Richard Smith, President  
I & E Supply, Inc., Milford, CT

10:10    **Attributes and Growth Requirements of**  
**Bentgrass Fairways**  
Dr. Ralph E. Engel, Dept. Crops & Soils  
Cook College, Rutgers University  
New Brunswick, NJ

**10:35 Baltusrol's Bentgrass Fairways**  
Mr. Joseph Flaherty, Superintendent  
Baltusrol Golf Course, Springfield, NJ

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**11:00 AM-2:00 PM Industrial Show Open**  
Exhibition Hall

---

—Afternoon—

**2:00 Preparation of Golf Courses for Championship Play**  
Mr. William Buchanan  
Mid-Atlantic Director  
USGA Green Section, Richmond, VA

**2:45 What it takes to Prepare a Course for the PGA**  
Mr. Richard Bator, Superintendent  
Oak Hill Country Club, Rochester, NY

**3:15 Golf Course Architecture from the Early Days to the Present**  
Ms. Janet Seagle  
Librarian/Museum Curator  
USGA, Far Hills, NJ

**3:45 The Fate of Nitrogen in Turf**  
Dr. William A. Torello  
Dept. Plant and Soil Sciences  
University of Massachusetts

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**4:30 PM- 6:30 PM Industrial Show Open**  
Exhibition Hall

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—Evening—

**7:00 Banquet and Winter School Ceremony**  
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### WEDNESDAY, MARCH 3

**ALTERNATE SESSION**  
College Room

—Morning—

**Chairman: Mr. Charles Mruk, Agronomist**  
FBC Chemicals, Inc., Providence, RI

**9:00 Nutrient Sources**  
Mr. William Hoopes, Manager  
O. M. Scott & Sons, Marysville, OH

**9:45 Liquid vs. Dry Chemical Applications for Lawn Care**  
Mr. Donald Burton, President  
Lawn Medic, Inc., Bergen, NJ

**10:30 Dealing with Thatch**  
Dr. John Shoulders  
Professor Emeritus-Agronomy  
VA Polytechnic Institute & State Univ.,  
Blacksburg, VA

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**11:00 AM-2:00 PM Industrial Show Open**  
Exhibition Hall

---

—Afternoon—

**2:00 Grooming Cemetery Grounds**  
Mr. Roger Kindred, Asst. Superintendent  
Mt. Auburn Cemetery, Cambridge, MA

**2:45 Beautiful Longwood Gardens - Maintained with T.L.C.**  
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**3:30 Care of Athletic Fields at Harvard University**  
Mr. John Cataldo  
Stadium Superintendent  
Harvard University, Allston, MA

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**4:30 PM- 6:30 PM Industrial Show Open**  
Exhibition Hall

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### THURSDAY, MARCH 4

**GOLF COURSE SESSION**  
Banquet Room

—Morning—

**Chairman: Dr. William A. Torello**  
University of Massachusetts

**10:00 Golf Course Maintenance in the Maritimes**  
Mr. Larry Brown, Superintendent  
Mactaquac Provincial Park Golf Course  
Keswick, N.B., Canada

**10:30 Turfgrass Insects**  
Dr. L. M. Vasvary  
Dept. Entomology & Economic Zoology  
Cook College, Rutgers University  
New Brunswick, NJ

**11:00 Bacterial Wilt of Toronto Creeping Bent**  
Dr. Joseph Vargas, Jr.  
Dept. Botany & Plant Pathology  
Michigan State University, E. Lansing, MI

**11:30 Lessons of the Past as they Apply Today**  
Mr. James Snow, Agronomist  
USGA Green Section, Far Hills, NJ

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**GENERAL INFORMATION**

**REGISTRATION**

- Registration is required for admittance to either the Educational Program or the Industrial Show. Registration - \$20.
- Banquet tickets will be available at the Registration Desk only until 12:00 Noon on Wednesday, March 3. Banquet - \$12.
- The Exhibition Hall will be open at 9:00 AM on Tuesday, March 2 and thereafter only when the Educational Program is not in session and vice versa.

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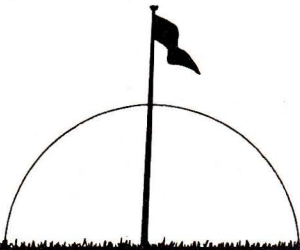
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## Natural Versus Artificial Turf—an Economical Alternative<sup>1</sup>

William B. Davis<sup>2</sup>

Given this topic, writers with different backgrounds and interests would, understandably, present different points of view. As a horticulturist who has spent the past 20 years doing applied field research in the development and management of high-use athletic areas, you might well expect that I am biased in favor of natural turf. I also believe that inclement weather is just part of the game for outdoor sports, such as football, baseball, soccer, rugby, and golf.

If our concern is primarily a high profit business, then there may be little argument that artificial turf is the most economical surface. If we require almost continuous use of the turf for a variety of activities, in order to pay the high cost of building and maintaining a multi-purpose stadium, nothing short of artificial turf is the answer. Such is not the case for many athletic fields or stadiums where artificial turf has been sold and installed, mainly because their turf managers could not maintain an acceptable natural turf. As horticulturists, agronomists, and managers of athletic areas, we have failed. Basically, we do the best we can with what we are given to maintain, and there are limits to what can be done. Professionally, the extent to which we play a major role in the decision-making process concerning development, use frequency, or budget needs to establish and maintain acceptable natural turf has not been recognized. Coaches, players, and businessmen (former players) control these major decisions, and, because they are people-oriented and have limited plant knowledge, they tend to respond to alternative solutions for high-use athletic areas differently than do plant-oriented turf managers.

Artificial turf is the best single thing that could have happened to the natural turf manager. We now have a very high cost alternative to natural turf which has given us the opportunity to say: "For that kind of money, we too can produce high-use, natural, athletic turf areas." Before the introduction of artificial turf, few decision makers would even consider the possible alternatives we have available for natural turf.

Several years ago an athletic director of a major university asked me to solve the problem of its soil-based football field. He offered a budget of \$20,000 and 3 months' open time to produce a new natural turf field, one which would give the university excellent playing conditions and high aesthetics for national television. The field also had to be in excellent condition through late November so that if it rained before or during the final football game, it would not be played in the mud. Within this time limit and budget, the task was impos-

sible. Before our meeting, the university had seriously considered another alternative: for \$650,000 and 6 months' construction lead time, an artificial turf could be installed that would be guaranteed for 5 years. Now, the university's athletic director was willing to listen to my alternative — a special sand growing medium for a natural turf field at a cost of \$200,000, complete with automated irrigation system and 5 months' construction lead time to grow a bluegrass and ryegrass turf.

Throughout the United States, many of our major league sports stadiums have switched to artificial turf. Monsanto's "Astroturf" is the most popular one. Some of these stadiums are completely indoors like the Astrodome in Houston, Texas; others are partly covered, which makes artificial turf the only choice. Several major stadiums are now returning to natural turf with various modifications of a sand-base growing medium. The reasons for returning to natural turf vary. Now that we have several years of experience with both artificial and the new sand concept for natural turf, we can better

<sup>1</sup>Presented at the First New Zealand Sports Convention, Massey University, Palmerston North, New Zealand. May 26-29, 1980.

<sup>2</sup>Environmental Horticulturist, University of California, Davis.

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Artificial turf has two major advantages:

- (1) The field can be extensively used, moving from one sport or activity to another, with a minimum chance of reducing its useful life over a 5- to 7-year period.
- (2) Annual maintenance costs are lower, and it requires a less technically trained management team. (Its management, however, can not be considered "low maintenance," particularly when compared with the type of average to low maintenance budgets many natural turf managers have worked with in the past.)

Several arguments favor the newer, sand-based natural turf athletic areas:

- (1) Construction cost of a sand-based field, even if it includes a closed cell system, ranges between one-third to one-half that of an artificial turf. For many fields where noncelled systems have been used, the difference in costs is even greater.
- (2) Serious vandalism to natural turf, particularly the new sand-base fields, can be repaired at considerably less cost than for artificial turf.
- (3) Total football injuries, both minor and serious, are 32 percent less on natural turf. When you look at only the very serious types of injuries, it makes little difference what type of surface football is played on.
- (4) Survey results show that 84 percent of the professional football players prefer natural turf.
- (5) Natural turf does not generate uncomfortable amounts of heat. In one study made in October at noon when the ambient air temperature was 78 ° F, the surface temperatures of blue grass and artificial turf were as follows:

Artificial turf . . . . .	125 ° F
(+ 46 ° F above air temperature)	
Bluegrass (½-inch tall) . . . . .	83 ° F
(+ 15 ° F above air temperature)	
Bluegrass (1½-inches tall) . . . . .	79 ° F
(+ 1 ° F above air temperature)	
Bluegrass (4-inches tall) . . . . .	67 ° F
(- 11 ° F below air temperature)	

In most of California, it is this heat problem which makes natural turf the first choice even when old soil construction methods are used.

In 1978, the only major stadium in California with an artificial turf, Candlestick Park in San Francisco, was converted back to a natural field. A type of cell system was chosen for this park in which the extensive drainage system overlaying a plastic barrier can double as a sub-irrigation system. The growing medium was a uniform, fine sand surface amended with fir bark. The field was open for professional baseball before the contractor had completed the job. The baseball players were not well pleased during the first season, which was to be expected, but the field was well received by football

players. Once a proper management program has been developed, this field could establish natural turf over artificial as the best answer for California's high traffic athletic areas.

During the past 15 years, our work with high-use athletic areas has centered on the use of special sands overlaying a tile system. Because of our climatic conditions, we have not felt that we could justify a closed cell system for drainage and subirrigation. We have worked closely with architects, contractors, and developers in the planning and construction of 15 football fields and seven multi-use part sites in northern California. We also have tested and supplied information for many projects both within California and throughout the U.S. We believe the key to these high-use areas is in the selection of a relatively fine particle size range of sand placed at a depth of 12 to 14 inches. This sand must accept and drain excess water rapidly and, once drained, still retain sufficient water in the grass root zone so that irrigation need be no more frequent than every 2 to 3 days during the normal summer weather. These are the same sands and the same horticultural concepts that we recommend for golf and bowling greens. The only real differences are these: we use different grass species, we can tolerate sand nearer the outer limits of our recommendation, and their management is less demanding. The table shows the particle-size range of sand used at different sites in northern California.

We do not recommend amending these sands with organic or inorganic materials, because our research and field experience have shown amendments to have a poor cost-benefit ratio. The benefits commonly attributed to amendments are improved nutrient and water-holding capacity. With the "right" sand, the advantages of amendments are small compared to the cost of the amendment and the special mixing requirements. All too often the mixing is so poorly done on large jobs that more problems are created than solved. Grass also is a very high producer of organic matter, and, once a turf is well established and properly managed, the cation exchange in the root zone is that of a sandy loam soil.

Each field varies in the extent and design of the drainage system according to its climate and use. Water moves rapidly through the 12 inches of sand to the sub-base soil, at which point extra water will create a perched water table. A tile system at this interface functions to drain off this perched water table. The best systems make use of a sloping subbase to the tile lines. One such system is illustrated on page 27, but this system may be modified in many ways and still achieve its purpose.

The sand-based field is no panacea. Overuse still will wear out the turf. Mismanagement can still reduce the quality and playability of the turf. The advantage of the

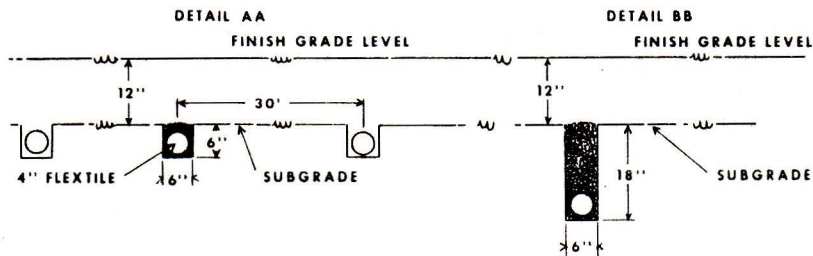
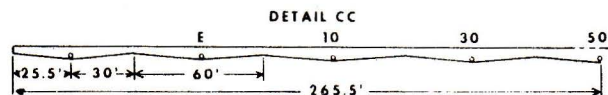
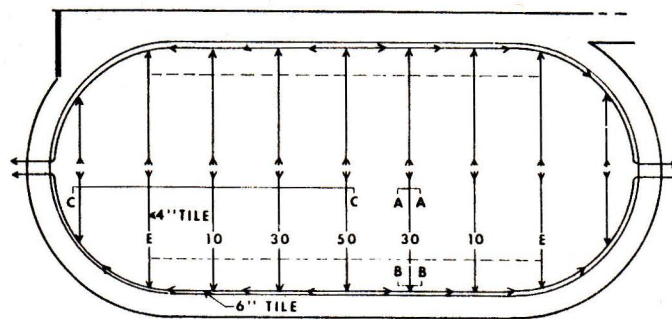
**Analysis of Representative Sand Samples According to Particle Diameter (mm) from Various Sportsfields in California (and Recommended Proportions)**

Location	Use	Fine gravel	Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay	Key fraction	Compacted Infiltration inch/hour
		(2.0-2.0)	(2.0-1.0)	(1.0-0.5)	(0.5-0.25)	(0.25-0.1)	(0.1-0.05)				
<i>Percent</i>											
Fortuna	Football Soccer	6.0	0.0	0.5	74.5	23.5	0.5	1.0	0.0	98.5	26
Eureka	Football	0.2	0.2	0.8	60.5	35.0	0.9	1.4	1.0	96.3	29
Ukiah	Football	0.0	0.5	1.0	69.0	28.0	0.6	0.5	0.4	98.0	49
Linhurst	Football	1.1	3.3	30.0	55.5	8.4	0.4	0.6	0.7	93.9	(?)
Delta	Baseball	0.2	2.2	19.0	44.5	28.0	3.5	1.7	0.9	91.5	21
Petaluma	Soccer	0.0	0.6	3.1	83.2	11.0	1.4	0.0	0.7	97.3	51
Salinas	Football	0.0	0.0	26.0	68.0	4.7	0.1	0.5	0.7	98.7	>70
Cabrillo	Football	0.0	0.3	1.0	65.4	27.5	2.3	1.7	0.8	94.9	27
Peralta	Soccer	0.1	3.0	42.5	45.5	4.9	0.6	1.2	3.2	91.9	37
Gilroy	Football	0.3	6.9	60.9	25.6	5.1	6.3	0.0	0.0	90.5	36

**Recommended proportions for construction**

Acceptable = 1.0 to 2.0 mm  
(0 to 10%) + 0.1 to 1.0 mm  
(80 to 90%) + clay to 0.1 mm  
(5 to 10%)

Desirable = 1.0 to 0.5 mm  
(0 to 15%) + 0.1 to 0.5 mm  
(80 to 90%) + clay to 0.1 mm  
(4 to 8%)



A suggested drainage system for a football field inside a quarter-mile running track.



sand-based field as compared to a natural soil-based turf field, is that the "right" sands are not compactable. Water moves into and through the medium. The more optimal growing condition produces a healthy, strong, growing turf. Even a badly worn field is not muddy. The field is playable even if it is raining. We can mow, overseed, aerate, and/or practice other management programs without waiting for the field to dry out. Fields can be flat, because we don't depend on any surface drainage to remove excess water. Disease problems are reduced because we have a better soil-to-air water relationship in a root zone. Fertility management is important and does require careful attention during the first 6 to 12 months. Once established, we have not found that sand-based fields require any more special attention than a properly managed soil-based field. We can over-leach sand-based fields by applying water too frequently and in greater amounts than are necessary. The sand-based field must have a well-designed irrigation system to supply uniform coverage. All too often we tend to flood-irrigate with a sprinkler system. This will not work on a sand field.

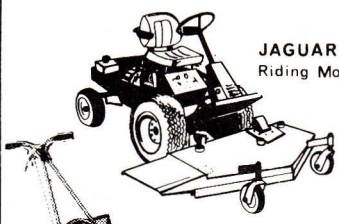
As turf managers, we do have alternatives. Where traffic is high and we must use our field during periods of wet weather, the sand-based field can be an answer. We must use the right type of sands, and, therefore, construction costs will generally be higher than for a typical soil-based field. Even if properly constructed, sand-based fields will not measure up to their potential with a minimum management program. Their real asset is the fact that they can be managed. They never need to be rebuilt and can always be managed back to a perfect natural turf field. For the vast majority of outdoor sports areas, there are few situations where an artificial turf would be needed or, over time, be a greater economical benefit than a sand-based natural turf.

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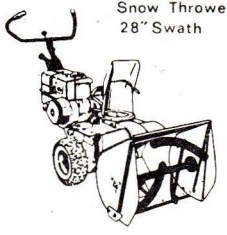
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*Editors note: Be aware that the sands in the western United States are much younger, and therefore more fertile than eastern United States sands.*

## Fertility Assay of Sands

Jack A. Paul<sup>1</sup>

Use of sand as growing media either as a component in soil mixes or alone stems from desirable physical properties imparted by sands, not their fertility. Generally, sands are thought of as being poor nutritionally. Under those circumstances where sand is used in potting soil, the fertility of sand is not important since nutrition in container culture is easily effected with combinations of chemical amendment, liquid fertilization, controlled-released and dry fertilizers. Under conditions where sand is used as a sporting turf soil (putting green, football field) and will not receive the intense fertilizer management of a container soil, inherent fertility is important. If sand can provide some of the plant nutrients, management is easier. Fertility of sands, as a separate class of soil, has not been evaluated, yet it would be useful to have this information.

The purpose of this work was to assess fertility of sands suitable for horticultural purposes with particular references to sands used for turf. The present study evaluates nitrogen (N), phosphorus (P), potassium (K), and sulfur (S) status of 35 sands using the pot testing method (Jenny, Vlamis, and Martin, 1950). Soil testing for estimating available P and K in sands is also presented.

Before discussing the results on fertility, it is worthwhile to review briefly the reason for using sand as a traffic soil. It is not necessary that all turf soils receiving traffic be constructed of sand. Under conditions of low to moderate traffic and with good management, soil other than sand can and will support good turf growth. Heavy traffic can cause extra demands on management to keep the soil permeable to water and air, and it is under such conditions that sands are most useful.

Soils containing silt and clay are more or less in a state of aggregation. Under a compactive force, moist soil aggregates deform and flatten, filling in the large air and water-conditioning pores between the aggregates. The remaining pores are very small and conduct water slowly. Sands form rigid networks of grains that can withstand compaction. After compaction, there is little change in numbers of conducting pores between grains, and so permeability to air and water is preserved. This ability to withstand compaction is the principal reason for preferring sand rather than finer textured soils.

### Particle size distribution

Since natural sands are generally unsorted sediments, particular attention should be given to the particle size distribution. Not all sands are ideal for growing plants or for managing. The particular size diameter of sands is given in the tables of the two preceding articles.

<sup>1</sup>Department of Environmental Horticulture, University of California, Davis.

Silt is 0.05 m and clay is less than 0.002 mm. Fine gravel is greater than 2.00 mm. Sands having a broad particle size distribution, i.e., a fairly continuous particle size representation, are poor horticultural sands, because the finer grains fit into pores between larger grains, and if silt and clay are also present (8 to 10% by weight), the problem is further aggravated. The resulting mixture is a very dense (bulk densities of 1.9 g/cc), tough matrix with only fine pores. We seek uniform sands in horticulture, medium sands for sport turfs and medium-coarse sands for potting soils. Uniform medium and medium-fine sands are permeable after compaction (6 to 12 in./hr.) and contain adequate available water (1¼ to 1½ in.) in the surface 4 inches of a 12-inch depth following drainage. Medium-coarse and coarse should probably be amended to increase plant-available water. For a review of sands recommended for putting greens see Davis (1973 a, b) and articles in this issue.

In selecting sand to meet the physical requirements for a traffic soil, to what extent is fertility sacrificed? Sands have little or no cation exchange capacity; sands taken from below the surface foot have no organic matter and probably a small microbial population. Visual inspection of some sands suggests that they consist primarily of quartz. Such sands would require careful and complete fertilization. Other sands appear to be rich in primary minerals, such as mica, feldspars and ferro-magnesium minerals. Thus, some sands appear to have no plant nutrient-bearing minerals, while other seem to have a full complement of such minerals.

### Fertility of sands

The pot test method was used to assess fertilizer requirements of 35 sands obtained from various commercial sources in central California. It consists of treatments with elements in various combinations with elements subtracted one by one - e.g. PKS minus N(N<sub>0</sub>). Treatments consisted of: NKPS: full; PKS: N<sub>0</sub>; NKS: P<sub>0</sub>; NPS: K<sub>0</sub>; NPK: S<sub>0</sub>; —: Check.

Plants were grown in 4-inch plastic pots containing 650 grams of sand. The fertilizers were applied as chemically pure salts at the following rates:

Element	Fertilizer salt	grams/pot	Pounds/acre	
			Element	Oxide
N	NH <sub>4</sub> NO <sub>3</sub>	0.281	300	—
P	Ca(H <sub>2</sub> PO <sub>4</sub> ) <sub>2</sub> •H <sub>2</sub> O	0.115	88	200
K	KCl	0.103	166	200
S	Na <sub>2</sub> SO <sub>4</sub>	0.144	100	—



Nitrogen was applied as a split application with one-half applied 45 days after planting.

One-hundred mg of seed of bentgrass (*Agrostis tenuis* cv. 'Penncross') were planted per pot. The grass was grown for 60 days, and three harvests were made by taking clippings 30, 45, and 60 days after planting. Total dry weight yield per pot was obtained by summing the three harvests. There were four replicates per treatment. Relative yield (yield of subtractive treatment per yield of full treatment,  $\times 100$ ) is used to compare fertilizer responses between sands.

All experiments were performed in a cool greenhouse (night temperature 55° F and day temperature 80° F) from April through October.

### Results

The following table summarizes the extent and frequency of fertilizer responses obtained for 35 sands.

Percent yield (percent)	Percent of sands deficient in			
	N <sub>o</sub>	P <sub>o</sub>	S <sub>o</sub>	K <sub>o</sub>
0 - 20	100	31	6.2	.0
20 - 40	—	6.2	18.8	3.1
40 - 60	—	25.0	31.3	6.2
60 - 80	—	15.6	31.3	37.6
80 - 100 +	—	50.0	18.7	53.1

#### Nitrogen

The N<sub>o</sub> treatment for all sands had relative yields (RY) of 0 to 20 percent. Yields of this treatment were no better than the check, which suggests that the sands were absolutely deficient in available nitrogen. This is not too surprising if the source of sand is considered. All came from subsurface deposits. Nitrogen-deficient grass was stunted and light yellow.

#### Phosphorus

Fifty percent of the sands tested were well supplied with

available phosphorus (RY, 80 to 100 percent) and 9 percent were severely deficient. It is interesting to note that, in the P<sub>o</sub> treatments for some sands, growth rate increased after the first clipping. This suggests that, with time, more phosphorus became available. Moderately phosphorus-deficient grass is stunted and dark green with narrow blades.

#### Sulfur

Sulfur-deficient sands appeared to be more or less represented in all RY categories. It is speculated that S compounds originally present in these sands were leached with low sulfate waters, and since no organic matter is present, there is no mineralization from organic sources. Sulfur-deficient grass is very similar to N deficiency.

#### Potassium

Fifty-three percent of the sands were adequately supplied with available K. Three percent were severely deficient, and 38 percent were moderately deficient. Potassium-bearing minerals, such as mica and the feldspars (microcline and orthoclase), would be the main sources of K; clay-derived K would be minor, since clay was generally less than 3 percent of the sand sample.

Micro-nutrient treatments were included in many of the sands, but no significant yield increment was obtained in these treatments. None of the sands tested indicated a need for lime, and no calcium (Ca) or magnesium (Mg) deficiency symptoms were noted, but this does not rule out the possibility that some sands will be deficient in these nutrients. Since only 35 sands were evaluated, no generalizations can be made regarding micro-nutrient and lime requirements.

### Chemical analyses

The pot testing method provides a reliable means for assessing the fertility status of soils, but it requires proper facilities and time. Soil tests are not as reliable, but if they are well correlated with fertilizer requirements, they are very useful. They are also less expensive. Soil analyses for phosphorus and

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potassium were performed on all sands and were correlated with appropriate subtractive treatments. The tests for sulfur has not yet been done for these sands. Nitrogen need not be considered for obvious reasons.

### Phosphorus

Available phosphorus was estimated on untreated sand samples by two methods: 0.5M NaHCO<sub>3</sub> extractable P and water soluble P (Rible and Quick, 1960). For the NaHCO<sub>3</sub> methods, extractable P is reported as ppm P on a soil basis, while water soluble P is expressed as ppm P in the extract. Both values are plotted against the RY of the P<sub>0</sub> treatment.

The correlation between P<sub>0</sub>RY and NaHCO<sub>3</sub> extractable P suggests that this procedure could be useful in predicting phosphorus fertilizer requirements. While the correlation is not excellent, a value of 3 ppm P appears to be near the critical level. This value is lower than is recommended for soil (6 ppm). The relation between P<sub>0</sub>RY and water soluble P provides a better correlation. The critical level is about 0.15 ppm P. This value is the same as that cited by Bingham (1962) for soil, with cereals as the indicator plant. Both methods are useful in estimating phosphorus fertilizer requirements in sands.

### Potassium

Available K was estimated by extracting with neutral normal NH<sub>4</sub>OAc (ammonium acetate). Sands have a very low cation exchange capacity, and extractable K is expected to be low even in sands well supplied with K. Beyond 20 ppm, there is no response to K fertilization. This critical value is considerably lower than for soils containing clay, but it is in keeping with the critical level found in sands in Australia.<sup>2</sup>

In addition to P and K analysis, salt and pH should be determined. Salt should not present a problem since it is easily leached if the sand is a permeable one. Sands having a very

<sup>2</sup>T. Arkley, Agricultural Consultant, Perth, W.A., personal communication.

low pH (4 to 5) indicate a need for lime or dolomite, while sand having a pH  $\geq$  8 may have lime present.

### Conclusions

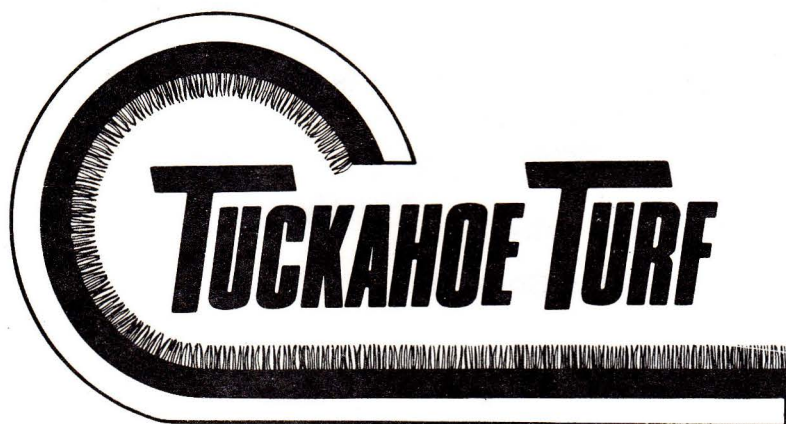
The results of the pot test for a limited number of sands indicate that they behave as might be anticipated for sub-soil. The extent and frequency of P deficiency is similar to surface soils which have been tested (Vlams, 1966). Nitrogen is completely lacking. Occurrence of S and K deficiencies is probably more frequent in pot tests than in valley soils in California.

It is apparent that all sands will require N to start grass, and many will also require S. Soil tests can help decide whether P and K should be added also. but sand well supplied with P and/or K initially may eventually become deficient in these nutrients as clippings are removed. Soil and tissue tests may be useful to indicate when these nutrients should be applied.

The work is part of the Turfgrass Adaptive Research Program, supported by a grant from the Northern California Golf Association.

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