PROCEEDINGS OF THE 49th NORTHWEST TURFGRASS CONFERENCE

October 9-12, 1995 Skamania Lodge, Stevenson, Washington

1995-96 President's Message

The Northwest Turfgrass Association's 49th Conference has finished and, as we have come to expect, was successful in many respects. To all of the attendees and presenters, I extend a warm thank you on behalf of myself and the Board of Directors.

Skamania Lodge provided a great site to showcase an excellent conference. Special thanks to Jim Medler who hosted our annual golf tournament under less than desirable weather conditions.

The major goal of the Northwest Turfgrass Association is to fund turfgrass research in the Northwest. In the past, our level of funding has hovered just above $30,000.00. At this year's conference, John Bodenhamer, Executive Director of the Washington State Golf Association (WSGA), announced his group's commitment to research for golf turf by budgeting $.50 per member from their association. This amount (over $40,000) more than doubles our research funding capability and is an indication that the end user of turf has begun to see the benefits of turfgrass research. Instrumental in securing the support of the WSGA was Mr. Tom Christy, CGCS. Through his efforts over the past year developing the Turfgrass Universities Research Fund (T.U.R.F.), he has guided the WSGA in making this important decision. Thank you for your tireless campaigning, Tom!

Thank you to all suppliers who participated in our sponsor program. The annual conference sponsor program provides a major portion of our annual research and scholarship funds. Your support of the NTA is much appreciated.

Best of luck to your new president, Tom Christy. I personally wish to invite everyone to our 50th annual conference at the Empress Hotel and Convention Center in beautiful Victoria, British Columbia, Canada.

Randy White, CGCS
President, Northwest Turfgrass Association

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EVALUATION OF DIVERSE KENTUCKY BLUEGRASS FOR POTENTIAL TURFGRASS USE[1]

Matthew C. Nelson, Dr. William J. Johnston, Dr. Richard C. Johnson, and Charles T. Golob.[2]

[1] Presented at the 49th Northwest Turfgrass Conference, Skamania Lodge, Stevenson, Washington, October 8-12, 1995.

[2] Graduate student, Assistant Professor, Agronomist, and Research Technician III, respectively, Department of Crop and Soil Sciences, Washington State University and USDA/ARS, Pullman, Washington.

INTRODUCTION

Kentucky bluegrass (*Poa pratensis L.*) is used in over 40 million North American lawns and is an important turfgrass for golf courses, parks, and sports fields (Bashaw and Funk, 1987). The tri-state region of Washington, Idaho, and Oregon produces more than 75% of U.S. Kentucky bluegrass seed (Ensign et al., 1989). The USDA-ARS plant introduction collection of Kentucky bluegrass consists of 267 diverse germplasm accessions from 27 countries, and may contain genotypes that have improved turfgrass characteristics and improved seed production capacity under traditional (burning) and alternative (non-burning) residue management strategies. Basic evaluation of this collection for agronomic descriptors has not, however, been completed and is needed to identify genotypes for residue management studies. From the collection, 228 accessions were evaluated along with 17 established cultivars from eight diverse morphological groupings (Table 1)(Murphy, 1990).

OBJECTIVES

1. Evaluate the USDA-ARS Kentucky bluegrass collection for agronomic descriptors.
2. Establish a core collection representing morphological diversity within the USDA-ARS collection.
3. Select accessions based on turf quality and seed yield, for future studies of turfgrass quality and seed production under alternative residue management systems.

MATERIALS AND METHODS

Germplasm accessions were evaluated for diversity at a 28- by 28-m irrigated site at Pullman, W A. Accessions were planted in 1-m strips with 0.3 m spacing in a randomized complete-block design with three replications. A total of 245 germplasm accessions were planted on 24 May 1994. Evaluation parameters (Table 2) were adapted from the standard descriptor list developed by the Forage and Turf Grass Crop Germplasm Committee. The plot was irrigated during the first growing season, and not irrigated during the second growing season. Broadleaf weeds were controlled with 0.42 kg a.i. ha1 bromoxyinil (Buctril) during establishment. Witchgrass (*Panicum capillare L.*) was treated with two applications of MSMA (Bueno 6) at 4.6 kg a.i. ha^{-1} on 21 June 1994 and 12 July 1994 (Robocker et al., 1977). Heading date, flowering date, and harvest date were measured in Julian days. Seed was hand harvested, threshed, air cleaned, and weighed for yield. In cases when plant stand was less than the 1 m planted, yield was adjusted to be proportional to 1 m. Cluster analysis was completed with SAS using Ward's clustering method (Romesberg, 1984).

RESULTS AND DISCUSSION

Data were collected on 17 parameters for 245 diverse Kentucky bluegrasses (Table 2). Wide variation existed in disease resistance, seed yield, and dwarfing character. Although highly significant, less relative variability existed in heading, flowering, and harvest dates. A core collection was generated from the data by cluster analysis. Twenty-two clusters were developed and one representative accession from each cluster was chosen at random to constitute the core collection (Table 3). This core represented 12 countries and approximately 10% of the accessions studied (228 PI accessions). Cluster data for turf potential and seed yield are presented in Table 4. Clusters 14, 15, and 16 all contain accessions with high seed yield. Clusters 9 and 11 represented dwarf types, with generally good turf characteristics, but relatively low seed yields. Clusters 10 and 12 also had accessions with good turf characteristics, and cluster 16 had accessions with good seed yield and turf characteristics. Cluster 22 represented fine textured types, and clusters 17 and 18 represented accessions with forage type characteristics. The core collection, nine cultivar checks, and 17 selections based on turfgrass potential and seed yield were chosen for future studies of seed yield under alternative residue management strategies and turfgrass characteristics.

CONCLUSIONS

Variability within the USDA-ARS plant introduction Kentucky bluegrass collection was pronounced; all parameters evaluated were highly significant. Although more testing is needed, germplasm within the collection has been identified that was superior for some traits compared to widely used established cultivars. Due to such variation, there is potential for selection of germplasm with improved seed yield under alternative residue management regimes, and improved turfgrass quality. Evaluation data will be available on the Germplasm Resources Information Network (GRIN) and PI collection seed is available from the W estern Regional Plant Introduction Station, Pullman, WA.

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Robocker,W. C., and C. L. Canode. 1977. Control of witchgrass in fields of seedling Kentucky bluegrass. Agron. J. 69:455-457.

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Table 1. Cultivar checks.

Subgroup A;	Compact types	'Midnight', 'Nublue'
Subgroup B;	Bellevue types	'Banff', 'Dawn'
Subgroup C;	Mid-Atlantic types	'Monopoly', 'Plush'
Subgroup D;	Julia types	'Julia', 'Ikone'
Subgroup E;	Very aggressive types	'Mystic', 'Washington'
Subgroup F;	Other or Cela types	'Coventry', 'Eclipse', 'Bartitia'
BVMG types		'Baron', 'Victa'
Midwest types		'Kenblue', 'Park'

Table 2. Agronomic paramaters evaluated.

Parameter	Mean	Std. Dev.†	CV††	Range
Emergence (d)	14.5	2.72	19	10-20
Texture (1-9)	5.7	0.93	16	2-9
Genetic color (1-9)	5.7	1.03	18	2-9
Uniformity (1-9)	5.8	1.83	32	1-9
Leaf habit (1-9)	5.0	1.28	26	2-8
Dwarf character (1 -9)	4.0	2.02	51	1-9
Biomass (l-9)	5.3	1.38	26	1-9
Mean canopy height (cm)	16.9	5.32	31	3-36
Turf potential (1 -9)	5.4	1.04	19	3-8
Spring greenup (1 -9)	5.6	1.36	24	2-9
MS MA phytotoxicity(0-3)	1.4	0.62	44	0-3
Powdery mildew (0-3)	0.9	0.99	110	0-3
Heading date (Julian date)	123.1	8.40	7	115-145
50% anthesis (Julian date)	148.3	7.34	5	135-176
Harvest date (Julian date)	181.2	6.42	4	171-222
Height at harvest (cm)	79.2	17.17	22	26-112
Adjusted seed yield (g m- 1)	56.7	34.27	60	1.6-191

*Qualitative traits rated by scale; 9=finest texture, best color, most uniform, upright leaf growth, most dwarf, most biomass, best turf potential, best spring greenup. MSMA and powdery mildew rated by scale; 0=no phytotoxicity, no infection, 3=severe burn, severe infection.

†Std. Dev. = standard deviation.

††CV = coefficient of variation.

Table 3. Core collection.

Cluster number	n†	PI no.	Origin
1	13	206725	Turkey
2	22	237282	Denmark
3	12	349223	Alaska
4	18	372738	Alaska
5	15	380992	Iran
6	7	371769	Alaska
7	13	372741	Alaska
8	13	371775	Alaska

Cluster number	n†	PI no.	Origin
9	13	368233	Alaska
10	13	349225	Alaska
11	6	349160	Alaska
12	14	574523	Maryland
13	1	440601	USSR
14	13	539057	USSR
15	11	229721	Iran
16	6	368241	Alaska
17	9	204491	Turkey
18	17	505898	USSR
19	11	303053	Sweden
20	5	286381	Netherlands
21	6	371771	Alaska
22	7	349178	Alaska

†n = number in cluster.

Table 4. Cluster data.

Cluster number	n†	Cluster means: Turf potential†† (l-9)	Cluster means: Seed yield (g m- 1)	Cultivar
1	13	4.9	26.6	Banff, Plush
2	22	4.8	36.5	
3	12	5.0	19.5	
4	18	4.8	56.0	Park, Eclipse
5	15	4.9	51.6	
6	7	5.6	62.4	
7	13	5.1	51.4	
8	13	5.7	49.0	Mystic, Coventry, Bartitia
9	13	6.3	17.5	
10	13	5.8	35.6	
11	6	6.0	30.7	
12	14	6.1	25.7	Dawn, Nublue Midnight, Ikone, Julia

Cluster number	n†	Cluster means: Turf potential†† (l-9)	Seed yield (g m- 1)	Cultivar
13	1	3.7	46.8	
14	13	5.4	99.8	
15	11	5.3	109.9	Kenblue
16	6	5.7	145.7	
17	9	4.8	86.2	
18	17	5.5	74.3	Washington
19	11	5.1	68.7	
20	5	5.5	75.2	
21	6	5.4	82.6	Monopoly, Victa, Baron
22	7	5.9	88.8	

†n = number in cluster.
††Turf potential rated 1-9; 9=best.

THE GOLFER' S GOLF COURSE EXPECTATIONS AND CONCERNS[1]

John Bodenhamer[2]

[1]Presented at the **49th Northwest Turfgrass Conference,** Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2]Executive Director, Pacific Northwest Golf Association and Washington State Golf Association

The following "Top l0" list was compiled based on the comments of a cross section of members of the PNGA and WSGA Boards of Directors, volunteers, and other association members and included men and women of varying ages and playing abilities. The question to which they responded was:

"What expectations do you have regarding the playing conditions, maintenance, and overall atmosphere of a golf course (home or away) when you play?"

THE GOLFER'S "TOP l0"

1. SMOOTH GREENS
2. NOTICE OF AERAFICATION
3. OPEN-MINDED SUPERINTENDENT

4. TEES ALIGNED PROPERLY/HOLE LOCATIONS NOT SET UNFAIR
5. BUNKERS MAINTAINED (REGULARLY RAKED / EDGED)
6. FIRM(DRY) CONDITIONS
7. PROTECT THE ONMENT
8. LEVEL TEES
9. GREEN GRASS
10. VARIETY IN COURSE SETUP

MAINTENANCE PRACTICES AND HOW THEY EFFECT THE COURSE RATING

1. CHANGE IN EFFECTIVE PLAYING LENGTH

A change of 22(18) yards in the playing length of the golf course will change the USGA Course Rating 0.1 strokes. A change of 93(85) yards will change the Slope Rating 1 point.

a. Tee placement - The most obvious way to increase or decrease the effective playing length of the golf course is to move all the tee markers behind or ahead of the permanent yardage markers on each hole. LE: Placing the tee markers 10 yards ahead of the permanent markers on each of the 18 holes decreases the overall length of the course 180 yards, which results in the Course Rating being 0.8(1.0) strokes too high and the SLOPE Rating being 2 points too high.

b. Dogleg or forced layup - Adding obstacles or moving tees that cause the Scratch Golfer to layup short of their normal 250(210) yard landing area or the Bogey Golfer to layup short of their normal 200(150) yard landing area increases their respective Course Ratings. Removing any obstacle or lengthening the distance to a dogleg that has caused a forced layup will result in the Course Rating actually decreasing.

c. Roll - Softening fairways increases the effective playing length while hardening them decreases the effective playing length. If over-night watering results in the condition of the fairways changing from average to soft, the USGA Course Rating will be increased 0.2(0.3)strokes. To a greater extent, if the increased watering results in the condition of the fairways changing from firm to average, the USGA Course Rating will increase 0.5(0.6) strokes and the Slope Rating will increase 1 point.

2. CHANGES IN OBSTACLES - In general, changes in obstacles has less effect on USGA Course and Slope Ratings than changing the effective playing length. Increasing or decreasing an obstacle rating by only 1 point will result in the USGA Course Rating being adjusted on 11 one-thousandths of a stroke. In order for the USGA Course Rating to change 0.1 strokes you must have a change of 9 points in the obstacle ratings.

Listed below are obstacles that are directly affected by maintenance practices and how they can change the USGA Course and Slope Ratings.

a. Fairway - Changing the mowing pattern on all par 4 and par 5 holes on the course by 10 yards per hole will adjust the USGA Course Rating 0.3 strokes and the Slope Rating 1 1/2 points.

b. Rough and Recoverability - Changing the rough height by 1 inch on all 18 holes adjusts the USGA Course Rating 0.7 strokes and the Slope Rating 5 points.

c. Green Target - Changing the holding properties of the greens because of over/under watering from "soft" to "medium" or "medium" to "hard" will adjust the USGA Course Rating 0.2 strokes and the Slope Rating 1 point.

d. Green Surface - A change of 1 to 1 1/2 feet in the Stimpmeter speed on all 18 greens will adjust the USGA Course Rating 0.2 strokes and the Slope Rating 1 point.

A change in other obstacles that we evaluate can also effect the USGA Course Rating and Slope Ratings, but the items listed above are items that are directly attributable to the maintenance staff. Based upon the items listed above, the following chart will show how the slightest change in maintenance practices can effect the accuracy of the USGA Course and Slope Ratings.

OBSTACLE/EFF.LENGTH FACTOR CHANGED	CHANGE IN USGA C/R	CHANGE IN SLOPE RATING
FAIRWAY	+ or - 0.3	+ or -1
ROUGH HEIGHT	+ or - 0.7	+ or -5
GREEN TARGET	+ or - 0.2	+ or -1
GREEN SURFACE	+ or - 0.2	+ or -1
TEE PLACEMENT	+ or - 0.8	+ or -2
ROLL	+ or - 0.5	+ or-1
TOTAL CHANGE	+ or - 2.7	+ or-11

As can be seen by the chart above, it would be possible that inaccuracies of 5 strokes or more in the USGA Course Rating and 20 points or more in the Slope Rating can result from inconsistent maintenance practices.

IT IS IMPERATIVE THAT COURSE SET-UP AND MAINTNANCE REMAIN CONSISTENT IN ORDER TO MAINTAIN THE CONDITIONS UNDER WHICH THE COURSE WAS LAST RATED

IPM EFFECTS ON MICROBIAL POPULATIONS OF GOLF COURSE PUTTING GREENS[1]

F. Brian Holl Ph.D., P.Ag.[2]

[1]Presented at the 49th Northwest Turfgrass Conference, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2]Professor, Pacific Turfgrass Research Program, Department of Plant Science
The University of British Columbia, 248-2357 Main Mall
Vancouver, B.C. V6T1Z4

Introduction

Integrated pest management [IPM] has developed as a concept from agricultural practices in the late 1950's and early 1960's. It entered into common use with the environmental movement of the 1970's and has often been associated [erroneously] with concepts of biological control and the absence of chemical pesticide use. IPM is a management system which incorporates common-sense, effective information collection, analysis, and knowledgeable decision-making. It is a management strategy which uses the most appropriate cultural, biological and chemical strategies for managing plant pests. In agriculture, this definition generally adds the modifying phrase...to maintain them below a specified economic threshold. While that may be appropriate in some turf applications, on the golf course, that threshold is aesthetic rather than economic and is lowest on the most intensively managed areas such as golf greens. IPM refers to the program designed to maintain a healthy, vigorous and attractive turf for the specific use pattern.

The Two Conflicts

Intensive management of the golf green functions in the context of two significant conflicts - one philosophical and the other biological, or agronomic.

Conflict # 1 - Philosophical

Many of today's golfers demand a green mowed to 32 mm, table top smooth, but providing a soft landing site, and visually "television" green. All of this on a sand-base, using grasses which may or may not be adapted to the site, and playable 365 days per year! Realistically, no grass has been created that can normally meet these stringent requirements without suffering from stress; even the best managed turf is "living on the edge" [along with the superintendent] to meet such demands. At the opposite extreme of the philosophical conflict is the proponent of golf courses as a toxic waste disposal site - the environmentalist who decries the alienation of the land base, and the use of water, inorganic fertilizers and chemicals to maintain course quality. While this extreme view is not universal, it has produced increasing constraints on the ability of superintendents to use water, fertilizer and chemicals. In the future, these constraints are likely to become more stringent rather than less so.

Conflict # 2 - Biological

The gross morphology of a plant includes shoots and roots; shoots are the engine for plant growth, using photosynthesis to provide carbon and energy. The roots enable the plant to obtain access to water and nutrients to fuel the engine. Maintenance of a 32 mm cutting height ensures that photosynthetic area is minimal. Every time shoots are mowed, there is accompanying root loss - uptake potential is altered and sites for entry of disease organisms are created. While root turnover is an important part of normal perennial plant cycles, under intensive management the process is exacerbated in conjunction with the highly reduced photosynthetic capability. The basic biological conflict, therefore, lies in the gap between management requirements to meet the required aesthetic and functional standards, and the essential requirements for healthy plant growth.

The Management Challenge

These biological and social constraints are part of the challenge facing superintendents in the production and maintenance of healthy turf on golf greens. Integrated pest management [IPM] is one aspect of the management strategy which can be applied to these issues. An effective IPM program incorporates cultural, biological and chemical controls in an integrated package. That approach is management intensive - it requires knowledge of the plants and pests, regular monitoring and careful record maintenance. It is not my intention to provide a primer on IPM today, but to draw your attention to a less common management focus ..... below ground.

I like to characterize our current approach to turf management as "iceberg management"; our attention is fixed on the 4% of the ecosystem aboveground, while we tend to ignore the 88% of the plant which is represented by the roots [92% If we include the thatch in that estimate]. Our traditional view of this murky underworld has been as the source of a variety of problems, notably as a haven for disease-causing microorganisms. However, the turfgrass rhizosphere is also inhabited by a diverse population of beneficial microorganisms - bacteria , fungi and actinomycetes.

Healthy soils are reflected by significant populations of these organisms which contribute variously to nutrient cycling [especially nitrogen], thatch degradation, soil structure [aggregation] and plant growth stimulation. The latter phenomenon is attributable to one or more of several mechanisms - solubilization of phosphorus, direct hormonal growth stimulation, and reduction of deleterious rhizosphere organisms [biocontrol]. Bacteria of the genera Bacillus and Pseudomonas have been shown to be involved in such processes. In addition, many examples of mycorrhizal formation are known to enhance phosphorus uptake by plants.

The challenge for managers is to re-orient their focus to that underground world as a significant determinant of aboveground plant performance. What effects do the management activities of an IPM program have on the soil microflora ?

Management and Soil Microbes

Cultural management

Cultural techniques include the traditional components of pre- and post-establishment turf management - species and cultivar selection, propagation materials, site preparation, irrigation, fertilization, mowing, aerification, topdressing and traffic management are all factors which can, and do influence the rhizosphere microbial population.

Appropriate selection of plant species and cultivars and the use of clean seed, sod or vegetative propagules on a properly prepared site will contribute to the develop of an effective associated microbial population. Too much water, inappropriate fertilization, severe mowing and other stress-inducing management practices will not only affect the visible turf, changes in the population sizes and distribution of soil organisms will occur. These changes will influence nutrient cycling, natural biocontrol, and ultimately such imbalances will enhance the potential for disease development in the plants.

Biological management

Biological management has traditionally been focused on pest control. Naturally occurring and introduced pest control agents have been exploited in a limited number of instances to contribute to biological control of insects, diseases and weeds. Our experiences to date have suggested that such agents are more complex in their function [than chemical pesticides], slower acting, but potentially longer-lasting. A significant disadvantage for their use in management of golf greens is the likelihood that the threshold level of control is unlikely to meet the demanding aesthetic standards currently in place.

What is the solution? One obvious answer may be that we [the golfers], may have to accept a lower standard than that currently provided; I rarely have the temerity to make that a public recommendation. The other side of the question then arises - if we won't change the standards, can we alter management to meet these standards ?While we have developing evidence of the impact of current management on soil rhizosphere mictobes, there is a knowledge gap in our ability to assess the long-term effects on these populations, and to determine the required management strategies to make effective use of the plant growth promoting and biological control capabilities of naturally occurring microorganisms. In other words, we are not yet at the stage of being able to provide effective management of this resource.

Chemical controls

The S/B chemical[1] control option has been an effective component of turf management strategies for several decades. Pesticides provide rapid response capability and varying levels of targeted pest control. Of the pest control arsenal, fungicides are the most widely used in the turf industry. In addition to the social and environmental questions about pesticide use, Dernoeden (1994) has indicated some more specific concerns which are directly relevant to the management of soil microbes:

1. Development of fungicide resistant pathogens.
2. Disturbance of the rhizosphere microbial balance and reduced populations of beneficial microorganisms.
3. Disease enhancement [of non-target pathogens].

Documented cases of fungicide resistance are now well known. The anti-microbial effects of fungicides will almost certainly influence a variety of non-target organisms in the ecosystem. Non-target disease organisms may develop a selective advantage, replacing one disease problem with another. Non-target beneficial microorganisms can be affected, reducing the ability of the system to decompose thatch, to recycle nutrients and to act as antagonists to pathogens. Repeated use of the same, or related fungicides, can, therefore, act to provide a long-term significant disruption to the microbial ecosystem as an unwanted side effect of the treatment regime. Accurate pest identification, appropriate control selection and use should be combined with good plant health management to avoid the development of these more extreme conditions. Such an approach will require a modification of our views of what is being managed to include that soil microbial population as a significant component of the overall strategy.

Understanding the Microbial Ecosystem
Life In the Underground

The rhizosphere ecosystem is a diverse, complex mixture of biotic and abiotic components. Our traditional knowledge of these systems relates primarily to the processes of nutrient recycling and the life cycles of pathogenic microorganisms. Out capability to exploit these relationships is in its infancy. Nelson [1995] has described the key role of organic matter in the management of microbial resources for plant health, and in particular, the disease suppressive qualities of composts as they influence microbial composition and activity in the soil.

Our work has been focused on attempting to understand some of the complexities of the rhizosphere system, and its response to current management . We are looking specifically at the bacterial and actinomycete components of the ecosystem in an attempt to relate characteristics of these communities to soil and plant health on the golf green. Many of the traditional techniques for soil microbial evaluation are dependent upon the ability to culture the desired organisms. Such techniques are inadequate for the ecological evaluation of mixed populations. We have been working on the development of a technique to evaluate the metabolic capacity of soil populations which is independent of culturability, rapid and predictive.

[Table 1.] Used to define the metabolic activity of a particular soil for gram negative, gram positive and actinomycete microbes.

Carbohydrates

adonitol
α-D-galactoside
α-D-glucose
α-D-lactose
α-methyl-D-glucoside
α-methyl-D- mannoside
arbutin
β-methyl-D-galactoside
β-methyl-D-glucoside
cellobiose
D-arabitol
D-furctose
D-galactose
D-mannitol
D-mannose
D-melezitose
D-meliobiose
D-raffinose
D-ribose
D-psicose
D-sorbitol
D-tagatose
D-trehalose
D-xylose
gentobiose
i-erythritol
L-arabinose
L-frucose
L-rhamnose
lactulose
m-inositol
maltose
maltotriose
mannan
3-methyl glucose
methyl pyruvate
mono-methyl succinate
N-acetyl-D-galactosamine
N-acetyl-D-glucosamine
N-acetyl-D-mannosamine
palatinose
sedoheptulosan
stachyose
sucrose
turanose
xylitol

Carboxylic acids

acetic acid
α-hydroxy butyric acid
α-ketobutyric acid
α-ketoglutaric acid
α-ketovaleric acid
ß-hydroxybutyric acid
cis-aconitic acid
citric acid
D-L-lactic acid
D-galactonic acid lactone
D-galacturonic acid
D-gluconic acid
D-glucosaminic acid
D-glucuronic acid
D-malic acid
D-saccharic acid
formic acid
y-hydroxy-butyric acid
itocnic acid
L-lactic acid
L-malic acid
malonic acid
N-acetyl-L-glumatic acid
P-hydroxy-phenylactic acid
propionic acid
pyruvic acid
quinic acid
sebacic acid
succinic acid

Polymers

α-cyclodextrin
ß-cyclodextrin dextrin
glycogen
inulin
tween 40
tween 80

Amines/amides

2-amino-ethanol
alaninamide
glucuronamide
lactamide

phenyl-ethylamine
putrescine
succinamic acid

Amino acids

D,L-carnitine
D-alanine
D-serine
y-aminobutyric aid
glycyl-L-aspartic aid
glycyl-L-glutamic acid
hydroxy -L-proline
L-alanine
L-alanyl-glycine
L-asparagine
L-aspartic add
L-glutamic add
L-histidine
L-leucine
L-ornithine
L-phenylalanine
L-proline
L-pyroglutamic add
L-serine
L-threonine

Miscellaneous

2-deoxyadenosine
2,3-butanediol
adenosine
adenosine-5-monophosphate
amygda l i n
bromosuccinic add
D,L-a-glycerolghosphate
D-lactic acid methyl ester
fructose-6-phosphate
glucose-1-phosphate
glycerol
inosine
salicin
thymidine
thymidine-5-monoghosphate
uridine
uridine -5-monophosphate
urocanic acid

Results from our early use of this technique suggest that it may be an effective means of differentiating greens of different "health", that it may reflect responses to different types of management [e.g. fertility], and that it may also be used to estimate relative sizes of microbial populations.

Figure 1 shows a differential response to fertilizer in a short-term experiment involving an organic and an inorganic nitrogen source. whether such differences can be monitored over time remains to be determined.

FIGURE 1. MICROBIAL SUBSTRATE DIVERSITY & FERTILIZER SOURCE

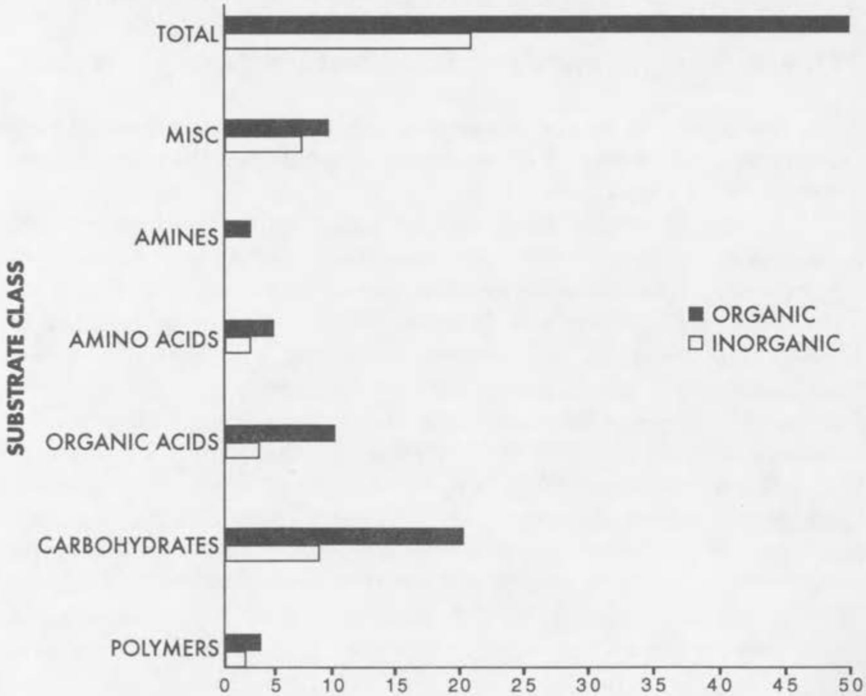
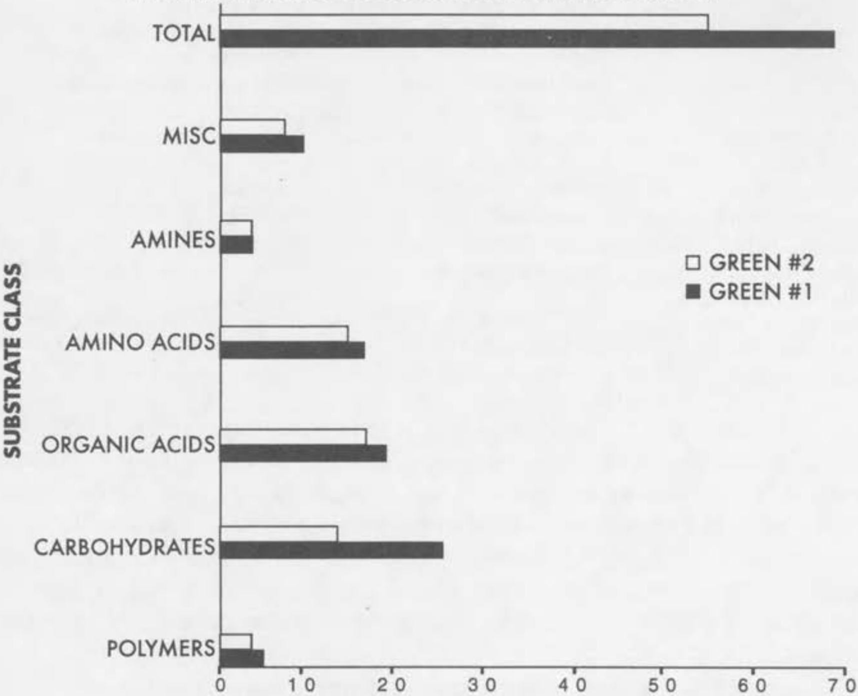


FIGURE 2. MICROBIAL SUBSTRATE DIVERSITY & SITE



Rhizosphere metabolic activity and the Biolog™ system

The technique we are developing uses a series of commercial multi-welled plates containing 95 different carbon substrates. The substrates are arranged in six classes

These data suggest that at least at the extremes of performance, the technique can determine differences and that modified root zones showing increased substrate diversity and metabolic activity are associated with better turf performance. We are currently following a group of greens using this technique to evaluate changes over time. The greens were selected as either "good" [seldom a management problem and-largely disease-free], and "bad" [variable performance - under stress likely to be a problem or suffer from disease]. These greens are being used to develop the database for subsequent comparative analyses. Once we have developed the database, we anticipate being able to apply the analysis to an "unknown" green and to determine where it falls along the spectrum from good to bad at any point in time. Depending upon the effectiveness of the system, we may be able to predict whether any particular green is toward or away from the good end of the scale, as well as its potential response to management or environmental changes. The analysis is relatively rapid [72 h] and economical. It should provide an additional tool in the evaluation and management of the resource which is so critical to the maintenance of aboveground plant health.

Conclusions

The microbial component of the plant rhizosphere is an important, but generally of plant health management. On the microbially-impoverished sand-based greens, rhizosphere management is likely to be an essential of moving to a more sustainable turf management strategy. It will become increasingly important for mangers to understand and use this underground resource for health as part of a sophisticated integrated pest management program. Integrated pest management strategies will include the use of organic matter amendments at construction and on established turf, cultural and biological management of the plant and soil biota, and the judicious use of pesticides.

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IRRIGATION: MAKE IT A FRIEND OF THE ENVIRONMENT[1]

Mr. Carl Kuhn P. E. [2]

1 Presented at the 49th Northwest Turfgrass Conference, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

2 Carl H. Kuhn, P.E. Senior Civil Consultant Kuhn Associates Consulting Civil/Irrigation/Drainage Engineers Mercer Island, WA

You might ask, with absolute humility, "What is the relationship of irrigation, as we know it, to the environment?'" Since Environmental Science has become a hallmark of scientific review, you might say that all we do, all we see, all we feel- all of life - affects the environment. We in the irrigation industry cannot escape that mandate. We are a part of the environment and will fine tune that relationship in the following pages.

Irrigation can be simply defined as the application of water for the sustenance of crops, in our case, principally turf. Irrigation can be quantified as follows:

1.Run a hose and portable sprinkler in one place and leave it run all night.

2.Set a mechanical timer station for 10 minutes in May and hope it will carry you all the way through July and August. Maybe even think about increasing it in July if you have time to get to it.

3.Run a computerized system. Crank in a program when the contractor turns it over to you. Don't let the contractor confuse you with computereze. Make your computer a very expensive "on"-"off" switch.

4.Run your computerized system with input from accurate weather data and field observation and trust that the EVT is not the same every day in July.

You can see that there is irrigation of every type and quality imaginable. All of the foregoing have an impact on the environment. They can and often do contribute to wasted water, runoff, loss of oxygen-generating plant life, flushing of nutrients or chemicals into the ground. Let us look at how we are becoming conscious of the environment even though we may not be aware of our efforts.

Uniform Application of Water

As part of the move to retain our environment, conservation and efficient use of water come into play. One of the major influences on efficient use of water is the drive toward uniform application. Do you or have you ever in the past evaluated your present sprinkler spacing and nozzle selection by requesting test data from the manufacturer so that you understand limitations of your system? If not, now is the time to begin looking in that direction. Let us look at some of the buzzwords that have entered into our industry regarding uniformity.

Coefficient of Uniformity (CU): determined from the statistical analysis of the irrigation sprinkler pattern. The higher the CU, the more uniform the water application. 100% is ideal. If you like formulas, try this one:

$$CU = 100(1 - D/M)$$
$$\text{where } D = (1/n)\sum(Xi - M)$$
$$\text{and where } M = (1/n)\sum Xi$$

Where CU = Coefficient of Uniformity
D = Average absolute deviation from the mean
M = Mean application
Xi = Individual application amounts
n = Number of individual application amounts

CU has been around for many years. At one time it was the only measure of distribution "quality". Subsequent studies have found that other measures can give improved insights into how well the sprinkler pattern is performing. As of this year, CIT continues to consider other significant quantitative criteria to improve on present day uniformity standards in an effort to gain even better levels of evaluation. CU generally referred to the "average", whether it was good, better or best.

Manufacturers have to continue improving medium range rotors while some also should improve golf rotor performance. Spray heads may never be improved to a point we should like to see.

Distribution Uniformity (DU): represents the average of the lowest 25% of the application rates in a sprinkler pattern divided by the average application rate of an entire area. This figure tends to compare the worst part of a pattern with the average.

Scheduling Coefficient (SC): Determines the area in a sprinkler pattern that receives the least amount of water and compares it to the average for the entire area. A SC of 2.0 tells you that you have to operate your system 2 times the average run time to ensure that the driest part of your pattern gets normal water application. A SC of 1.0 represents a perfect sprinkler pattern.

This figure provides excellent guidance. If the SC is high, you will end up either with dry areas or, if you overcome the dry areas, wet areas that suffered because you had to over-water to eliminate the dry spots (except in ideal sandy soils with no thatch on the turf).

Recent years have created much interest in the area of uniformity since there was little to go on up till the last decade except what a manufacturer published and that had little relationship to uniformity. The California Agricultural Technology Institute (California State University at Fresno), had instituted an offshoot titled "The Center for Irrigation Technology" which conducts studies related to the art and science of irrigation. You may recognize the acronym "CIT". Since their inception, one can quickly determine the variances between pressures, spacings, nozzling, etc., between the same heads, between the different heads of the same manufacturer and between different manufacturers. One could say that this independent testing facility has attracted much interest on the part of manufacturers since their product is being evaluated by independents, not necessarily in agreement with in-house testing. It is well and good that independent testing exists since it has perked the interest of manufacturers to improve their products and to ensure that there products are properly utilized.

While recent experience indicates that testing equipment and methodology still varies somewhat between manufacturers and independent testing laboratories, it is encouraging to see continued improvement in this area. It can still be better than we know it here in 1995.

Water Budgeting

Several municipalities and counties in the State of Washington have already implemented a Water Budget requirement. It simply states that you are entitled to use a given amount of water for irrigation of a give square footage of land. This process applies to certain forms of new construction wherein areas of the site are irrigated. It is another hoop to jump through but is one tailored to slow the erroneous conception that water supplies are unlimited. While municipalities may find it difficult to enforce their own water conservation ordinances, is it only a matter of time before we find ourselves complying by other mandates?

A recent Summer drought got our attention in no uncertain terms. For years, we in the Puget Sound country in particular, have lived with a plethora of water, an unlimited supply. Of course the Summer use constraints were implemented annually, calling for those with even-numbered addresses to water on even-numbered days, those with odd-numbered addresses watering on odd-numbered days. That seemed to work well until one Winter when mother nature forgot to snow very much and she put that snow down the drain with an early Spring thaw. All of a sudden we were in serious trouble",.. no snow, no storage, no Summer water.

A few of you who were being served by municipal water supplies felt the impact first. In the order of use priority, homes came first, home lawns came in a distant second, parks and playfields a remote third and golf course last place. Oh yes, they allowed as how you could water tees and greens but the rest of the course went to hay.

I have made mention before of what I call the **persuasive syndrome.** This is when the matter at hand has sufficient political clout that to even be involved in the process of irrigation during a drought, regardless of the source of water, is a no-no. Such was the case in the drought of '91 where at least one public golf course that derived its water from a well, ceased all but the most vital irrigation just to avoid the public outcry. Do you also remember some of the clubs posting signs to advise the passersby that they were not using domestic water to irrigate? Those were hard times.

Before I start into the actual description of water budgeting, let me paint a hypothetical picture of budgeting. Let us assume that power suddenly becomes critically short. The bureaucrats try volunteer rationing but it does not seem to work. In a desperation move, they put limit meters on all of our houses, Each meter has a 750 kwhr limit per month. When a home reaches the 750 kwhr limit, the electricity to that home shuts off and does not re-start until the first of the next month. Would it be a good bet that each of us with that type of dictate would find a way to stay under the 750 number? We might not like the imposition but we would soon learn the meaning of conservation by the simple process of paying attention. The same approach can be applied to the use of water but let us hope that we never get to a point in life where these "limit" mandates run our lives.

It is time for us to start considering conscientious use of our water. A water budget is a start, not the complete answer, but a start. One current water budget code states " **A water budget for irrigation purposes shall be established for all new developments except single family residences or where the total landscape area Is less than 500 square feet".**

$$WB = ETo + AF \times LA \times CF$$

Where ETo = Net seasonal irrigation requirements in inches

Where AF = Adjustment factor of 0.8 which results in an irrigation efficiency of 0.625

Where LA = Landscape area in square feet

Where CF = Conversion factor of.0.62 to convert ET0 to gallons per square foot

Now that we have determined our budget, let us see how our design meets this budget.

We now have EWU (estimated water use) which gives us another formula.

$$EWU = \frac{ETo \times PF \times HA \times CF}{IE}$$

Where ETo = Net seasonal irrigation requirements in inches

Where PF = Plant Factor

Where HA = Hydrozone in square feet

Where CF - - Conversion factor of 0.62

Where IE = Irrigation efficiency

What all of this simply means is that you determine in advance how much of a property can be irrigated and what the allowable water use shall be. This determination shall be made part of the building permit process.

Where this legislation fails is that one can do just about anything one wants after the permit process is completed. That is unless we intend to have "meter police".

At the present time, some of the water budget codes do allow as how " **playgrounds, sports fields, golf courses and schools may be allowed additional water"**. This is a variable which likely can be modified when water supplies start to become a problem.

Alternate Sources

Our southern neighboring states have known about water shortages for many years. Most new course cannot be constructed unless they plan to use effluent water. Let me pause for a moment and correct my technical English..,.,...the proper terminology for tertiary treated waste water is not "effluent water", is not "reclaimed water" is not "sewage water" is not "treated water" is not "gray water" but is properly defined by the most current buzzword *" recycled water"*.

In new housing developments in Florida, they now install three mains down each street. A sewer main, a watermain and a "recycled water main". If you irrigate anything, you use recycled water. These recycled waters, be it Florida home irrigation use or Arizona golf course use, are treated through a third stage of treatment called tertiary. By the time the water goes through this sophisticated staging, it is harmless and carries no more than a stigma which some find hard to avoid.

Here in the Puget Sound country, we are making moves toward the use of recycled water. The most significant problem with recycled water is that the point of production is seldom near the point of need. It is just not practical to consider piping water half way across a city's pavement to deliver recycled water to a remote golf course. Our Renton treatment plant is gearing up for a limited distribution of their recycled water and are just now completing a mainline that will serve several parks and a golf course. The new Boeing Customer Services Training Center at Longacres is designed to use recycled water when the recycled water becomes available. The Tukwila Municipal Golf Course (Foster Golf Links) is contemplating the same. King County Fort Dent Park is also considering recycled water. Of course, these few users will not be capable of using all of the Renton treatment output but that is not the goal; the goal is to save other precious fresh water by substituting recycled water. We suspect that other commercial users of irrigation water will look toward use of recycled water when available.

Modification of Soils

It was mentioned previously that irrigation has an impact on the environment through leaching of nitrates down into the soil and thence to destinations unknown. Dr. Stan Brauen of WSU has provided excellent data on the leaching of nitrates in sand profiles, both plain sand and organically-modified sand. Although there appears to be little difference in the leaching rate after several years, the first year leaching is significant. It was determined that the leaching rate in plain sand was substantially greater than in the organic-modified sand. For this reason, ballfield design, which in the past 15 years was using plain medium-grain sand, has now reverted back to our organic concepts of the 1970 era.... sand modified with organics (on large projects usually fir sawdust with a 15% organic to 85% sand mix), Even some golf course construction that had strayed to pure sand planting mediums, has returned to the old basics of sand and organics. The backtracking to old design methods is environmentally driven but has several agronomic advantages principally the fact that the organics assist in the cation exchange process. Going back to sand/organics in our athletic field design does impact the cost of the project as follows:

1. The cost of mixing sand and sawdust as opposed to the direct pit-to-field concept has a definite cost impact. Mixing requires a large paved area and careful mixing by front-end loader or other mechanized mixing means.

2. Since the organics will eventually decompose, the sand profile that is to remain is the driving force. If we will eventually need an 8'' depth of drainable profile, the sand/sawdust mix must be applied in the original construction at a depth of lO" approximately. This again has an impact on first costs.

Equipment

Last year when I had the privilege of addressing this conference, we talked about the various means of conserving water and electrical power and the use of equipment which assisted us in that direction, i.e., computers, weather stations and variable frequency drive pumps. It holds that careful, effective application of water will not only result in conservation but will also help the environment by:

1. Saving a precious resource.

2. Ensuring that only as much water as is needed is being applied.

3. Leaching and passing of nitrates is reduced.

4. Proper application avoids runoff that leaves undesirable turf loss at high points and saturated bogs at the low points.

5. Allowing EVT and subsequent field observations (including soil probes, etc.) to drive the system rather than guesswork. This is very important in the western slopes of the Cascade mountains where Summer vari-

ables of EVT, if properly monitored, can be an effective water saving tool. In water use for residential or commercial landscaping, there have been innovations that make more efficient use of water such as:

1. Xeriscape: Arizona's idea of using rocks and cactus in place of water-consuming turf.

2. Drip Irrigation: Highly popular approach to low-flow applications at defined spots such as tree root balls, plant bases. This eliminates the need to water everything in sight just to keep trees or shrubs alive. This method has also become very popular in vineyards. It discourages weed growth since water is not applied between rows. It also creates very dusty conditions since the area between rows is no longer covered with the greenery of weeds and native grasses.

3. Micro-Irrigation: Small, localized applicators of water. Slow application denies runoff.

4. Underground feeding: new innovations that apply water from beneath the turf rather than from the surface. This concept is being reviewed for effectiveness particularly since no two sites have the same soil conditions.

(SEPA)State Environmental Protection Act
(EIS)Environmental Impact Statements

Every major construction project requires an EIS statement as a result of laws passed by the State and embellished by local governmental bodies. New golf courses require a costly, in-depth study which relates to every aspect of our environment including water use, water rights, zoning, chemical use, runoff, traffic, animal environments, wetland impact, noise, pollution, etc. A new golf course by today's standards is a major undertaking and requires numerous, costly studies even before the first shovel of earth is turned. It is likely that the future will not be any easier.

Recent park projects are now facing the same reviews particularly with respect to wetlands, sensitive areas, etc. Do not assume that a new site or even an existing site being renovated will not face the close scrutiny of environmental regulation. We are all in this together!

The Future

This recent headline presents an earthshaking forecast "Global water shortage forecasted". There is now concern for water usage throughout the world, not just in our local area. This type of national or worldwide attention will most certainly generate new checkpoints relating to water consumption. Since irrigation, both agricultural and turf, is likely the highest of all users, you can expect more review of our methodologies, our programs and our waste. Here are a few possibilities.

Water Rights: Current applications are slow to come by. Some watersheds have been closed to additional consumption. Lake Washington is a good example of a seemingly plentiful source that now is no longer available for lakeside home irrigation. Regional areas such as the Methow Valley in North Central Washington, are establishing water policies that will likely serve as standards for other Northwest regions.

Mitigation: Each well application is reviewed with an eye on how the well would impact (1) other wells in the area (2) streams in the area and even (3) rivers in the area. Costly studies must be undertaken to ensure that any new well will not have adverse impacts on other wells, fish spawning, or general stream flows. In a recent case, a newly drilled well capable of 450 gpm production, required mitigation that put 150 of those 450 gpm into nearby stream beds.

Consumption Control: All water rights have some form of written limits, both in gallons per minute withdrawal rate and yearly consumption. It is interesting to note that many water rights issued in the past have constraints on the unit withdrawal rate but allow for nearly double the yearly needs. At any rate, there have been cases where withdrawal may exceed the allowed gpm withdrawal rate, Few pumping stations have a meter which would verify water use; however, meters may well be required in the future for new wells and perhaps retroactively on existing high-use wells. When we find ourselves pressing for use of a limited supply, the government will certainly start looking at the relationship of pumping to the actual allowed water right.

Large Project Water Budgeting: Water Budgeting is now being applied by various governments for commercial landscaping. As water becomes more precious, it is possible that this same concept may be applied to large turf projects.

Where Do We Go From Here

The word "Environment" has not only found a permanent place in our dictionaries but it has become a major factor in all that we do in new construction or in maintenance. We can choose to continue to swat at it like a pesky gnat or we can choose to accept it as part of our lifestyle. It would be to your benefit if these areas that I have described are addressed with the question "What can I do to make my world of plants a better one?" Try implementing improvements that help the environment.

It may hurt but only for a little while!

Lastly, it is important for us in the irrigation industry to continually keep the public informed of our ongoing efforts to protect our environment. There is no shame in telling the world that we are not standing idly by but that we are pro-active in environmental issues. What better way to brag about well maintained turf than to quote that famous author and lecturer, Larry Gilhuly, who said that an acre of good turf provides enough oxygen to satisfy the needs of 220 earthlings.

DEALING WITH PLAYERS WHO DON'T WANT CHANGE[1]

Mr. Larry Gilhuly[2]

[1] Presented at the **49th Northwest Turfgrass Conference**, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Western Region Director, United State Golf Association

The Problem

1. It costs more money but seldom heard as the reason

   a. Happy with existing situation
   b. Too old to see results
   c. Don't like disruption in routine of retirement
   d. Lack of confidence in the superintendent
   e. Dislike for the messenger (low digit, young, new member etc.)

2. Lack of education on the subject

The Solution - not always possible

1.Education through communication or If you don't talk they will walk
2. Organize your steps
3. Speaking skills
   a. Must be able to speak to the level of the audience
   b. Tone or attitude
   c. Always tell the same story to every group
   d. Take classes, especially if you speak in public on environmental issues

4. Writing skills
   a. Proper English and punctuation
   b. Form of letter or report should be professional
   c. Always have someone else edit your written word
   d.Take classes to improve

5.Photographic skills
   a.Always take pictures in good times and bad
   b.Always include pictures or preferably slides when selling ideas
   c.Take classes if necessary

d. Have a good 35mm camera

6. Networking
   a. Fellow superintendents
   b. Extension specialists
   c. USGA TAS visit/letters/reprints/membership meetings
   d. TGIF
   e. Golf pro/manager
   f. Specialists-irrigation, drainage, arborist, soils lab, architects

The Hot Issues - examples of successful methods of communication

1. Irrigation System
   A. Establish the need
   a. Photos, slides and video
   b. Analysis by a qualified designer
   c. Field trip with committee and board
   d. USGA TAS visit
   e. Educate and communicate for at least one year to small groups
   f.Single, educational meeting with superintendent, designer, USGA and financing

2. Architectural Change - Warning Emotions Involved!
   a. Are there agronomic requirements ? If so proceed, if not pro ceed with extreme caution
   b. Use an Architect
   c. Photos - Broadmoor Golf Club

3. Bunker Sand - Warning - Do Not Get Emotionally Involved!
   a. Photos
   b. Soil lab analysis
   c. Split bunker to test proposed sand

4. Equipment
   a. Photos and slides
   b. Open house
   c. Demonstrate, demonstrate, demonstrate
   d. The lease option

5. Staff Size
   a. Required maintenance vs. available labor
   b. Section maintenance
   c. Seasonal vs. summer vs. full tim labor

6 .Trees - Warning - Emotions Involved!
- a. Time lapse photos
- b. Use of arborist for pruning and selection - Tualatin
- c. Use of architect to replant properly

7. Winter Play
- a. Photos of damage
- b. Spikeless issue
- c. Reduce tee use
- d. Handicaps frozen also
- e. Get it in writing
- f. Reverse the course

8.Maintenance Facility
- a. Photos
- b. Open house
- c. Committee meetings
- d. Architect for building
- e.Wash area issue

9.Natural Areas
- A.Sell the concept
- a. Reduced fertilizer
- b. Reduced water
- c. Reduced chemical
- d. Above all, reduced or transferred labor
- B. Examples
- a. Widgi Creek
- b. Royal Oaks
- c. Sunriver South/Tokatee
- d. Semiahmoo/Salishan/Oregon Golf Club
- e. New York Audubon Program

10. Mowing Heights
- a. Maintenance standards voted by membership
- b. Broadmoor and Manito operations
- c. Board retreat - Riverside and Mid Pacific examples

11. Conclusion
- a. Upgrade your speaking and writing skills
- b. Use all forms of photography to your best ability
- c. Use available outside sources to help sell programs
- d. Remember, If you do not increase their smarts,
They'll just remain grumpy, old farts!

TOPDRESSING WITH CRUMB RUBBER FROM USED TIRES ON ATHLETIC FIELDS AND OTHER HIGH TRAFFIC TURF AREAS[1]

Dr. J.N. Rogers, III, and J. T. Vanini[2]

[1] Presented at the **49th Northwest Turfgrass Conference**, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Department of Crop and Soil Sciences Michigan State University, East Lansing, Michigan

Introduction

Over the last few years the focus on athletic field maintenance has intensified. Primary reasons for this occurring include an increase in recreational sport activity, the gradual shift from artificial turf to natural grass, and an increase in concern for player safety and liability. Most of this maintenance responsibility falls on the shoulders of athletic department administrators and turf managers who desperately need more information specific to their turf problems. The athletic field research program at Michigan State University has feverishly attempted to keep up with these shift in attitudes through various turfgrass studies. Most of the studies have been aimed toward increasing turfgrass wear tolerance through variety testing or physically protecting the soil from compaction and the plant from damage.

In 1991, 234 million tires were discarded in the United States, many of them in landfills.

However, 25 out of 47 states have prohibited these tires from landfills, and 46 out of the 47 have legislated government funding to recycle the tires (1). This usually means the tire must be broken down into very small pieces and subsequent uses for these parts sought out. While the metal/steel in the tire are easily sold, finding a market for crumb rubber particles (114" and less) has been more challenging. One idea researched at Michigan State University since 1990, is the use of crumb rubber as a soil amendment in different turfgrass situations. The theory is that the crumb rubber particles introduced to the turf/soil system will increase turfgrass wear tolerance, reduce soil compaction, and subsequently reduce turf system inputs.

Original studies of incorporating crumb rubber into the soil profile have proven it to be an ideal soil amendment for high trafficked areas. However, it required taking an area out of play for three or four months, an often impractical task for an athletic field manager. Thus, the objective of this research was to provide an incorporation method which is less disruptive and easier than tilling crumb rubber into the soil profile. One method investigated was topdressing the crumb rubber into the turf/soil surface.

Topdressing plays many roles in enhancing the turfgrass environment. Among these benefits include thatch modification, a smooth playing surface, modification of the soil surface, and winter protection (2). Putting greens and sportsfields profit from this maintenance practice, primarily because they are intense traffic areas with high quality standards, and the games played rely on the importance of a smooth and uniform surface. Specifically, soccer and football fields are subject to more abrasive action due to the nature of the games played on them. In most cases, a sand/organic matter mix or 100% sand is used to promote the aforementioned qualities. However, the most intensively worn out areas, usually by mid-season, are past the point of repair in terms of turfgrass cover, and topdressing will not alleviate the problem. This can be detrimental for the playing field due to the intense traffic areas on the field becoming the most sparse areas or the least dense turf stand (Soccer and football fields are most vulnerable to wear in between the hashmarks and the goal mouth and mid-field portions, respectively). This effect is magnified on low to medium maintenance sports fields. With the absence of turf, the aesthetics and playing field quality are dramatically reduced which can ultimately lead to player injuries. Additionally, sand has more abrasive edges, leading to scarification of the crown tissue area particularly those areas under stress and poor environmental conditions for recovery. The abrasive action of the sand can also be detrimental to any high traffic turf area as well as those under reduced light, (e.g. shade) growing, and recuperative conditions (i.e. cooler weather). The crown tissue area of the turfgrass plant is the source of regeneration of leaves, stems, and roots. While the importance of keeping it alive is obvious, just as important is to provide a favorable environment for this regeneration to take place. Once this area is thrashed and mangled, either by the sand particles or the play on the field, the plant could very easily die thus resulting in bare soil. Consequently, aesthetics and the playability are dramatically reduced, and the potential of surface-related injuries increases exponentially.

Thus the hypothesis was that topdressing crumb rubber, applied in the same manner as any other topdressing, can dramatically reduce the abrasive action caused by the nature of the athletic activity. With an increase in surface area and rounder edges, (in comparison to sand), the crumb rubber is able to cushion the crown tissue area while still providing a smooth and uniform surface, improve overall turf quality and reduce compaction. Inevitably, this improves the playability and aesthetics of the playing surface. Further, if areas that are reseeded or established on an annual or frequent basis are not worn substantially because of topdressing with crumb rubber, one can logically assume a reduction in inputs for turfgrass management and subsequent dollar savings.

Materials and Methods

A trial plot was established on an 80% sand: 20 % peat mix (Table 1) at the Hancock Turfgrass Research Center (HTRC) at Michigan State University, East Lansing, Michigan on 29 July 1993 to determine optimum topdressing rates for high trafficked areas, specifically targeting high school and collegiate athletic fields and playgrounds. To determine optimal particle sizes and application rates, crumb rubber was topdressed in a 2x5 randomized complete block design with three replications. There were two sizes of crumb rubber (10/20 mesh and 1/4" size) and five treatment amounts (0.0, 0.05, 0.10, 0.125, and 0.25 inch) added to the

Table 1. Crumb Rubber Sieve Anaylysis for the Crumb Rubber Topdressing Study at the Hancock Turfgrass Reserch Center, 1993

Category (Size range)	Sand (%)1	1/4" size(%)	10/20 mesh (%)
Gravel(>2mm)	0.9	93.3	16.6
Very Coarse (1-2mm)	8.8	3.7	39.4
Coarse(1-50mm)	44.3	1.5	17.5
Medium(.50-.25mm)	39.6	1.3	22.4
Fine(.25-.10mm)	5.8	0.2	3.8
Very Fine(.10-.05mm)	0.6	0.0	0.3
Total Percentage	100	100	100

surface in equal applications on 29 July, 11 September, and 5 October 1993, and reached final levels at 0.0, 0.15, 0.30, 0.38, and 0.75 inch. Crumb rubber was not applied in 1994. Treatment areas were 10ft x 12ft. Crumb rubber was topdressed with a rotary spreader and then dragged in for as even distribution as possible on a perennial ryegrass (Lolium perenne var. Dandy, Target, and Delray) and Kentucky bluegrass (Poa pratensis var. Argyle, Rugby, and Midnight) turfgrass stand. (Because of the relatively small plot sizes, the rotary spreader was a suitable means for application. On larger areas, a belt-type topdresser works excellent.). On 16 May 1994 trafficked lanes were slit-seeded with Lolium perenne var. Dandy at 1.1 lbs./1000ft.^{2} The rubber particles eventually settle down to the soil surface. However, crumb rubber will not transgress through the soil profile because of being lighter or having a lower particle density: (rubber's particle density is 1.2 g/cc versus soil particle density at 2.65 g/cc). During the study, measurements were made as to the crumb rubber's effectiveness in reducing impact absorption (surface hardness measured with the Clegg Impact Tester) (3), reducing compaction (thereby providing a favorable environment for growth and recovery), improving turfgrass color, and sustaining turfgrass density.

In 1994, impact absorption was collected by the Clegg Impact Soil Tester (2.25kg hammer). Impact absorption values were recorded with the Brüel and Kjaer 2515 Vibration Analyzer, replacing the read-out box. This analyzer allowed for further evaluation of surface hardness characteristics as described by Rogers and Waddington at The Pennsylvania State University (4). The values recorded was an average of four measurements. Shear resistance was measured with the Eijkelkamp Shearvane (5). The value recorded was an average of three measurements. Surface temperature was read by the Barnant 115 Thermocoupler Thermometer. Soil moisture recordings were provided by the gravimetric method (6).Three soil samples (7.6 cm) per treatment were used for this method. Density and color ratings were observed on 27 October and 4 December.

In 1993, wear treatments were initiated on 26 August and ended 14 November and in 1994, wear treatments were initiated on 6 September and ended 15 November, for a total of 48 games simulated each year. Wear treatments were applied by the Brinkman Traffic Simulator (BTS) (7). Two passes by the BTS is equivalent to the traffic experienced in one football game between the hashmarks between the forty yardlines (8). The field tests conducted were to originally assess athletic field conditions. However, we quickly realized the results observed translated to a wide range of highly trafficked and compacted areas commonly seen on campuses, from intramural fields, game and practice fields to areas where a Saturday afternoon tailgate party takes place.

Results and Discussion

While our data were collected throughout the 1993 and 1994 seasons, due to spatial costraints, our purpose is to only highlight the trends we observed in 1994, and results from one data collection date will be presented. Whenever a test regarding turfgrass wear and soil compaction is conducted, chief among the components to be evaluated following the wear is turfgrass density and color. These are important to the field manager as they are often indicators of good playing conditions. Turfgrass color and density ratings provided substantial evidence that turfgrass conditions have been maintained despite intense traffic . These findings are consistent throughout the 1994 season and were attributed to the crumb rubber particles protecting the crown tissue area of the plant (Values shown are after 40 games simulated with the BTS). During the 1993 season the density ratings were dependent upon the amount of rubber used as well as the size of the rubber (data not included). We had higher turfgrass densities where we used the smaller rubber size (10/20 mesh) and high rates. We believe this was because the smaller particles were able to work to the surface faster, in 1993 during the fall, thus protecting the plant. When this relationship was not evident in 1994 it was logical to conclude the larger particles had also worked to the surface during the winter and were also now providing the protection to the turfgrass plant. This is significant because the smaller particle sizes are more expensive, an important factor in all decision making processes.

While there were no turfgrass color responses in 1994 regardless of crumb rubber size or rate, we saw a increase in color immediately after putting the rubber down in 1993. This response was positively correlated to crumb rubber rate. We still do not have the exact reason for this response as we saw no increases in color in 1994.

Table 2. Effects of crumb rubber size and topdressing rates on color and density rsatings on a kentucky bluegrass/perennial ryegrass stand under trafficked conditions t the Hancock Turfgrass Research Center, East lansing, MI. 1994.

	Color Ratings		Density Ratings	
Crumb Rubber Particle Size	27 Oct	4 Dec	27 Oct	4 Dec
1/4"	5.9	4.6	67.7	60.0
10/20 mesh	5.9	4.4	72.1	64.0
Significance*	NS	NS	NS	NS
Crumb Rubber Topdressing Depth				
0.00"	5.7	4.7	53.3	41.7
0.15"	6.0	4.7	61.7	50.8
0.30"	5.9	4.6	71.7	63.3
0.38"	5.7	4.6	73.3	65.8
0.75"	6.2	4.1	89.5	88.3
Lsd(0.05)	NS	NS	11.0	14.3

NOTEScale for Color Ratings: 1-9; 1-Brown, 9-Best, 6-Acceptable
+Indicates a significant difference at the 0.05 level.

The amount of crumb rubber used as a topdressing played an important role in affecting surface characteristic. Impact absorption values (G_{max}) were significantly lower at high crumb rubber rates in 1993. While this phenomenon did not continue in 1994, the surface characteristic, duration of impact (Tt), time to peak (Tp), and rebound ratio (rr%)

Table 3. Effects of crumb rubber size and topdressing rates on a variety of field measurement values measured on a Kentucky bluegrass/perennial ryegrass stand after 46 football games simulated Hancock Turfgrass Research Center, Michigan State University, East lansig, MI, on 10 November 1994.

Crumb Rubber Particle Size	Impact absorpt. (G_{max})	Time of duration (Tt)	Time to peak (Tp)	Rebound Ratio	Shear resist. (Nm)	Soil Moaisture(%)	Surface Temp.(ºF)
1/4"	60	10.3	5.7	0.216	14.2	16.3	47.
10/20 mesh	62	10.2	5.8	0.236	14.7	16.6	47.8
Significance*	NS	NS	NS	NS	NS	NS	NS
Crumb Rubber Topdressing Depth							
0.00"	58	10.1	5.6	0.168	11.9	16.2	47.6
0.15"	60	9.7	6.1	0.181	15.3	16.5	47.6
0.30"	62	9.9	5.5	0.210	13.7	16.3	47.6
0.38"	61	10.5	5.7	0.257	16.0	16.8	47.7
0.75"	62	11.1	5.8	0.314	15.4	16.4	47.8
Lsd(0.05)	NS	1.0	0.4	0.03	2.1	NS	NS

showed the effectiveness of crumb rubber (0.75") in providing a softer, more resilient surface. Tp, Tt, and rr% values increased at the high rates of crumb rubber. These characteristics are important parameters as they further define critical elements of surface hardness, such as, duration and severity of impact as described by Rogers and Waddington at the Pennsylvania State University (3). When an object is in contact with a surface the longer the time of impact the more resilient that surface and more likely the surface will resist compaction. Crumb rubber particle size was not significant in regards to these surface hardness characteristics.

In 1993, shear values decreased significantly as crumb rubber levels increased. In 1994, as crumb rubber levels increased, shear values increased significantly and stabilized. However, differences between particle sizes were not significant. To help explain this scenario, crumb rubber was topdressed in 1993 but not 1994. In 1993, the crumb rubber had not settled down to the crown tissue area, when the shear vane apparatus was applied to take a measurement, the teeth or fins could not grip the surface as well. One possible correlation to this is when a player digs his/her cleat into the surface, and it slips out from underneath. However in 1994, after a growing season and the crumb rubber settled to the soil surface and stabilized, shear values increased significantly as crumb rubber levels increased. This settling process, in part, also explains the lack of significant differences in impact absorption values in 1994 as compared to 1993.

In 1993, surface temperatures were significantly higher as crumb rubber levels increased. Although data was not significant on 10 November, the effect of crumb rubber on surface temperatures was significant due to the relationship between turfgrass growth and soil temperatures. As surface temperatures drop below 50°F the growth and recovery of turfgrass slows. Keeping temperatures higher can lead to increased playing quality conditions. This also holds true in the spring time as well, a factor very important to golf courses in the northern United States. For instance, on 7 April (data unpublished), there was a 7.5°F from the check treatment to the highest crumb rubber treatment. The exposure of crumb rubber at the surface heats the turf surface and revitalizes dormant turfgrass. This translates to a quicker spring green-up, an important factor for any field used in early spring. One concern we had was the effect of the crumb rubber on turfgrass during the summer. As the density of the turf stand increases during the growing season, the effect of crumb rubber on surface temperatures moderates due to the shading effect of the turfgrass, an effect measured and confirmed during 1993 and 1994.

Although crumb rubber is an excellent tool, it is not a "cure-all". Therefore the use of crumb rubber cannot be an exclusive means for maintaining turf in any high traffic turfgrass area, and must be used as a tool integrated into the management program. It should also be noted that we recommend the field manager must have a 100% turfgrass stand, or as close to this as possible, before making any crumb rubber applications. Therefore, our research does conclude topdressing between 0.375 and 0.75 inch (not more than 0.25 inch at any given application) would be a good level to achieve for high traffic areas. Thus, the "Take Home Message" is that crumb rubber will not resurrect the turfgrass, but it will protect the crown tissue area of the plant which becomes vital in improving the longevity and quality of a high traffic turfgrass stand. This is shown in the magnified photographs of sand and crumb rubber particles (Figures 1-4). The sand particles have sharp edges and will tear turfgrass tissue. Crumb rubber has more rounded edges and subsequently there is less abrasive action to the turf plant.

Table 2. Estimates costs to re-estabish a 1000ft^2 area annually per year versus topdressing with crumb rubber at 0.75 in. for a five year period.

Items	Re-establishing	Topdressing Crumb Rubber
Seed, Fertilizer, Labor, Aeration, Watering, and Seedbed prep. for one year.	$400.	$400.
Topdressing crumb rubber at 0.75" (1800lb. x $0.15/lb)	$0.	$270.
Re-establishing annually for four more years at $400./year.	$1600.	40.
Miscellaneous costs	$200.	$200.
Total	$2200.*	$870.*

*Prices are an estimation of costs and do not include equipment or inflation.

While the research to date has been extremely promising, we have not covered every scenario in the turfgrass industry. First, we do have confidence that the crumb rubber topdressed at 0.50 to 0.75 inch levels (200 to 1800 lbs/1000 ft.^{2}) will increase turfgrass wear tolerance and prevent soil compaction in turfgrass maintained above 0.63 inch. We have done little testing at cutting heights below 0.63 inch, and while we remain optimistic that crumb rubber would provide similar findings, obviously there will be some limits. Second, except for early in 1993, we have seen little differences in response from different crumb rubber sizes in our studies. However, we have noted the smaller sizes are easier to work with in terms of working into the turf area. It comes as no surprise this is a more expensive product, and we also caution against using a too finely granulated product as this could cause a detrimental effect in the soil profile relationship. a cost breakdown of 1000ft.^{2} for re-establishing an area versus topdressing crumb rubber can provide an idea of the necessary steps involved to continually re-establish an area. This is only an estimation of the costs however it does provide an idea of the dollar savings that can be attained over an extended period of time.

Another point not researched to date is the effect of crumb rubber on warm season grasses. We have no reservations about it protecting the turf plant but there is some question as to overseeding cool season grasses in the fall. There is a need for research in this area. The final area is the question of contamination from crumb rubber particles in terms of soil and water quality. We have had crumb rubber tilled in the ground at MSU since 1990 and monitor soil samples annually. The major constituents of rubber are iron, sulfur, and zinc. While iron and zinc levels have increased in our tests, none have approached levels of concern nor do these elements pose concerns to the water quality. At no time have we seen any toxicity to the turfgrass plant during our studies.

We are confident, we have found another use for a difficult to reuse product that poses environmental hazards and takes up landfill space. When topdressed, crumb rubber can extend turfgrass wear tolerance and reduce soil compaction a high traffic areas. These high traffic areas exist on every athletic field as well as walk paths, golf courses, and main event venues on campus. The more this product is researched and tested the more uses will be found. Michigan State University has a patent pending on this use of crumb rubber and has sold the use rights to Jai-Tire Industries, Denver, CO (800-795-TIRE).

Royalties paid to Michigan State University will go toward turfgrass research. A deep appreciation to the Michigan Turfgrass Foundation goes out for funding the assistantship to research this project.

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Screening Antagonistic Microorganisms for Suppression of Microdochium nivale and Gaeumannomyces graminis var. avenae[1]

Gwen K. Stahnke, Carrie Foss, and Lenora Jones 2

[1] Presented at the **49th Northwest Turfgrass Conference**, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Extension Turfgrass Specialist, Diagnostic Plant Pathologist, and Research Technician, respectively, Washington State University, Puyallup, Washington

Utilizing naturally occurring microorganisms to suppress turf diseases would provide an environmentally acceptable alternative to repeated fungicide applications. Microbial suppression of plant pathogens has been extensively documented in the literature (Sutton and Peng; Weller, et al.; Nelson). During the first phase of the biocontrol project, a literature search was conducted and researchers working with suppressive organisms were consulted nationwide, including Dr, Eric Nelson (Cornel University), Dr. David Weller (USDA-Pullman), and Dr. Fred McElroy (Eden Bioscience). We obtained information indicating that greenhouse testing would provide more reliable results than laboratory screening. Based on that information, it was determined that the focus of the study would be screening three organisms in the greenhouse on turfgrass for suppression of take-all and Fusarium patch diseases. Isolates of *M.nivale* and *G. graminis* var. *avenae* were cultured from golf course and home lawn samples. Organisms suppressive to take-all of wheat, *G. graminis* var. *tritici*, were obtained from Dr. David Weller at USDA-Pullman. In addition, Eden Bioscience, under the direction of Dr. Fred McElroy, has cooperated on this project by providing protocols, culturing microorganisms, and treating seed with the antagonistic microorganisms for a preliminary experiment.

FUSARIUM PATCH DISEASE; *Microdochium nivale*

INTRODUCTION

Fusarium patch is a foliar turfgrass disease caused by the fungus

Microdochium nivale. This disease can damage most grass species. The disease is observed as circular patches which may first appear water-soaked and later may change color from orange-brown to dark brown and finally gray. Fusarium patch is active during cool, wet weather. Succulent grass produced by high nitrogen fertility is more susceptible.

Fungicide applications, in addition to cultural strategies, are used to manage Fusarium patch disease in high quality turfgrass. Fusarium patch disease problems can be reduced by providing balanced fertilization, avoiding overfertilization, and not applying urea as a sole nitrogen source. However, fungicides may be applied repeatedly to manage this disease. Fungicides recommended for management of Fusarium patch include several highly or moderately at-risk fungicides. Repeated use of these fungicides may result in strains of *M. nivale* resistant to the fungicide (Chastagner and Vassey). Bacterial antagonists identified as suppressive to Fusarium patch disease could provide an alternative to fungicide applications.

MATERIALS AND METHODS

Fusarium patch disease was diagnosed on turfgrass samples submitted to the WSU Puyallup Diagnostic Laboratory. The causal organism, *M.nivale*, was cultured from the diseased samples. A single spore culture of each isolate was prepared and transferred to dilute PDA to induce sporulation. Two isolates were selected, 203 and 1159, and stored in cornmeal /sand medium.

Preliminary Experiment

A preliminary experiment was conducted to evaluate the ability of the selected isolates to infect and to determine nitrogen sources and fertilization rates for predisposition of the ryegrass to infection. Sixteen perennial ryegrass seeds (Essence+) were planted into each 1" diameter cone-tainer tube packed with vermiculite. Plates of the two *M.nivale* isolates were flooded with deionized/distilled water and scraped. The solution was filtered twice through 4 layers of cheesecloth and applied with a spray bottle to the ryegrass. Six tubes of each fertility level were inoculated. All plants received standard fertility of 1/4 lb N/1000 sq ft using Peter's 20-20-20 weekly. The three treatments consisted of: (1) standard fertility only; (2) additional fertilization with two 1/2 lb N/1000 ft^2 one week apart; (3) additional fertilization with two 1 lb N/1000 ft^2. The cone-tainer tubes were place in a dew chamber for 48 hours, then placed in the greenhouse. The ryegrass plants were evaluated 20 days after inoculation.

Fusarium Patch Experiments

Two experiments were conducted which included the bacterial antagonists. In each experiment, Essence+ ryegrass was planted in 1" diameter tubes. The grass was fertilized twice with 1lb. urea prior to inoculation in addition to standard fertilization with Peter's solution. The ryegrass plants were treated bacterial antagonists (2-79, *Bacillus* sp., or Q65c-80) or water two weeks after planting. Colony forming units (CFUs) of antagonists and other foliar organisms were determined 24 hours after treatment. The treated plants were then inoculated with a *M.nivale* spore or hyphal suspension, containing approximately 4×10^5 propagules per ml. Three weeks after inoculation, plants were rated for color and disease infection. Grass samples from each replication were cultured on cornmeal agar to determine recovery of *M. nivale*. Color was rated on a scale of 1 to 9 with 1 corresponding to brown grass and a 9 rating for dark green. Disease was rated on a scale of 0 to 5. Replications rated 0 had no diseased plants and a 5 rating corresponded to > 95% of the blades infected.

RESULTS

In the preliminary experiment the greatest infection was found on plants fertilized twice with 1 lb. urea N/1000 ft^2 which was the highest rate tested. Both *M.nivale* isolates chosen, 203 and 1159, were pathogenic to the ryegrass in the preliminary experiment.

CFUs of bacterial antagonists varied between 10^2 and 10^4 per cm leaf blade in the Fusarium patch experiments. The bacterial antagonist 2-79 reduced Fusarium patch disease symptoms caused by isolate 1159 as compared to the treatment with a water application. The foliage color in treatment 2-79/1159 was significantly better than treatments *Bacillus* sp,/1 159 and Q65c-80/1159. There were no differences in color between the 203 isolate treatments.

DISCUSSION

The bacterial antagonist 2-79 reduced disease on plants inoculated with the 1159 isolate. There was no suppression of disease using 2-79 and the 203 isolate when compared with the water treatment control. This may have been observed due to variance of isolates in their pathogenicity. This may also have resulted because the inoculation of ryegrass plants with *M.nivale* isolates 1159 and 203 was conducted in the third experiment using a hyphal suspension which increases variablity in infection.

TAKE-ALL PATCH, *Gaeumannomyces graminis* var. *avenae*

INTRODUCTION

Take-all patch disease can cause serious damage to newly established sand-based bentgrass turf. It is caused by *G. graminis* var. *avenae,* a soil-borne microorganism which infects roots and stolons during cool, moist weather. Symptoms may change from small, light brown patches initially to larger bronze or reddish-brown rings or patches. This disease is difficult to control with fungicides. It has been observed, however, that as competing or antagonistic microbial populations buildup in the soil environment, the disease declines in severity in a manner similar to take-all of wheat (Nilsson and Smith).

MATERIALS AND METHODS

The purpose of this project was to test antagonistic microorganisms for suppression of take-all patch disease in a greenhouse study. The three bacteria tested in the first phase of the project were 2-79, Q65c-80, and *Bacillus* sp. 2-79 and Q65c-80 are strains of *P. fluorescens,* 2-79 has been extensively studied for its ability to suppress take-all of wheat (Bull, et al.; Weller and Cook).

Pathogenic isolates of *G. graminis* var. *avenae* were cultured from six golf course samples of *Agrostis* sp. Basal stem pieces were sterilized with 1% silver nitrate, rinsed in sterile distilled water three times, dried and plated onto SMGGT3 media (Juhnke et al.) Colonies which produced pigmentation in the media and hyphal tips curving at the margin of the colony were identified as *G. graminis* var. *avenae.* Two take-all isolates were selected and used to inoculate sterilized oat kernels. The oat kernel culture was grown at room temperature for three weeks. The inoculum was then ground and mixed with sterile sandy loam at 0.5% w/w after screening through a #8 screen. Five grams of the inoculated soil was layered onto sterile vermiculite in cone-tainer tubes.

Bacterial antagonists, *Bacillus* sp., Q65c-80, and 2-79 were separately mixed with methyl cellulose and applied to bentgrass seeds. Treatments with methyl cellulose only, untreated seed, and non-inoculated soil were also included in the experiments. There were five replications per treatment with 160 seed per replication. Three experiments were conducted to test the effect of the three antagonists on suppression of take-all infection.

The treated and untreated bentgrass seeds were layered onto the soil and covered with a fine layer of sterile vermiculite. The bentgrass was fertilized using 1/4 lb. N/1000 ft^2 rate of Peter's (20-20-20). After 4 weeks, the bentgrass was harvested by rinsing the roots. Plants were rated for disease according to Weller, et al. (0 = no disease, 5 = plant dead). Crown segments were cultured on SMGGT3 for recovery of the pathogen.

RESULTS

There was no statistically significant take-all patch disease suppression as a result of seed treatment with the three bacterial antagonists tested. Though, not statistically significant, there were fewer root infections in the *Bacillus* sp./RC1 treatment compared to the water/RC1 or MC/RC1 treatments. The highest disease rating was observed in MC/RC1 treatment.

DISCUSSION

Suppression of disease-causing organisms in a field situation is affected by several factors, including the amount of disease inoculum, pathogenicity of the disease-causing organism, and effectiveness of the antagonistic bacterial strains. The concentration of *G. graminis* var, *avenae* inoculum added to the sterile soil (0.5% w/w) was based on research conducted with take-all of wheat (Weller, et al.). The inoculum level has not been determined for take-all disease development in the Pacific Northwest. It is possible that the inoculum level used in these experiments could be reduced and correspond to a field situation. More effective bacterial antagonists may be identified through further greenhouse experimentation.

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BALANCING ENVIRONMENTAL CONCERNS ENVIRONMENTAL PRESSURES IN THE EASTERN VERSUS THE WESTERN UNITED STATES[1]

ROBERT Y. SENSEMAN[2]

[1] Presented at the **49th Northwest Turfgrass Conference**, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Former Agronomist, Northeastern Region United States Golf Association,
Green Section

A comparison between the environmental pressures that persist in the Northeastern Region (which includes New York, New Jersey and New England) versus the Pacific Northwest are in stark contrast to one another. The major factors that contribute to these differences are the severe weather patterns which persist in both the winter and summer. A large percentage of rainfall occurs in the summer months in the form of violent thunderstorms usually followed by periods of intense heat. Poor soils and poor grass growing environments contribute to the stress that is placed on the plant.

The predominant turfgrasses found in the region are cool season grasses. Of those, Poa annua, perennial ryegrass and creeping bentgrass are the most widely grown. The turfgrass manager must exercise careful and diligent management as well as rely on the use of pesticides to combat the effects of disease, weeds, and turf-destroying insects. Pesticide budgets range anywhere from $30,000 per year up to a high of in excess of $100,000. The southern portion of New Jersey is very much in the transition zone and pesticide usage will be higher there than in upstate New York where the environmental pressure is not as great. Correspondingly, Long Island and Westchester Counties have moderate to severe environmental pressure and pesticide usage is variable although it is much higher than what normally is found in upstate New York.

Public awareness of pesticide usage is extremely prevalent especially, in Nassau and Suffolk Counties. Typically, for a new pesticide to gain registration, the manufacturer will have to conduct separate groundwater studies on Long Island, in addition to the national testing required by the EPA. This often leads to lengthy and costly investigative studies and many times the pesticide does not gain registration. In contrast, Westchester County and upstate New York are more lax than Nassau and Suffolk Counties, however registration is far more difficult than in neighboring New Jersey which appears to have very few regulatory constraints prohibiting new pesticide registration. Golfer awareness of specific pesticides such as Daconil and phenoxy-based herbicides such as dicamba is great and on some courses, their use has been banned by the Board of Governors of the Club. Many superintendents are initiating integrated pest management programs in an effort to reduce pesticide usage.

Certainly, there are a number of other factors which contribute to disease pressure such as compaction, thatch accumulation, poor drainage, bad growing environments and imbalanced plant nutrition. A good growing environment is critical to minimize the effects of summer heat stress. Many northeastern courses have been over planted with trees and as a result, many greens, tees and fairways are grown in shade and in areas of poor air circulation. We all understand the positive effects that occur when there is adequate light and good air circulation, however there is an attitude among golfers that restricts aggressive tree thinning and removal. In some cases, proper tree thinning cannot be performed due to property line restrictions. In those cases, electric oscillating fans are being used to promote air circulation.

A poorly drained rootzone is a haven for development of root and foliar pathogens, not to mention wet wilt. After the middle of June, northeastern weather patterns become severe. Violent thunderstorms are capable of depositing 1"-2" of rain at a time. After the clouds clear, it is very likely that daytime temperatures can reach 90ºF. or higher, with relative humidity levels ranging between 90-100%. The intense heat and high relative humidity can stimulate the development of wet wilt and the extended leaf canopy wetness duration promotes diseases such as Pythium, brown patch and summer patch. To improve the rootzones on putting greens, superintendents are using a combination of three cultivation methods. Typically, core aerification is performed in either the spring or fall, or both, followed by at least one deep aerification treatment, normally in the fall. The HydroJect aerifier is becoming a popular method to improve water permeability and rooting.

The Right Grass

Selecting and growing the most adaptable turfgrass is critical for both summer and winter survival. During the past several years, annual bluegrass and perennial ryegrass has been severely injured in the winter due to crown hydration injury and in the summer due to extreme heat stress and disease activity. Obviously, the most desirable grass for putting greens is creeping bentgrass, however even under the best circumstances, older putting greens normally will not have creeping bentgrass populations in excess of 70-80%. The real dilemma occurs when cultivating fairway turf. Perennial ryegrasses do withstand traffic quite well, however, they are extremely susceptible to crown hydration injury as well as Pythium and brown patch disease. The creeping bentgrasses are highly adaptable to the region and conversion programs can be initiated whereby clippings are collected, lightweight mowers are used and the spread of creeping bentgrass can be accelerated by using plant growth regulators. To a lesser degree, perennial ryegrasses are being grown. Prograss has proven to be extremely effective when 2-3 applications are used in the fall, in conjunction with aggressive overseeding of perennial ryegrass, to convert annual bluegrass fairways to perennial ryegrass. However, the Prograss program is expensive, and many superintendents have lost confidence in perennial ryegrass due to winter injury and their susceptibility to summer diseases.

Disease Pressure

Disease pressure in the northeast region can be extremely great. Depending upon the exact geographical area where the course is located and membership expectations, fungicides will be applied on the greens, tees, and fairways. Most courses will treat fine turfgrass areas for pink and grey snow mold. This spring Red Thread diseases on perennial ryegrasses and fine leaf fescues were extremely high as well as red leaf spot on creeping bentgrass and required treatment. Creeping bentgrass is susceptible to dollar spot and more and more cases of basal crown rotting anthracnose are being reported. Diseases that are particularly severe on perennial ryegrasses include brown patch as well as foliar Pythium. The most widely treated disease of Poa annua, aside from those already mentioned, is summer patch. Normally, only putting greens receive preventative fungicide treatments which call for 3-4 applications of a sterol inhibiting fungicide at high rates.

Insect Pressure

A whole host of insects are capable of invading turfgrass stands in the Northeast, but perhaps the most common insect problems that are treated include cutworms, annual bluegrass weevil and white grubs. Many courses elect not to treat for Hyperodes weevil as this is a form of annual bluegrass control. However, on those courses which have high populations of annual bluegrass, they have no choice. Typically, Hyperodes weevil populations will begin to invade as adults when forsythia blooms in the spring. Around the first part of June, the eggs that the adults have laid in the leaf sheaths of annual bluegrass plants will hatch and larvae will begin to voraciously feed on Poa annua. The larvae begin invading from the perimeter edges of fairways and roughs to the closely mowed grass on the putting greens. Initially, contact insecticides such as Dursban are used to control the adults, however as larvae begin to proliferate, soil insecticides such as Turcam and Oftanol are required. It is not unusual to see 3-5 generations of Hyperodes weevil throughout the course of the summer season.

White grubs are capable of creating damage to fairways and roughs in August and early September either by root feeding or as a result of animals digging up the turf to feed on the grubs. Most courses will treat fairways and green surrounds preventatively to prevent turf loss due to grub activity.

Aside from annual bluegrass, crabgrass and goosegrass are the most problematic summer annual weeds, and are routinely treated for on fairways, green surrounds, tees, and to a very limited extent, putting greens. Pre-emergence treatments for crabgrass usually account for 20-40 acres of treated turf. In an effort to reduce the amount of pesticide applied, many have tried using Acclaim post-emergence herbicide in light frequent rates for control of crabgrass and goosegrass or have mapped areas and spot-treated with pre-emergent herbicides.

As one can see, the potential for turf loss due to environmental stress is extremely high and it is possible to apply a great deal of pesticide to combat these pressures. Many superintendents have abandoned blanket spraying and are using mapping, and aggressive scouting and sampling techniques to reduce pesticide usage. However, with the scouting and spot-treating techniques, a major component for an effective program is timely spray applications. At many courses, this is not feasible and turf may be lost due to golfer restrictions of timely treatments. The other major concern in the region is the fate of pesticide rinsate and equipment washrack rinsate. Unlike many golf courses in the Northwest, very few have initiated 100% containment programs to capture and recycle rinsate.

Conclusion

The Pacific Northwest is fortunate in that environmental pressure is relatively mild compared to that of the Northeastern Region. However, regardless of which portion of the country you are located in, all efforts must be made to select disease and insect resistant grasses. Forecasting, mapping, scouting techniques and good integrated pest management programs can reduce the acreage treated, and thus, limit environmental exposure.

Maintenance Standards For Soil Base Soccer Fields

Mr. Tom Cook[2]

[1] Presented at the **49th Northwest Turfgrass Conference**, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Associate Professor, Horticulture Department, Oregon State University, Corvallis, Oregon

Good quality soccer fields are rare based on my observations of fields in Oregon. Ironically the poor condition of many of the fields isn't from lack of maintenance inputs. The real problems include lapses in maintenance at critical times of the year and often heroic but misguided attempts at major cultural practices. By performing desirable maintenance practices at appropriate times, maintenance personnel can get the most out of the resources at their disposal. What follows are guidelines for maintenance of fields at levels ranging from professional quality fields to unirrigated youth soccer league fields. I've titled the different levels of maintenance as follows: Professional Quality, Good Quality, Budget Irrigated, and Non-Irrigated. For this paper I have used the Willamette Valley in Oregon as the climatic site for recommended maintenance practices. With that in mind the guide will be most useful throughout Western Oregon, Western Washington, and perhaps lower Western British Columbia.

A thought to ponder is that if you asked several "experts" for their opinions on how to best maintain fields you would probably get several different answers. The key is to discern between matters of style and matters of substance. Issues involve choices of fertilizers, grass cultivars, and which machine does the best job of coring or dethatching. The important point is that people who know what they are trying to accomplish will get good results with whatever machine they use, or whatever fertilizer they apply. When I look at other peoples recommendations, I try to determine if what they advise will work, not whether they advise doing exactly what I would do. Maybe the point is simply that there is no one way to do anything. Decide what needs to be done and then figure out how to achieve your goals using the resources you have at your disposal. I cringe when maintenance people tell me they knew what to do but didn't do anything because they didn't have just the right machine.

Matters of substance are more important to worry about. Over the years I've concluded that soil fields are by nature " mudholes" and will be generally wet and mushy during the winter season. When I see recommendations to install subsurface drains on these fields to improve drainage I get angry because I know it won't work. Likewise when I see recommendations for miracle penetrants and soil enhancers I get frustrated because they promise to do things they just can't do. The old adage that, "If it seems to be too good to be true it probably is," is appropriate here. With soil fields it is important to accept their limitations and work to get as much mileage out of them as possible. With that in mind please read on!

Professional Quality Fields

Most of us probably dream about the mythical perfect soccer field that is smooth, flat, dense, and green. With a perfect profile and grass mowed short it plays fast, gives perfect bounces, and is easy on the players feet. Well, you can forget about perfection because we are starting with a native soil profile and soil fields will never be perfect. What follows are my recommendations for cultural practices that can give the best possible soil base field. To be honest, I doubt that even most pro's get to do all of the things I will list. The real purpose is to create a model against which you can judge your current maintenance practices.

1. MOWING

Mow 2 times per week April through October
Mow weekly February through March and November
Mow as needed during December through January

Total projected mowings per year = 70

2. CLIPPING REMOVAL

Sweep, vacuum, or otherwise remove clippings from the turf after each mowing from April through October.

Projected clipping collections per year = 56

3. FERTILIZATION

Fertilize with an N-P-K ratio 5-1-4. Use products containing mixtures of soluble and controlled release nitrogen. Slow release sources such as Nutralene, IBDU, Polyon, Poly-S, ESN, etc., are products of choice. Avoid straight soluble sources to avoid flush growth and peak and valley growth.

Time applications for mid-spring, early June, mid to late July, mid September, mid October, and early December, depending on turf vigor and appearance. With a consistent application schedule, rates of 1lb N / 1000 sq ft total N per application, should be adequate to produce acceptable turf. Turf under low fertility may require up to 2lbs N/l000 sq ft to achieve acceptable turf quality. Actual application rates and frequencies will vary for every field and can only be determined by observing turf performance.

If you fertilized a field that is 75 yds by 110 yds. at a rate of 1 lb. N/l000 sq. ft. you would need approximately 170 lbs N. Using a 25% N fertilizer, you would need 680 lbs. of fertilizer for each application. Six applications per year with a 25% N product would require 4080 1bs. of fertilizer.

4. OVERSEEDING WITH PERENNIAL RYEGRASS

Plan on one to three overseedings per year. Overseed the entire field at least one time per year. Target seedings on areas such as goal mouths, and field centers are acceptable if the rest of the field is in good shape. In years when play destroys significant areas, reseeding should follow tilling and regrading.

Overseeding rates:

General overseeding, modest wear = 5 lbs seed/l000 sq ft
(5 lbs seed/l000 sq ft) X (170,000 sq ft/field) =
850 lbs seed/field/overseeding

Target overseeding heavy wear areas = 10 lbs seed/l000 sq ft

Timing for overseeding:

– General or target overseeding after the fall season is over. Do this even as late as mid to late November.
– General or target overseeding in early spring. Do this around spring break on school fields, or early April on non school fields.
– General or target overseeding in late spring. Do this in June as soon as school is out or when the spring season is over.

5. CORING

Coring soil fields gently is important for minimizing surface compaction and improving infiltration of irrigation water. Core fields 3 to 4 times per year with conventional 0.75" hollow tines. Sweep up cores, drag and mow cores, or use a core pulverizing machine to break up cores.

Time coring for late March to mid April, once school is out in June, mid August before fall sports begin, and at the end of the fall season if the field is firm enough to drive on. Avoid coring during the playing season to avoid objectionable debris on the field during play.

On fields with a history of poor drainage consider vertidraining rather than coring during the June and/or August periods. Set vertidrain solid tines to a depth of 8" to 12" or as deep as possible up to those depths.

6. TOPDRESSING

Topdress fields 4 to 5 times per year using golf green quality sand. Apply sand with machinery designed for that purpose avoiding large vehicles such as dump trucks. Rutting caused by dump trucks does more damage than good. Time topdressings during spring through fall when the fields are drier and less likely to be rutted by equipment. Topdress before irrigating, not after.

As used here topdressing serves to firm and smooth the field and helps provide top quality surfaces. Topdressing does not improve drainage.

Each topdressing should total approximately 0.25" per application. A sequence of 5 topdressings per year will put a maximum of 1.25" of sand on a field. A realistic target is about l" of sand per year for two to three years followed by 0.5" to 0.75" annually after that.

Total volume of sand required per year for a 75 yd by 110 yd. field: assuming 5 applications per year at 0.25"each for a total of l.25" comes to 656 cu yd/ field/ year. For a single application on a regulation soccer field, plan on approximately 130 cu. yd. of sand.

7. THATCH REMOVAL

Once per year in conjunction with overseeding and coring use a flail or solid blade dethatcher to remove organic debris that has accumulated at the surface. This debris is often composed of fresh grass parts that have been ground into the surface via players cleats. In that regard it is different than thatch we might see in an undisturbed lawn. Its important to remove as much of this material as possible to prevent development of an organic bog that becomes anaerobic and causes the surface to become impervious to water.

Dethatching is best timed in June when the soil is firm and relatively dry. A typical sequence of activities might include coring, dethatching, debris removal, overseeding, topdressing, and finally fertilization.

Good Quality Fields

Good quality fields are typical of the good fields we occasionally see in parks or at some schools. They are green, dense, and relatively smooth. They always stand out in the summer and early fall periods. Once late fall and the rainy season arrive they fall apart but are generally better than most other soil fields in the area. They aren't as well groomed as professional quality fields but most of us would be happy if they were our fields. As you'll see, the numbers will change but general care is quite similar to professional quality fields.

1. MOWING

Mow weekly March through October
Mow as needed November through February

Total projected mowings per year range from 40 to 45.

2. CLIPPING REMOVAL

Sweep, vacuum, or otherwise remove clippings from turf after each mowing from April through October.

Projected clipping collections per year = 28

3. FERTILIZATION

Fertilize with an N-P-K ratio approximating 5-1-4. Use products containing mixtures of soluble and controlled release nitrogen. Slow release sources such as Nutralene, IBDU, Polyon, Poly-S, ESN, or similar products are products of choice. Straight soluble sources should be avoided during the main growing season but may be useful during late fall to enhance winter growth. Time applications for mid-spring, early June, mid September, late October, and mid to late December, depending on turf vigor and appearance. On healthy turf, rates of 1 lb N/l000 sq ft per application, should be to maintain functional turf. Turf that is weak may require up to 2 lb N/l000 ft to achieve acceptable turf quality. Actual application rates and timing will vary for every field and should be based on observation and your judgment.

Using a 25% N fertilizer applied 5 times per year at 1 lb. N /1000 sq ft on a full-sized soccer field you can plan for 3400 lbs. fertilizer / year.

4. OVERSEEDING

Plan on using enough seed to over seed file entire field at least once. Most of the time overseeding will take the form of target seeding heavy wear areas such as goal mouths and field centers. In years when use destroys turf completely and grades are mined by wet weather play, plan on tilling and grading affected areas and reseeding rather than simply overseeding.

Overseeding rates:

General overseeding = 5 lbs
seed/1000 sq ft
Plan on 850 lbs seed/full size field

Core fields 2 to 3 times per year with conventional 0.75" hollow tines. Sweep up cores, drag and mow cores, or use a core pulverizing machine to break up cores.

Time coring for late March to mid April, once school is out in June, in mid-August before fall sports begin, and at the end of the season if the field is firm enough to drive on.

On fields with a history of poor drainage, consider substituting vertidraining during the June period. Set vertidrain solid tines to a depth of 8'' to 12" or as deep as possible up to those depths.

6. TOPDRESSING

Even on good fields it is generally not feasible to topdress consistently. Topdressing is a labor intensive activity that few schools can even consider. What I generally see is sporadic heavy topdressing that does more harm than good. The few departments I know that have attempted topdressing, have rarely been able to sustain the effort more than 2 to 3 years. Results are generally promising if you can sustain a program at least 3 years, otherwise it's not of much value.

A single field topdressed 5 times at 0.25" per topdressing requires approximately 650 cu yd. of sand. Plan on 130 cu yd. for a single topdressing.

To get the most mileage out of a topdressing program concentrate applications in the dry months from April through August. Shoot for monthly applications of no more than 0.25" each. The goal is to buildup a fairly uniform layer of sand prior to the wet season.

7. THATCH REMOVAL

Once per year in conjunction with overseeding and coring, use a flail or solid blade dethatcher to remove organic debris that has accumulated at the surface. Removing thatch helps prevent development of an organic bog that plugs the surface and often contributes to the anaerobic stench common on sports fields.

Dethatching is best timed in June when soil is firm and relatively dry. A typical sequence of activities might include coring, dethatching, debris removal, overseeding, topdressing, and finally fertilization.

Budget Irrigated Fields

These are typically poorly maintained fields, with permanent bare areas in goals and field centers. Often grass is not watered in summer until a few weeks before play begins. In some cases the water is turned on in spring and not turned off until late fall. As a rule these fields are not routinely overseeded, are rarely fertilized, are occasionally buried under heavy sand topdressings, and provide poor quality surfaces to play on. They are among the first fields to lose grass and mush up in fall. In short they are the most typical fields I see.

As I see it these are the fields that will benefit most from a well thought out and creatively planned maintenance program. Every shot counts in maintaining these so they provide functional playing surfaces. The following will vary significantly from the professional and good quality field guides.

1. MOWING

If you can't do anything else, try to keep these fields mowed at least weekly. This is most important during the summer months. Summer mowing will insure that you have the best turf possible in fall.

Mow weekly March through October
Mow 2 times per month in November and February
Mow at least monthly in December and January
Total projected mowings add up to 38.

2. <u>CLIPPING REMOVAL</u>

Don't worry about removing clippings on these fields.

3. <u>FERTILIZATION</u>

Do what you can to get these fields fertilized. Concentrate on fertilizing spring through summer to get fields back in shape by fall. Use primarily soluble or mixed soluble - slow release products. Products based on SCU (sulfur coated urea) offer good initial and fair residual response at relatively low cost. Look for products approaching 5-1-4 ratios for N-P-K. Co-op's and other fertilizer suppliers can often custom blend to your specifications.

Timing: Mid to late April apply 1.5 lbs. N/l000 sq ft
Early June apply 1 to 1.5 lbs. N/ 1000 sq ft
Early September apply 1 to 1.5 lbs. N/l000 sq ft

Total fertilizer required assuming 4 lbs N/ 1000 sq ft/year using a 25% N product = 2727 lbs fertilizer.

<u>Note:</u> Don't get into the habit of routinely applying 15-15-15. While it works okay, it is a waste of Phosphorus and may be more expensive per pound of Nitrogen.

4. <u>OVERSEEDING</u>

All overseeding on these fields should be targeted at wear areas. Use perennial ryegrass for overseeding. There are at least 90 good cultivars so there is no need to get confused about which is the best. Just remember to avoid " LINN " and unnamed common types.

Target overseed wear areas at the end of the fall season if the field is not too torn up. If you simply broadcast the seed, there is a good chance it will germinate and fill in before spring sports start. It is always worth a try because if it works you are way ahead in spring. When worn areas are not overseeded they eventually become dominated by annual bluegrass which on these sites often behaves as a winter annual. It actually looks good in late winter but then dies in late spring, leaving you with bare ground again in summer.

If the wear areas are too torn up to simply overseed, wait until late spring and till and regrade the areas before seeding. If you have to import soil to get the surface back to its original grade, use soil similar to what is already there. Tilling in or layering two or three inches of sand on soil doesn't accomplish anything and may make it more difficult to get new seed to germinate. Tilling and regrading is more effective than burying dead grass with a heavy topdressing and trying to seed over that. If you take the approach of tilling and grading you will probably find it is something you will do once every few years because you generally will have better turf year around. Healthy turf will hold up better than weak turf.

If you overseed in fall and don't get a catch, come in during spring or early summer and slice seed the area with a tractor mounted machine. The main point is to make regular overseeding an important part of your maintenance program. It will go a long way towards improving year around turf quality.

Overseed at rates of 5 to 10 lbs seed / 1000 sq ft, using the heavy rates in fall or when you have a short time frame to get turf ready for play. At the 5 lb rate plan on using 850 lbs seed / 1000 sq ft to overseed a full size soccer field.

5. CORING

Core as many times as you can manage each year. Realistically that will probably be 3 times a year if you are really dedicated. Use conventional 0.75" hollow tines, and drag or mow the cores to break them up. Time coring for spring break, again when school is out, and one more time in late summer before fall sports begin. Don't core if it is too wet to safely drive your tractor across the field. Under real wet conditions you do more damage to the field than good.

Every other year contract to have the field cored with a vertidrain to get deep penetration. You'll be surprised at the improvement in turf performance.

6. TOPDRESSING

Topdressing has limited value on budget fields because it needs to be done on a light and relatively frequent basis. Use your time, money, and people for basic maintenance practices instead. Poorly conceived topdressing efforts are one of the most common screw ups I see on school fields. Usually what happens is you make a heroic effort to round up the dump trucks and some reject concrete sand and bury the turf throughout the field. Dragging usually moves the sand into the tire ruts and leaves you with 2-4 " of sand in some areas and none in others. Now that you have smothered the turf a lot of it dies so field density is reduced. You increase irrigation to speed recovery and find the sand dries out quickly while the original soil becomes wet and mushy. Recovery is slow, field quality declines, and by fall the fields are not ready to play. In short, you wasted a great deal of time and effort and accomplished nothing.

Instead of topdressing, concentrate on good old fashioned turf culture!

7. <u>THATCH REMOVAL</u>

Once a year find a flail mower and set it down low so you can effectively dethatch and do some minor surface grading. Follow dethatching with slice seeding and fertilizer then water thoroughly. June about the time school is out makes for good timing, provided you keep the field moist enough to get good germination of the perennial ryegrass. This is much more effective than topdressing as described above and is probably less expensive.

Budget Non-Irrigated Fields

Sadly, there are a lot of non-irrigated fields that are being used for kids soccer. Ironically, when I am approached by people about installing irrigation on these fields, I usually tell them not to! The reason is not that I don't like kids. The reason is that these fields are generally maintained by volunteer groups and lack the resources needed to maintain irrigated fields. In fact they can barely maintain unirrigated fields. My point is that as soon as fields are irrigated they need to be mowed all summer long and ultimately need a lot more inputs. I try to emphasize that before they start irrigating they need to get geared up to do the maintenance that will be required. At that point the conversation ends with them being disheartened and me feeling like a villain.

So what can be done with non-irrigated fields? I think they can be a lot better than most are, if you do the right maintenance practices at the right times. Remember that even though these fields will never be great they can be functional and have a complete cover of grass.

1. <u>MOWING</u>

Find a way to get these fields mowed regularly. Don't depend on already strapped school district maintenance personnel to go out of their way to help you out.

Mow weekly from September through November.
Mow 1 to 2 times per month as needed during December through February
Mow weekly March through June
Mow every two weeks July through August

Total projected mowings adds up to about 36.

2. FERTILIZATION

Fertilizer is an important tool on unirrigated fields. Summer drought stress will always leave fields weak as fall soccer begin. By the end of fall most of these fields will be very thin and torn up. Fertilizer applied at the onset of fall rains will stimulate grass during the season. Another application in early December or just after the season ends will maximize growth through winter and provide dense turf for the spring season. Fertilizer applied in early spring will help turf handle wear in the spring season. If June is wet you can even fertilize then to develop dense turf prior to the summer stress period.

Fertilize with an NPK ratio approximating 5-1-4. Fertilize with soluble or mixed soluble-slow release fertilizers. Keep in mind that on these fields you generally want to stimulate growth to aid recovery from drought or wear. The early and end of season applications should each be about 2 lbs. N / 1000 sq ft. The early and optional late spring application can be at lower rates if turf is in good shape. Plan on 1 to 1.5 1bs N/1000 sq ft at these times. The late spring application should only be applied if there is adequate rain to dissolve it and wash it into the soil where turf can use it.

With a 25% N fertilizer applied 3-4 times per year, plan on 5-6 1bs of N per year. This adds up to about 3400 to 4000 lbs of fertilizer per year for a full size field. If this is more than you can afford, drop the late spring application. The fall and late fall are the most important so don't miss them.

3. OVERSEEDING

Every summer drought will cause severe thinning of turf on unirrigated fields. What is left may be further destroyed during fall play.

Overseeding is important if you hope to maintain turf density at an acceptable level.

Without irrigation you have to rely on natural rainfall for germination but temperatures are often too low for good growth during the rainy season. It seems like an impossible task. Fortunately we have perennial ryegrass which germinates and grows fairly well even in cool weather. Established in late fall, it can often survive the drought the following summer. That implies that regular overseeding every fall can actually increase turf cover over time. In all but the driest years that is exactly what happens.

The key in overseeding non-irrigated fields is to be realistic about what you can achieve. It will be two steps forward and one step back!

Target or general overseed each year at the end of the fall use period. If the field is firm enough to drive on, overseeding via a tractor mounted slice seeder is a great way to go. If that's not possible, broadcast on the surface and take your chances. The key areas are always the heavy wear sites but overseeding the entire field is a good idea.

General overseed at 5 lbs / 1000 sq ft and raise it to 10 lbs /1000 sq ft for target areas such as goals. One scenario involves slice seeding the entire field followed by broadcast seeding the heavy wear areas.

Timing is pretty simple. Late fall works best because it gives the perennial the most time to establish before summer drought hits it. Spring seedings often come up just fine but mortality is high when drought comes in summer.

Final Notes

The preceding discussion focused on active maintenance practices useful for a variety of different types of fields. A final strategy useful for soccer fields needs to be addressed in this paper because it can have a profound impact on all fields regardless of how they are maintained. I saved it for the end because it seems to be controversial and I didn't want readers to get mad and quit reading too soon! This revolutionary strategy is called many names but I'll call it FIELD ROTATION in this paper.

Field rotation involves moving goalposts several times per season so games are always played on live green grass. To do this effectively, goals need to be designed so they can be moved by two people in a reasonable amount of time. In addition, field maintenance people need to be geared to stripe fields quickly and accurately so the new lines are easy to see. The best. way to do this is to use paint for stripes instead of killing out permanent stripes at the beginning of each season. My suggestion is to design fields more or less square and larger than needed so goals can be moved at least one goal width to the left and one goal width to the right of center and 5 yd. forward or back. If all these positions were used in one season, there would be 9 different field configurations possible. This would increase the time period in the fall when games are actually played on green grass. It would also reduce the tendency of goalies to dig large craters at the goal mouths which require major repairs at the end of the season. Even if fields were moved only three times per season the impact on field quality would probably be significant.

I see this simple strategy as the cheapest and most effective way to extend the functional life of turf on most soccer fields. Unfortunately, when I mention it to soccer clubs they reject it almost out of hand. It seems the prospect of building safe moveable goals is too much for most groups to even attempt. I believe there are enough engineers in the world that someone can come up with a simple but effective goal that will withstand kids climbing on it without collapsing and injuring the climbers. Likewise there are lots of different machines that are reasonably priced and capable of striping fields fast. The hardest part of moving goals and restriping fields is getting organized to do it. In my opinion, there is more than enough organization to implement this strategy in nearly every soccer group I have ever talked to. If the goal is to provide the best possible playing conditions for the kids, this is clearly the most cost effective way to do it. When you consider your options for your fields start with basic maintenance and incorporate the simple concept of moving goals. I think you will be surprised at how effectively this combination will improve the quality of your fields.

SUMMER PATCH: IDENTIFICATION AND MANAGMENT IN TURF![1]

Henry T. Wilkinson, Ph. D.[2]

[1] Presented at the **49th Northwest Turfgrass Conference**, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Professor, Department of Natural Resources and Environmental Sciences,
University of Illinois, Urbana-Champaign, Illinois

IDENTIFICATION OF SUMMER PATCH

Summer patch is caused by a soil-borne fungus that attacks the roots, crowns, rhizomes of bluegrass, the roots and crowns of fescue, and the roots crowns, and stolons of bentgrass. The fungus has been found in many different soils where these turfgrasses are grown. There appear to be a number of different variations of the same fungus (Magnaporthe poae). The most notable difference is mating type, which means that the fungus requires two different mating types to produce sexual spores. This occurs very rarely in nature. The fungus generally lives as mycelium in the soil. In the spring when the roots begin to grow, the soil is generally moist. When the temperature of the soil around the roots increases to about 70 F, the fungus that causes summer patch starts to attack the roots. You will not be able to observe this attack, but it is going on. At the same time, the turfgrass is producing new roots. As the spring continues and the soil either warms up or the soil dries out, the attack of the roots will slow down, but it does not stop. At the same time, the roots also start to slow down in terms of growth. If cool, wet soil conditions prevail for several months, the grass roots may be heavily colonized, but still you will not be able to see the symptoms of summer patch. Only when the turf plants are stressed do you see the typical symptoms of summer patch. When the plants are stressed for moisture, the fungus will attack the inner parts of the roots and crowns. When this happens, the plant can no longer obtain enough water and it will wilt or die. That is why the symptoms of summer patch are generally observed in the middle to late summer, when temperatures reach the 85-95 F range. It can be said that summer patch is a stress related disease because the disease is only serious when the turf is stressed after the roots and crowns have been colonized.

To determine if your turf is infected by summer patch, you should consult with a turfgrass pathologist. Diagnosing summer patch is difficult because the symptoms are observed during stressful weather conditions, which are also conducive to other turf diseases. Important in the diagnosis of summer patch are the type of grass, the age of the grass, the health of the roots, the soil moisture and heat conditions of the previous spring and the rate and extent of turf symptoms you observe. It is difficult to see the fungus on the grass roots without a microscope and even if you do see fungi colonizing your grass roots, it is impossible to determine if they belong to the summer patch fungus or another fungus.

CONTROL OF SUMMER PATCH USING FUNGICIDES

As a result of my extensive research on summer patch, I offer the following update which addresses predicting summer patch development in bluegrass.

There are two research programs underway from which I base my comments. Firstly, part of my annual field research program will determine at what natural soil temperature the summer patch fungus (Magnaporthe poae) colonizes and causes disease on bluegrass that is not moisture stressed. My field program investigates increasing soil temperature during the spring of the year. To date, no other conclusive research has been conducted on the development of this fungus on grass roots during the spring of the year.

Secondly, a special research project was developed to answer several questions regarding the best application site for fungicidal suppression of *M. poae*. The intent of this laboratory study was to carefully determine if five different commercial fungicides could: i) suppress the fungus when applied to the foliage after the fungus had colonized the roots; ii) suppress the fungus when applied to the soil after the fungus had colonized the roots; and iii) suppress the fungus either before or after colonization of the roots when applied directly to the roots. The preliminary results showed that if the fungus was allowed to colonize the roots, none of the foliar or soil applied fungicides effectively suppressed the fungus.

Collectively the results from the field and the laboratory studies have allowed me to develop some recommendations for the use of certain fungicides for the suppression of summer patch of bluegrass. The recommendations, or model if you would, could be listed as follows:

1. The fungus starts colonizing roots at about 68 +/- 3 F if there is sufficient moisture.

Recommendation: Fungicides should be applied at that time in the spring when the soil temperature is 68 +/- 3 F.

2. The soil temperature measured was the mean daily average which generally occurred at about 10-11 a.m.

Recommendation: Measure the soil temperature at about 10-11 a.m. or at that time when the soil temperature approximates the daily average temperature.

3. Most of the roots of bluegrass and annual bluegrass that become infected are in the upper 5 cm (2 inches) of the soil profile, not including the thatch layer if one exists.

Recommendation: Measure the soil temperature at a depth of about 5 cm or 2 inches under the turf.

4. Preliminary data indicated that a single application of fungicide applied as described above will be sufficient and that repeated applications during the summer especially after symptoms have developed are of little value in suppressing the disease.

Recommendation: For the Mid-West, a single application of fungicide in the Spring, applied at the high recommended rate should produce the best results. Use of this product may vary as the distance from central Illinois is increased. In western Washington State and Oregon, the long cool and wet Springs may create conditions that would require more than one application of fungicide.

5. Only in controlled field experiments did fungicides have a high level of suppression. This was not the case in naturally infested turf. Empirical studies have shown that the suppression of summer patch will generally require several years of an intensive chemical and cultural program.

Recommendation: Do not consider that a single application of a fungicide is a stand-alone cure for summer patch. It is one component of an integrated program. Cultural practices that maintain a healthy growing turf are just as important for the control of soil-borne diseases.

6. No research has been done to determine if the fungus is active in the soil during the fall of year. While no research has been done in the field, two facts have come from laboratory studies. The fungus requires a soil temperature of at least 68 F yet will still grow on roots at a temperature of 86 F. The fungus colonizes living, growing roots not dead or quiescent roots.

Recommendation: If a sod is displaying the symptoms of summer patch during the months of July-September, then the spring control program was not effective enough and a treatment during the following spring should be encouraged. In addition, an experimental application of fungicide in the Fall should be considered. The Fall application should be timed when the grass roots are growing. This will vary greatly from turf to turf and depend on climate, soil, mancgement and so on. Generally, if the roots are going to grow in the fall it will probably be at a soil temperature cooler than 80 F. The temperature will be more likely between 65-75 F when sufficient water is present. Crowing roots will be white and flexible.

7. Empirical studies have shown that a wet turf and wet soil under turf are most conducive to realizing disease suppression from the application of fungicides for the control of summer patch.

Recommendation: The turf should be moistened to a depth of at least 5 cm (2 inches) and more if possible. The fungicide should be applied in at least 5 gal. water per 93 sq. meters (1,000 sq. ft). An additional 1.5 cm of water should be applied after fungicide is applied.

These comments represent my preliminary research on summer patch. More needs to be done and research is slow and costly. I hope that these comments are useful and will encourage you and your company to continue to support my research.

SUMMER STRESS ON TURFGRASS[1]

Henry T. Wilkinson, Ph. D.[2]

[1] Presented at the **49th Northwest Turfgrass Conference,** at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Professor, Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana-Champaign, Illinois

Turfgrass stress is not limited to summer conditions, but without question, this is when it is the most severe. Stressed turf is generally recognized by poor growth (leaf growth or turf color), but the causes of turf stress are much more complicated. But instead of identifying the causes of stress, focus on the how the turfgrass plants respond to the many stresses that they are exposed to. The grass plant is the "control center" in terms of determining the quality of a turf. Every year your turf will be exposed to numerous stresses and at certain times the combined effect of multiple stresses could result in turf destruction. More often turf plants respond to stresses in a way to minimize the damage, thus preventing destruction. As a turf manager, your goal should be to predict and understand the various stresses that your turf is exposed to and use proper methods to minimize there impact. To help you achieve this, I will first consider the natural behavior of turf exposed to the summer climatic conditions and then look briefly at the various pests and cultural practices and how they could affect your turf.

Cool season turfgrasses respond to the change in seasons much as trees do. In the spring, the roots are active and the leaves are extending at rapid rates. Mid-spring brings on the drive to flower and produce seed. When a turf is trying to flower and produce seed, root growth and leaf extension will naturally slow down, These various processes are controlled by hormones produced by the plant. The stress of flowering, causes the plant to slow leaf and root growth. One possible means of reducing this natural stress is to supplement the turf with fertilizers, especially nitrogen and potassium. As the turf completes the flower-seed forming stage of growth, the soil and air temperatures have warmed considerably. Generally, it is June by this time, and the turf will resume root and leaf growth. During this time, the turf generally shows very little symptoms of stress. When grass is growing strong, the amount of stress required to significantly weaken the turf is high, consequently, you often do not see poor quality turf in June. Even damage from diseases and insects, which are active during this time of the year, is not often reported for this time of year.

REMEMBER: TURF THAT IS GROWING STRONG CAN TOLERATE A LOT OF STRESS BEFORE IT WILL DECLINE!

In late June (this can vary depending on where your turf is located in the cool season turf growing region) the soil and air temperatures continue to climb to near or above 80 F (25C) and the amount of natural precipitation declines, In addition the length of daylight hours is changing. Of the three climatic conditions (temperature, moisture and daylight) temperature is the most influential. When the cool season grasses are heated up, they want to slow down their growth. Generally, roots and leaf growth is dramatically reduced, while rhizomes or stolons continue to grow. This is the time that other stresses are going to be much more damaging to the turf. There are three reasons for this: i) disease and pest activities will be at their highest during this time; ii) the turf can not produce new tissues as fast as they can be destroyed, and iii) use of turf is intense.

Diseases of turf destroy grass tissues. If the rate of destruction is greater than the rate of plant growth, you will see the symptoms of the disease. This is the case in the summer. The turf simply can not recover from loses due to disease. Likewise, insects chew on the roots and crowns of turf during the summer months, When the rate of insect injury exceeds the rate of turf growth, the plants will suffer and show it. This too occurs during the summer months. Finally, the use of turf increases in the summer. Foot traffic, wear, compaction, and general damage from various sports activities all add to the pressure on the turf. If the plant can not respond, which is difficult and slow at best in the summer, the turf will show the symptoms of stress: thinning, blue-green color, brown leaves, stunting and death. The challenge for the turf manager is how to both revive the grass and reduce the severity of the various stresses.

A practice that most turf managers attempt is to try and force the turf to grow, even during the summer months, when the grass is trying to go dormant. Yes, in the summer, cool seasons will go partially dormant, This is a natural response to heat and drought. The plant will shut down the leaf growth and put its limited reserves into growing rhizomes, stolons and crowns. The reason is simple: these are survival structures and will prevent the turf plants from dying should the heat and drought of summer persist for months. For example, during hot summers without rain, grass needs only about 1/4 inch of water per month to remain viable. It will look dead, but in fact, it' s rhizomes or stolons are alive and waiting for cooler temperatures and moisture. Mangers that continue to supply turf with water and nutrients during the summer will force the grass to grow, but the activities of diseases, pests and humans also increase. As most managers know, staying ahead of problems during the summer is a challenge.

Here are a few suggestions to consider for preventing and managing your turf in the summer and reducing the effects of stress:

1. In the spring and early summer encourage the grass to grow. This can be achieved in part by maintaining moist soil around the roots and keeping an adequate supply of nutrients in the root zone soil. In addition practices that reduce compaction, increase aeration and drainage will improve the health of the turf.

REMEMBER: TURF THAT HAS GROWN STRONG IN THE SPRING WILL TOLERATE STRESSES OF SUMMER!

2. In the summer months, water the root zone, i.e., that depth of soil in which the roots are found.

3. Spoon feed your fertilizer: apply a balance (N:P:K) fertilizer and/or other nutrients as needed, but do not over supply them,

4. Do not make dramatic cultural changes during the summer. For example, do not change the height of cut much, but continue to mow the grass as needed.

5. Use preventative pesticide programs for those areas with a history of disease or insect problems.

6. Distribute use patterns on the turf as much as possible to reduce compaction and wear.

7. If you have the opportunity to renovate or reestablish turf, select those cultivars that have good summer quality ratings for your area.

Summer stress on turf is brought about by a combination of the natural growth patterns of cool season grasses, climatic extremes of heat and drought, your cultural practices, the use of the turf and pest pressures. A strong turf with plenty of roots, rhizomes or stolons and crowns will resist stress the best. To manage stress, you must try and establish balance in your turf, thus avoiding dramatic changes which could exceed the ability of your turf from tolerating stress.

INDOOR GRASS FOR WORLD CUP '94 AND BEYOND[1]

Dr. John N. Rogers, III, Mr. John Stier,
Dr. James R. Crum, and Dr. Paul E. Rieke [2]

[1] Presented at the **49th Northwest Turfgrass Conference**, at Skamania Lodge, Stevenson, Washington, October 10-12, 1995.

[2] Department of Crop and Soil Sciences, Michigan State University East Lansing, Michigan

In November 1991, the Detroit World Cup '94 Bid Committee requested help from turfgrass scientists at Michigan State University to install and maintain a natural turf field inside the Pontiac Silverdome for the 1994 World Cup soccer tournament. At least $120 million was expected to be pumped into the local economy, much of the money coming from international visitors.

Research began in the summer of 1992 to determine the installation and management procedures required for a natural turf field inside the Pontiac Silverdome. Preliminary research was conducted inside the stadium during June/July '92. Grass types, plant growth regulators (PGRs), and supplemental lighting were evaluated.

Due to use restrictions inside the Silverdome and time restrictions (the demand by FIFA to prove the indoor turf concept would work by playing a U S. Cup game in June 1993), a 6600 ft^2 research dome was built in August 1992 at the MSU Hancock Turfgrass Research Center. The fiberglass fabric used to cover the research dome is the same type of fabric used at the Pontiac Silverdome and other facilities around the world. Lack of suitable light poses the greatest obstacle to maintaining turfgrass inside the stadium as the fabric transmits less than 10 % of total sunlight and filters out much of the blue light crucial for plant growth. Diseases, heat, and moisture problems have also proven to be important factors in the management of indoor turfgrass.

Over one dozen experiments were conducted inside the research dome between autumn 1992 through winter of 1994. Two grass species, three soil types, five PGR rates, five fertility regimes, and six light levels were tested to devise a comprehensive program for managing turfgrass inside the Pontiac Silverdome. In addition, a prototype of the modular system for containing the portable turfgrass field was built and installed inside the research dome in January 1993. The construction of the mini-field provided vital information on the techniques required for the Pontiac Silverdome field.

Construction of the field at the Pontiac Silverdome began March 1, 1993. The soil, a sand:peat:soil mix, had been prepared inside the Pontiac Silverdome from January 2-4 and stored in a shed on the stadium parking lot. Over 1850 steel hexagonal modules, 49 ft^2 each, were placed together to form the field and filled with the soil mix. The soil was compacted and the field leveled prior to sodding.

The sod, a mixture of 85% Kentucky bluegrass and 15% perennial ryegrass, was grown in California during the winter of '92-'93 and shipped to Michigan by refrigerated trucks. On average, 10,000 ft^2 of sod per day was installed between April 12-22. Ten to 30 people worked 10-12 hours each day to construct the field from March 1 through April 22. Labor was supplied by local golf courses, lawn care companies, and MSU students, staff, and faculty.

Establishment of the field occurred during the latter half of April until the beginning of June, 1993. The field was mown and irrigated daily to encourage a high plant density and prevent moisture stress. Six traveling sprinklers (rain trains) were used to irrigate the field. Reel mowers were used to provide a high quality cut at low mowing heights (2" initially then decreasing to 1.25" prior to moving the turf indoors). Fertilizer was applied biweekly to maintain a consistent supply of nutrients.

Between June 7 to June 11, thirty people worked over a 44 hr period to move the field inside the Pontiac Silverdome. The modules were moved inside the stadium on flatbed trailers. Fork trucks were used to position the modules on the floor to form the field. Over the next few days the field was rolled and mown to prepare it for play. Seams between the individual modules were topdressed and rolled to achieve a uniform, level playing surface.

On June 19, 1993, in the first major sporting event ever played indoors on natural grass, defending world champion Germany defeated England 2-1 in the final game of the U.S. Cup '93. Over 62,000 spectators attended the game. Forty-five million people in 70 countries watched the game on TV. Players, coaches, and spectators alike loved the field. "The field is perfect..." exclaimed German coach Bernie Vogts. "I've never experienced a field in such perfect condition-a big compliment," Germany's leading scorer Juergen Klinsman commented. On June 21 the world champion U.S. national women' s team defeated the Canadian national women's team 3-1. Then, for four days, the field was used for the '93 Watchtower Convention. Finally, two additional soccer games were played on the turf during the next 10 days.

The turf held up well through all four games and team practice sessions. FIFA officials flew in from Zurich, Switzerland on June 29 and proclaimed the " experiment" a tremendous success.

Between June 30-July 2 the field was moved outdoors and reassembled in the parking lot (total time = 28 hrs.). During the rest of the summer and autumn the field was maintained as a high quality athletic field, with daily mowing and irrigation. Proper fertilization aided recovery of the turf and no sections required replacement or even overseeding. In mid-December a winter cover was placed on the field to prevent winter desiccation. The cover was allowed to stay on until mid-March when it was removed just prior to the advent of warm weather.

Fertilizations and mowing started in late March, speeding the springtime recovery of the turf. Throughout the spring of 1994 the turf was mown daily and irrigated frequently using two large water reels (another type of traveling sprinkler). Sand topdressings were applied several times to maintain a level playing surface.

Television crews and newspaper reporters/photographers were continually present at the Pontiac Silverdome field during the spring and summer of 1994. The media was often on hand for such routine practices such as mowing and fertilization. All of the field maintenance was done by MSU staff and students who performed remarkably well, especially in the light of TV cameras, and without any mishaps.

Installation techniques were improved upon from 1993. Between June 10 to 12, 1994, the field was moved back inside the stadium over a working period of only 30 hours. Seams between the modules fit together so well that additional topdressing was not required. Ball roll and bounce evaluations were conducted by World Cup turfgrass evaluator Steve Cockerham (University of California-Riverside) and were deemed quite acceptable. Except for lining, the field was ready for play within 24 hours after the last module was placed. On the afternoon of June 10 an international press conference was held on the floor of the stadium with the partially installed field covering nearly one-half the surface. MSU turfgrass scientists, World Cup, and Pontiac Silverdome officials were interviewed by news media from Great Britain, Japan, Mexico, Switzerland, and other nations, plus over one dozen national newspapers and television stations.

On June 14 the field was lined and the goalposts were installed. The field was relined twice more during the tournament, once on June 20 and again on June 27.

Beginning during installation, the field was rolled daily using a combination of single drum, three-gang, or mower-type rollers. Following rolling, the field was brushed to stand the turf upright for mowing. Occasionally a turfgrass sweeper brush was used to remove turfgrass debris. The field was mown daily at a height of l" (2.54 cm). Clippings were collected and discarded. Irrigation was unnecessary while the turfgrass was inside the stadium.

The first week the turf was indoors the weather was hot and humid, with temperatures and humidity in the 90' s. Twelve portable, industrial fans were moved constantly around the field to aid air movement and promote drying of the turf to prevent disease development. Non-turf related traffic was kept to a minimum in order to minimize additional turfgrass stress. Advertisement signboards and television cameras comprised the bulk of the non-turf related traffic. In addition, the field was visited by representatives from the (National Football) Players Association, Chuck Schmidt, the general manager of the Detroit Lions, Wayne Fontes, the head coach of the Detroit Lions, and many of the Detroit Lions team members.

On June 17 the Swiss national soccer team held practice for 1.5 hrs in the stadium and appeared quite satisfied with the field conditions. Afterwards the U.S. soccer team held their practice, followed by an inspirational video and music that evening. On Saturday, June 18, the U.S. and Switzerland played to a 1-1 draw before an enthusiastic crowd of over 70,000 people. Despite the week of hot, humid weather, ideal neither for turf or spectators, the field conditions after the game remained outstanding. No divots had torn through the turfgrass mat layer to expose the soil despite the use of steel cleats by many players. Divots were repaired the day following the game by lifting and pulling the sides of a worn area together similarly to fixing divots on a golf green.

The day after the game temperatures and humidity finally decreased to 70-80 F with 60-80% humidity. On June 21 the Romanian national team practiced on the field. The following afternoon, June 22, Switzerland defeated Romania 3-1. On June 23 the Swedish national team practiced inside the stadium, followed in the afternoon by the Russian national team. One of the Russian coaches remarked that in Russia they could only dream of having such a high quality field.

Unfortunately for the Russians, on Friday, June 24, they were soundly defeated by the Swedes 4-1.

During the weekend of June 25-26 the divots were once again repaired. On Monday, the Brazilian national team entered the stadium for the last regular practice session inside the Silverdome during the World Cup. On June 28, Brazil and Sweden played to a 1-1 draw. Brazil went on to win the World Cup 1994 championship, with Sweden finishing third.

From June 29-30 the sod was cut from the field and shipped to Belle Isle, Michigan, where it was used in the construction of a new soccer field. The soil was sold to a golf course construction firm and used to build nine putting greens. The steel modules were shipped to a remote site of the Pontiac Silverdome property where they were put up for sale by the World Cup Host Committee to help defray field operating expenses. As in 1993 the turf survived the four soccer games and six practices in fine condition. Many players spoke quite favorably of the indoor portable turfgrass field' s quality., none expressed dissatisfaction.

Coaches, fans, and media alike were thrilled with the indoor turfgrass field. The success of the turfgrass system has generated interest in indoor turfgrass for sporting events around the world. Japan leads the pack of potential indoor turf users–in July 1994 they tested an indoor turfgrass system for the new Japanese Football (soccer) League at the Fukuoka Dome.

Research is continuing at Michigan State University to develop management schemes for turfgrass under low light levels, including both outdoor and indoor situations. Now that we have established the techniques for the short-term maintenance (< 60 days) of indoor sports turf, much of the current and future research will be aimed at maintaining turfgrass indoors or under low light levels on a long-term (>60 days) or permanent basis. During the summer and autumn of 1994 several companies/groups have approached Michigan State University exploring the potential for indoor turfgrass for sports fields. Negotiations are underway with some of these companies to develop indoor turfgrass fields.

Research currently in progress includes evaluation of several Kentucky bluegrass varieties, both old and new, for their performance under shade. In a second project undertaken in conjunction with a Japanese [stadium] architectural and construction firm, we are evaluating the use of iron and magnesium applications to improve the quality and durability of Kentucky bluegrass under three levels of reduced light.

A third main project focuses onthe use of a novel turfgrass species form Germany, Poa supina. Collected in the Alps, it is related to annual bluegrass but is perenneal species like kentucky bluegrass. Unlike other Poa species, P. supina is stoloniferous, able to quickly recolonize an area dirupted by traffic. In addition, the grass is purportedly shade and traffic tolerant. Our research objective is to determine the suitability of the species for use as a sports turf in both outdoor and indoor applications. Plots have been established both indoors and outdoors. Experiments are underway to define fertility and light requirements of the grass, its ability to withstand sports-type traffic, and the use of PGRs and iron to improve its color. Other experiments are defining its disease susceptibility.