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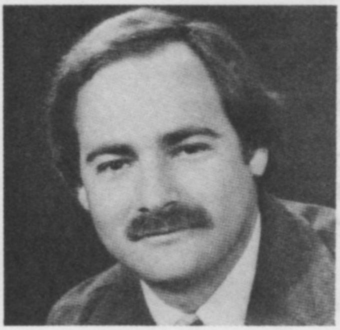
PREFACE

One of the primary objectives of the **Northwest Turfgrass Association** is to disseminate current turf development and maintenance information available from research, study and experimentation to interested persons. The annual **Northwest Turfgrass Conference and Exposition** and publication of the proceedings from each conference is one of the ways the association has chosen to accomplish this objective.



Bo C. Hepler

When I think back over this past year, I think of a new beginning, as well as an end of an era. Our Forty First Annual Turfgrass Conference marked the beginning of taking on a new executive director, Mr. Blair Patrick of Organization Management, who will be handling the business of the association as we continue to grow larger year after year. We had a record attendance at Salishan Lodge reflecting the great educational program offered this year as well as the desire of the turf industry as a whole to keep abreast of everchanging turf management techniques.

One of the major purposes of the Northwest Turfgrass Association (NTA) and to distribute funds for turfgrass research in the Northwest. This was a prosperous and beneficial year in that we were able to award in excess of $32,000 for research programs in the Northwest.

1986-1987 had some bitter-sweet moments as we saw the end of an era in the retirement of Dr. Roy Goss. Bitter in the way that we are losing the leadership and guidance which Roy has generously extended for over thirty years to the NTA. Sweet in that it's a very deserved rest for a job well done. In gratitude for this service, Roy was awarded an honoring lifetime membership, and was elected as our first Board Member Emeritus.

My sincere thanks is extended to past president Mark Snyder for his invaluable help in the planning process of this year's convention at Salishan Lodge, as well as all of the officers and directors I had the pleasure of working with on the board this year. Thank you all for a job well done!

Best wishes are extended to our new president, Jim Chapman and his board for the 1988 year to come.

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TABLE OF CONTENTS

A REVIEW OF THE NORTHWEST TURFGRASS ASSOCIATION - A 30-YEAR PROJECT [1]

Dr. Roy L. Goss [2]

[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Extension Agronomist, Western Washington Research and Extension Center, Washington State University, Puyallup, WA

The following information will cover only the last 30 years, but before delving into this, let's go back and take a brief look at the beginnings of the Northwest Turfgrass Association.

A group of interested people composed of Johnny Harrison, Glen Proctor, Wilford Brusseau, Louie Schmidt and Cliff Everhart, who were golf course superintendents (then known as golf greenkeepers) in 1948, approached the College of Agriculture Dean Shaffer to see if Washington State University couldn't help in some way of doing research and also helping at annual conference to help keep the interested turf people of that day better informed. Al Law was asked to assist. He served faithfully for many years — four as executive secretary. The Turfgrass Association was not incorporated in 1948 and did not become a corporation until the early 1950's. The annual turfgrass conference was held on the campus of Washington State University, then known as Washington State College, every year until the early 1960's. All of the conference attendees stayed at the old Washington Hotel and there was a great deal of comradery among this small group. There were usually about 70-90 in attendance at the conference. There is no indication of who served as President of the Association or Conference during the 1948-49 years, but in 1950, Ivan W. Lee became the first president, followed by Ed Fluter, then Sam Zook in 1954, Milt Bauman in 1955 and 1956, Don Hogan in 1957, 1958 and 1959. The other presidents and their sequence will follow by the year in the following text.

The early day turfgrass conferences had their programs dominated with such problems as pearlwort control, proper aerification methods, fertilization programs, disease control, etc. It doesn't seem that the need for this type of program has ever changed and we are still dealing with that type of problem today. I was once told by a group of golf course superintendents that if we could come up with a control for pearlwort, we would be heroes. Well, pearlwort has come and gone with respect to being able to control it, and many other difficult problems have been solved, and we are still not heroes, nor did we expect to be.

After the Turfgrass Association became well organized, they realized a need for a research program to delve into the problems that were peculiar to the Pacific Northwest. They relentlessly pursued this effort with the administration of Washington State University, and with their pledge of financial support, Washington State University eventually agreed to create a position for turfgrass research and extension. This position has essentially created information for the entire Pacific Northwest since 1958, and the programs that have been carried out at the Western Washington Research and Extension Center at Puyallup have served quite a large geographic area. The following information is a year-by-year excerpt of highlights from the Turfgrass Topics, with the exception of 1958.

1958 - PULLMAN - DON HOGAN, PRESIDENT

1. Washington State University hires Roy Goss for the research position.

2. Research initiated on chickweed and pearlwort control.

3. Cooperative programs were initiated with C. J. Gould on turfgrass diseases. Dr. Gould had been working on Fusarium patch, fairy ring and a few other diseases since the late 1940's.

4. Turfgrass research field laboratory established at Farm 5 at Puyallup.

1959 - WASHINGTON HOTEL, PULLMAN - DON HOGAN, PRESIDENT

1. Turfgrass Topics, Vol. 1, No. 1, published February 1959.

2. A new bluegrass variety in the making was discussed by Dr. Patterson. The variety later became known as Cougar.

3. The First Turfgrass Field Day was held at the Western Washington Experiment Station on August 20, 1959.

4. The ''President's Corner'' was initiated in Turfgrass Topics. Don Hogan wrote the first column.

5. The ''Oregon Compost Heap'' column was started, and Byron Reed wrote this column for several years.

6. Turfgrass Research and Extension position was created, and Roy Goss filled both positions - 50% research and 50% Extension.

7. Northwest Turfgrass Association gets tax exempt status. A tremendous amount of work was done on this by Henry Land, Glen Proctor, Milt Bauman, Don Hogan, and others including the writer. It was a lot of work and cost the Association a great deal of money, but we can now accept grants of money that are tax-free to the donor.

8. Washington State University was still Washington State College.

1960 - UNIVERSITY OF WASHINGTON CAMPUS, SEATTLE - GLEN PROCTOR, PRESIDENT

1. We are still called The Turf Association. In order to distinguish between ourselves and horse racing, we applied for a corporate name change to Turfgrass Association.

2. Northwest Mower and Marine Company donates first greens mower for research at Puyallup.

3. The column entitled "This 'N That From WA and Idaho" was initiated by Bill Strahl.

4. Dacthal and Zytron were both found very effective in preemergence control of crabgrass control. Bensulide had not yet been heard of.

5. 1960 Turfgrass Conference at the University of Washington. Rooms were $7.50 and Conference Registration was $3.50 per member.

6. Bob Finley, longtime golf superintendent retired from Seattle Golf Club, passed away.

7. Ophiobolus patch disease was first identified at Puyallup.

1961 - WASHINGTON HOTEL, PULLMAN - BYRON REED, PRESIDENT

1. Henry Land, Sr. retires as longterm treasurer following the death of his wife, Bernice who was his helper. Dick Haskell became the new treasurer and served in that position for many years.

2. Turfgrass Research Golf Tournament was held at Broadmoor Golf Club on March 6, 1961.

3. 1961 was a hot, dry summer. Wetting agents and anthracnose received a great deal of attention that year. Wetting agent research had been conducted since 1959.

4. Light intensity factors were first discussed and the effect of shade.

5. Dr. J. K. Patterson died.

1962 - WASHINGTON HOTEL, PULLMAN - BYRON REED, PRESIDENT

1. Roy Goss was elected Executive Secretary after the death of Ken Patterson at the September Conference.

2. The importance of potassium stress was first discussed.

3. Cautions on playing frosted and frozen turf were given and published in "Turfgrass Topics".

4. Athletic field construction and maintenance was presented in a series of articles.

5. Turftype ryegrasses haven't arrived yet.

6. Columbus Day Storm on October 12 caused tremendous damage on the West Coast.

1963 - THUNDERBIRD HOTEL, PORTLAND, OR - HENRY LAND, SR., PRESIDENT

1. First turfgrass short course was presented to the golf course superintendents.

2. Over 200 attend the July 11 Turfgrass Field Day.

3. Turfgrass winter injury warning is given again.

4. Fourth year of wetting agent investigations completed.

1964 - VILLA MOTEL, BURNABY, B.C. - MILT BAUMAN, PRESIDENT

1. The first discussions of sulfur requirements for turfgrasses were begun. Intensive sulfur research continued for the next 10 years and significant results were obtained on turfgrass quality, Poa annua decrease, decrease in Fusarium patch disease and total control of take-all patch disease.

2. A. V. McCann, long time Canadian Golf Course Architect, died in Adgust. Bill Southerton, long time retired superintendent from Spokane Country Club, died in December.

3. Recommendations for mowing bluegrasses were 3/4 inch. We learned a very short time later that this is disastrous for Kentucky bluegrass.

1965 - HAYDEN LAKE COUNTRY CLUB - KEN PUTNAM, PRESIDENT

1. Summer turfgrass losses - soil oxygen and anaerobic conditions were discussed in Vol. 7, No. 2 of "Turfgrass Topics" in September 1965.

2. Paul Brown, longterm Supporter of the Turfgrass Association and TV gardening personality, passed away.

3. Dick Fluter, student at Oregon State University, received the Oregon Turf Managers Association Scholarship for that year.

4. Dr. Austenson, Agronomist at Puyallup, leaves for Canada. Herman Austenson cooperated with the golf course Superintendents and other turfgrass people in the early years in certain turfgrass investigations before the major research program was established.

1966 - SALISHAN LODGE - HARVEY JUNOR, PRESIDENT

1. I'm tired of Poa annua - Dr. W. H. Daniel, from Purdue University, described his 5-step method of eradication of Poa annua with tricalcium arsenate.

2. The largest turfgrass conference ever was held at Salishan with 185 registered attendance and 230 at the banquet.

3. Must have been a good year, not much else happened.

1967 - HARRISON HOT SPRINGS, B.C. - DICK MALPASS, PRESIDENT

1. Zytron, Dow Chemical Company, produced 100% control of speedwell (chemical was later removed from the market).

2. Dacthal was found effective on Veronica control.

3. Potassium Symposium was conducted at the American Society of Agronomy Meetings with Division C5 - Goss participated. We had several years of potassium data with respect to turfgrass quality and its effect on turfgrass diseases by 1967.

1968 - ALDERBROOK INN, UNION, WA - GEORGE HARRISON, PRESIDENT

1. Glen Proctor retired from Rainier Golf and Country Club and spent full time for the next few years designing and building golf Courses through the corporation of BG&P, Inc.

2. Henry Land, Sr. retired from Tacoma Country and Golf Club. Henry was an avid hunter and fisherman as well as one of the best supporters for turfgrass research and extension programs.

3. Dr. Marvin Ferguson retires.

4. Mr. John Escritt, Director of the Sports Turf Research Institute at Bingley, Yorkshire, England was an invited guest at the Northwest Turfgrass Conference.

1969 - HAYDEN LAKE GOLF AND COUNTRY CLUB - GEORGE HARRISON, PRESIDENT

1. This year was the first hearings to outlaw DDT and other chlorinated hydrocarbons.

2. Costs to maintain Joe Albi Football Stadium were presented by Charlie Thurman. Records indicated the field could be maintained for close to $1,000 per year.

3. New herbicides for Poa annua seedhead control were tested. Po-San was very effective.

4. First International Turfgrass Research Conference was held at Harrogate, England. Goss attended and presented a research paper.

5. Roy Goss wrote articles on comparing natural grass with artificial turf.

1970 - SALISHAN LODGE - TOM KEEL, PRESIDENT

1. Tersan 1991 - A new fungicide for Fusarium patch disease control came on the market.

2. The first tests on Manhattan turftype perennial ryegrass were initiated. You can see that many of our better grasses of today haven't been around very many years.

3. Roy Goss discusses the consumptive use of water and evapotranspiration factors (ET). Considerable research has been done since 1970 and water use factors and water consumption are probably some of the key research in modern times.

1971 - CHINOOK HOTEL, YAKIMA, WA - TOM KEEL, PRESIDENT

1. First trade show was attempted at Northwest Turfgrass Conference that year. The trade show was moderately successful, but not enough to stimulate a great deal of interest for a few years yet to come.

2. Tests were first initiated for Ophiobolus patch disease control.

3. Jim Chapman initiates ''Thatch Patch'' column in Turfgrass Topics. Jim Chapman was reporting on much of the same territory that was vacated by Bill Strahl.

4. Dick Malpass elected to the Board of Directors of the Golf Course Superintendents Association of America.

1972 - OCEAN SHORES, WA - DICK SCHMIDT, PRESIDENT

1. Fund raising was first initiated to hire a Turfgrass Research Associate.

2. European crane fly problems first emerged in western Washington. They were first observed in Whatcom County near Blaine and Bellingham and have since marched southward, perhaps as far south as San Francisco.

3. EPA says 2,4-D, 2,4,5-T and 2,4,5-TP pose no environmental or health problems.

4. Warnings were issued again in writing in ''Turfgrass Topics'' for turfgrass winter injury.

5. Tom Cook, undergraduate Student at Washington State University, receives GCSAA Scholarship.

1973 - HARRISON HOT SPRINGS, B.C. - JOHN ZOLLER, PRESIDENT

1. First ever joint Northwest Turfgrass Association-Western Canada Turfgrass Association Conference at Harrison Hot Springs.

2. Second International Turfgrass Research Conference was held 1973 at Blacksburg, VA.

1974 - SUNRIVER, OREGON - MILT BAUMAN, PRESIDENT

1. The Board of Directors of the Northwest Turfgrass Association approved the hiring of a Turfgrass Research Associate. Funds were accumulated for approximately three years before sufficient amount was available to hire this Associate.

1975 - CHINOOK HOTEL, YAKIMA - CLIFF EVERHART, PRESIDENT

1. Tom Cook was hired as the first Research Associate on February 1, 1975. Tom Cook had just completed his Master's degree at the University of Rhode Island and was ready to go to work.

2. New sand putting green was established at Farm 5 Turfgrass Research area. About 8 inches of sand of good quality was placed over the native soil for sand root zone studies.

3. Light, frequent sand topdressing study were initiated. Sand root zone putting greens and sports fields have been under construction in western Washington since 1956. The first fully planned sand root zone putting green, to my knowledge, was built at Overlake Golf and Country Club and the writer

during the summer of 1956. We used 90% sand and 10% fibrous spaghnum peat moss. This proved to be an insufficient amount of peat moss and we eventually increased this by 25% loose volume.

4. Poa annua control programs were initiated with endothal and other chemicals were investigated as well.

1976 - SPOKANE SHERATON HOTEL - JOHN MONSON, PRESIDENT

1. Dick Malpass was elected GCSAA President this year.

1977 - SALISHAN LODGE - JOE LYMP, PRESIDENT

1. Dr. Charles Gould retires as research plant pathologist from the Western Washington Research and Extension Center after 36 years at this location.
2. Tom Cook was hired by OSU Horticulture Department in September of this year.
3. ''Winter roulette'' was written by Roy Goss to warn golfers or other sports enthusiasts not to play frosted and frozen turf grasses.

1978 - RICHLAND, WA HOLIDAY INN - SAM ANGOVE, PRESIDENT

1. Dr. John Roberts was hired as the second Research Associate. Dr. Roberts had just completed his Ph.D. in Agronomy-Turf at Purdue University. Dr. Roberts was also an undergraduate student at Washington State University.
2. Dr. Gary Chastagner was hired as Research Plant Pathologist to replace Dr. Chuck Gould.
3. Warnings again were issued on winter damage from playing on frozen turf.

1979 - PORT LUDLOW ADMIRALTY INN - JOE POTTENGER, PRESIDENT

1. Winter damage was severe during the winter of 1978-1979. A tremendous amount of Poa annua was lost through winter desiccation without snow cover.
2. The Northwest Association of Golf Course Superintendents sponsored a raffle car and the proceeds were to be used for turfgrass research. Larry Gilhuly and others spearheaded this drive with great success.
3. Roy Goss takes sabbatical leave to New Zealand from November 1979 to April 30, 1980. His principle investigations were centered around phosphates and sulfur and their effect on Poa annua and bentgrass.

1980 - SUNRIVER, OR - EARL MORGAN, PRESIDENT

1. Mount St. Helens erupts, May 18 and created tremendous problems east of the Cascade Mountains for a while.

2. Dr. W. J. Johnston joins WSU faculty just in time to help dig out from the ash.

3. Cliff Everhart, retired Superintendent at Manito Golf and Country Club, died October 24.

4. Dr. John Law, third Research Associate is hired at Western Washington Research and Extension Center. Dr. Law received his Ph.D. from University of Rhode Island.

1981 - TYEE MOTOR INN, OLYMPIA, WA - DICK SCHMIDT, PRESIDENT

1. This was the first year of the recession and there was a gasoline shortage, which must have significantly impacted the attendance at the turfgrass conference.

2. There was severe damage during this year from the European crane fly, which had moved on South of Tacoma.

3. Washington State University Soils Testing Lab closed this year due to lack of funds to continue operating. This was the beginning of a six-year financial drought which seriously impacted many programs at Washington State University.

4. ''Irrigation Malpractice'' - A discussion on proper irrigation water application was written in Vol. 24, No. 2, ''Turfgrass Topics'', September, 1981.

5. This was a bad year. It seemed like nothing was good that year according to the above.

1982 - TOWNE PLAZA MOTEL, YAKIMA, WA - NORM WHITWORTH, PRESIDENT

1. Necrotic ring spot had not yet been isolated nor identified. It was thought to be a take-all patch-like symptom and organism.

2. Necrotic ring spot symptoms were reported as early as 1960, although we didn't know what was causing it.

3. Dr. David F. Allmendinger, retired Superintendent of the Western Washington Research and Extension Center, died.

1983 - KAH-NEE-TA RESORT - DICK MALPASS, PRESIDENT

1. Two original founders of the Northwest Turfgrass Association, Wilford Brusseau and Louie Schmidt, died.

2. Dr. Jeff Nus, Ph.D. graduate of Iowa State University, was hired in October as Research Associate at Western Washington Research and Extension Center.

1984 - SPOKANE SHERATON HOTEL - RAY MC ELHOE, PRESIDENT

1. Milt Bauman, Sam Zook and Ed Jennings all retired this year.

2. Necrotic ring spot disease was positively identified. The fungus causing this disease is Leptosphaeria korrae.

3. Larry Gilhuly, Assistant Superintendent at Seattle Golf Club, resigns to join the USGA Green Section staff in California.

4. The Commercial Trade Show was reinstated at the NTA Conference with very good success. Bill Campbell and his hard-working crew ran the Trade Show.

5. Sulfur was recognized as significantly reducing Fusarium patch disease.

1985 - RIPPLING RIVER RESORT, WELCHES, OR - GARY SAYRE, PRESIDENT

1. Harvey Junor retires after 47 years at Portland Golf Club.

1986 - RED LION INN, PASCO, WA - MARK SNYDER, PRESIDENT

1. The Vertidrain deep-tined aerifier makes its first appearance. This machine has proven extremely useful on sites previously difficult to aerify with hollow-tined equipment.

2. Rubigan was shown to be effective on necrotic ring spot disease and Poa annua control. Dr. Chastagner and the writer initiated test plots in 1982-83 and tests are still in progress at this time.

3. Clip Collard retired.

4. "BLACK LAYER" rears its ugly head. Much has been written about Black Layer, although it is simply nothing more than an anaerobic condition. Good aeration, good drainage and water control must be exercised to prevent this Black Layer.

1987 - SALISHAN LODGE - BOWDEN (Bo) HEPLER, PRESIDENT

1. Blair Patrick, Organization Management at Olympia, WA, was hired as Northwest Turfgrass Association Executive Director. All records and activities of the Association have been transferred to Olympia. Just because we now have a full-time executive director does not mean that we can all sit back. We need to support this individual and provide help and information in every way possi ble.

2. Roy Goss refutes many of the ''Black Layer'' theories - it is strictly a soil management problem.

3. Roy Goss promises, faithfully, to retire in January 1988.

TURFGRASS AND SOIL IRRIGATION NEEDS IN REVIEW [1]

Dr. Roy L. Goss [2]

[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Extension Agronomist, Western Washington Research and Extension Center Washington State University, Puyallup, WA

Perfect irrigation is nearly impossible to achieve and may not be practical, but there is a great deal of improvement that can be made. There are many variables that affect optimum water application, and turfgrass managers should become competent in their understanding of these variables. These variables include type of turfgrass facility, such as parks, schools, golf courses, etc., type of grass - bluegrasses, bentgrasses, ryegrasses, Poa annua, etc., soil texture, soil structure, soil depth, water infiltration rates, water permeability rates, water holding capacity, topography, shade, wind, etc. Armed with this information, an irrigation designer can create a system with the greatest effectiveness and efficiency. In spite of the fact we utilize all of the above factors and create a perfect system, there is another major variable and that is the human factor. In other words, how precisely is the system operated by the individual? All this good engineering goes down the drain if we don't utilize other knowledge and common sense.

DETERMINING WATER NEEDS

1. Evaporation Pans. Anyone can purchase a standard U.S. Weather Bureau evaporating pan equipped with the proper gadges, etc. and you can operate this on your own or you can accept weather data from the nearest station to you. You might even consult the weather bureau with respect to their data and your specific location.

2. Calculate Evapotranspiration (ET). The coop coefficient for our turfgrasses is generally about 60-75% of open pan evaporation. This factor takes into account all of the parameters such as heat, wind and relative humidity as they affect soil evaporation and transpiration from the leaves. Ongoing research at Puyallup may result in a change in this coefficient.

3. It is usually accepted that approximately 80% of the calculated evapotranspiration will produce turf of good quality. Application of water based upon 100% ET would likely end up with excessive application, waste of water and leaching of plant nutrients.

4. Tensiometers. There are a number of different tensiometers which can be used to measure the soil moisture. When properly installed, these

instruments will give a reasonably good estimate of soil moisture. The best application of these instruments is on soils of uniform texture and depth. In most turfgrass applications it is almost impossible to find good, uniform soil conditions over the entire area. Therefore, watering by tensiometers could result in major errors. Tensiometers fail completely as a rule when hydrophobic areas or localized dry spots are not controlled.

5. Soil Probes. Probably the most useful tool to any turfgrass manager for proper irrigation is the soil probe. You can train yourself to estimate the amount of soil moisture while at the same time examining the depth of the rooting system. It is my opinion that most of the available water should be removed from the root zone before re irrigating. This permits greater oxygen diffusion into the soil and will encourage deeper rooting of turfgrasses.

6. Watch the Grass. The appearance of the grass will tell you when the need for water is critical. Water stressed turfgrasses are generally blue to gray in appearance, will not spring back readily when walked upon and will usually have less dew formation than surrounding turf grasses. This can happen while the turf remains green, but only a short time is required after this until the turf turns brown.

HOW TO MAKE IRRIGATION WATER MORE EFFICIENT

The most important factor in irrigating turfgrasses is how much water do you get into the root zone, not how much came out of the nozzles. Unless you carefully examine the root zone following water application, you may miss the important fact that water doesn't enter all areas of the irrigated surface uniformly. Minor surface irregularities, commonly cause water to run off of high spots and collect in the low spots causing overwatering. The high spots frequently turn brown and the low areas are lush green with excessive growth or sometimes develop into wet, muddy areas depending upon soil type, maintenance practices and intensity of use. Some methods of increasing irrigation efficiency can be enumerated as follows:

1. Grade all areas to a smooth and uniform surface. This does not imply to grade it flat, but simply to have the surfaces smooth. This should be thoroughly considered before planting. However, many older turf grass areas have lost the original surface smoothness and should be regraded. This can be accomplished by stripping the sod from the area, placing on pallets and moved off the site, followed then by disking, rotovating, harrowing and grading until the surfaces are once again smooth, and then replace the sod.

2. Deep subsoiling - Turfgrass areas that were prepared with heavy equipment and especially when the soils had field capacity moisture or wetter, will usually have a significant amount of compaction built in. This should

definitely be relieved by subsoilers, rippers on caterpillars or other means of compaction relief prior to planting.

3. Intelligent use of wetting agents - The surface tension of turfgrasses usually increases as summer advances and heat builds up. Water will not readily penetrate surfaces with high surface tension without the use of wetting agents. These areas should be identified and wetting agent applications commenced as early as April in the Pacific North west and maintained throughout the irrigation period.

4. Hollow-tined aerification and slicing - Heavily used turfgrass areas such as sportsfields, golf courses, parks, etc., should be hollow-tine aerified three to six times per year depending upon the degree of compaction and infiltration rates of water.

5. Deep solid tined aerification (Vertidrain) - Different innovations of deep tined aerifiers have been developed over many years, but the machine that seems to be producing some of the best results in the Pacific Northwest today is the Vertidrain, which has the capability of inserting 1-inch tines 16 inches deep into the soil or 3/4-inch tines 12 inches deep. The action of this machine tends to loosen compacted soils to a depth much greater than any other machine can achieve without seriously disrupting the turfgrass surface. This machine has been successfully used on nearly all applications of sports fields, play grounds, parks, putting greens and especially on golf course fairways.

6. Cover rocky and gravelly outcrops with soil or sand - Some of the greatest compaction occurs in gravelly soils due to the inability of hollow-tined aerifiers to penetrate. The solid tined deep aerifiers have proven quite successful in some of these applications, but hollow-tined aerification is practically useless. A minimum of 4 inches of sandy soil or sand alone should be spread over problem areas which will help solve the problem and will allow normal maintenance programs.

7. Thatch control - As thatch depth increases, the tendency for water runoff increases during the summer, particularly on sloping topography. It has been frequently observed that a typical irrigation may not penetrate to the bottom of the thatch layer. Therefore, roots will have to grow in the thatch layer which only perpetuates and enhances the problem. Turfgrass managers should try to keep the thatch controlled to a depth not to exceed 1/2 inch.

BETTER DESIGNED IRRIGATION SYSTEMS

Irrigation systems designed to meet my best expectations will cost significantly more money than what usually gets installed. Is it worth just a small percentage increase in cost to achieve near-perfect effectiveness of an expensive long term capital item such as an irrigation system? I think so. As an agronomist, I do not have the knowledge to design high tech irrigation systems, but I have observed a few areas where improvements can be made.

1. Slow precipitation rate systems - For the most part, irrigation systems apply water, measured in inches per hour precipitation, greater than the infiltration rate of the soil. In this case, water will accumulate on the surface in flat areas or run off high spots and accumulate in low spots with sloping topography. Irrigation systems that have the capability of multiple cycles during any one given irrigation period can greatly alleviate the problem of water runoff.

2. Individual head control - I believe this is a must on facilities such as golf courses with variable topography. The golf course superintendent should have the capability of having any head operating at his discretion. I would question the value of individual head control on flat surfaces such as sports fields.

3. Smaller heads - Systems designed with smaller heads usually result in greater efficiency and effectiveness and particularly in reducing the precipitation rate and obtaining better coverage.

4. Fewer heads per valve - With many of the old systems, a mainline valve may control too many lateral heads. They either all operate or none of them operate. It is difficult to irrigate uniformly and effectively with this type of system.

5. Back-to-back, part-circle sprinklers at the junction of putting greens and fairway approaches - Soft, muddy areas are frequently encountered on golf course aprons and approaches due to one sprinkler head covering both the green and the fairway. Front-to-back sloping greens frequently result in water running off to the front and compounding the problem. Usually, fairway soils are heavier textured than the normally constructed greens with sand profiles. These fairway soils should be irrigated deeply and infrequently, while the putting green soils may require less water more often, although we should try to extend the interval between irrigations as long as possible in all of these areas.

CONCLUSIONS

Due to the variability of soils in many turfgrass areas as well as minor undulations, it is nearly impossible to maintain totally green conditions over the entire facility, especially on golf course fairways. It is my opinion that we should learn to live with a few minor brown areas during the peak of summer. Anytime that I observe not a single brown area on golf course fairways, I have to think that there is probably a certain amount of over-irrigation going on. In more recent times, however, wetting agents can be injected into irrigation systems and totally cover fairways, tees, greens, and the entire golf course, for that matter. This does cost a few more dollars in the maintenance budget, but if this is important to the turf manager's clientele, then we should budget for it.

We absolutely cannot neglect our maintenance practices of aerification, wetting agents and thatch control. These three factors go hand-in-hand with respect to maintaining optimum conditions. Managing these three factors to an adequate degree will result in grasses with better vigor, better appearance and deeper root systems. This type of program will go far in helping to promote better turfgrasses and reduction, if not elimination, of Poa annua.

Finally, any irrigation system that is installed today should be placed in trenches no shallower than 20 inches to the top of the pipe in order to allow the use of deep tined aerifiers and/or subsoilers when necessary. Installation of drain lines should be based upon the same principle.

LOW APPLICATION RATES FOR IRRIGATION [1]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

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We have heard today about the fundamental principles of low rate infrequent application along with the descriptions of new products on the market to implement these concepts. We will now discuss briefly examples of how we might achieve these desirable precipitation rates and the benefits of the lower cost of new systems or remodeled systems plus savings in operational costs for those systems that rely on pumping.

Short and Intermediate Ranges

First we will compare sprinklers for the smaller and intermediate sized areas that one might encounter in commercial and formal park areas. To achieve the minimum number of sprinklers to cover a given area for a spray system a typical selection would be a sprinkler rated with a 15 foot radius operating at 35 p.s.i. which will discharge, depending on the particular manufacturer, from 4.0 to 5.8 gallons per minute. Assuming an average of 5 gallons per minute with spacings of 55 percent for triangular and 50 percent for square patterns the precipitation rate for this system will range from 2.0 to 2.15 inches per hour. Certainly we can agree that most soils, particularly with a turf cover, cannot accept this very high rate. Unless the water application is cut to extremely short increments, runoff and saturation at the surface will result when irrigating.

Comparing a stream rotor sprinkler which is designed for much lower rates of precipitation with the spray system we can achieve much lower rates of application. This type sprinkler that can be rated at 28 foot radius at 35 p.s.i. would discharge 2.7 gallons per minute. With the same formula for spacing as the previously mentioned spray system the precipitation rates would drop to 0.27 inches per hour for the triangular configuration and 0.33 inches per hour for the square pattern. The decrease in precipitation rate would range from 83.5 percent to 87 percent.

When comparing the cost for installation between the spray system and the rotor and assuming a single line configuration of eight sprinklers in a row, we find that for the spray system the range of piping would be from 3/4 inch to 1-1/2 inch, while for the rotor system the piping sizes would range in size from 1/2 inch to a maximum of 1 inch in size. As to the number of sprinklers with increase in sprinkler spacing due to the longer range of the rotor we find that we would have a 63 percent decrease in number of sprinklers and a 46 percent decrease in the lineal footage of pipe. Therefore we can plainly see that the stream rotor concept produces much more favorable precipitation rates while resulting in a substantial decrease in installation cost.

Precipitation Rate Control

Pressure regulation is an excellent method of stabilizing the desirable precipitation rate once it is achieved. For spray type sprinklers compensating orifices are available to produce uniform discharge. This coupled with pressure regulating remote control valves can give excellent results. When utilizing rotary pop-up units, there are basically two methods of producing equal gallonage for each sprinkler. One is pressure regulation of the remote control valve when operating a group of sprinklers on a single valve (commonly known as battery type system). This is not exact control but approaches very satisfactory results. Even more precise control can be produced when selecting pressure regulation control at each individual sprinkler. This is a common feature available with valve-in-head sprinklers. Installation of this type result in the most efficient sprinkler irrigation available.

Medium-to-Long Range

Continuing with another comparison, we will review rotary pop-up sprinklers that are best utilized in larger turf areas such as golf courses, athletic playing fields and parks. Utilizing a current conventional sprinkler, we could select a performance of 59 foot radius operating at 70 p.s.i. discharging 16.9 gallons per minute. Selecting a factor of 55 percent of the diameter for a triangular spacing we would have a resulting precipitation rate of 0.445 inches per hour. Should we choose one of the sprinklers of lower discharge recently available on the market we would find that at 59 foot radius and 45 p.s.i. would require 12.1 gallons per minute.

Using the same ratio of spacing, the precipitation rate would be 0.318 inches per hour. The differential is a decrease of 28.5 percent in the precipitation rate. Certainly under the later condition we would have potential of more effective application of the water applied to infiltration into the soil and percolation through the root zone.

Regulation Pumping Costs

We discussed briefly before the potential of saving in piping size and in some situations the cost of sprinklers. One other area where there can be a significant reduction in cost is the energy saving when we are depending upon a pumping facility to supply the water to the system. With a standard system and assuming a nozzle pressure of 70 p.s.i. with a combined elevation differential and friction loss of 30 p.s.i., we would need to discharge at the pump station the water supply at 100 p.s.i. Changing to a reduced pressure system the nozzle pressure would be 45 p.s.i. plus the losses of 30 p.s.i. for a total of 75 p.s.i. discharge. The difference of 25 pounds pressure would equate to a drop in head of 58 feet.

Applying the horsepower formula which is $\frac{\text{GPM X head-in-feet}}{\text{3960 X efficiency}}$ we are able to calculate in horsepower the reduction in energy requirement. For example, assuming 1000 gallons per minute for a conventional system, the required head for the pump is 240 feet allowing for suction lift. Referring to a selected pump curve performance, we find a typical unit would have an efficiency of 75 percent requiring 81 horsepower. The pump would need to have a 100 horsepower motor as the next standard motor is 75 horsepower and is too small. For the low pressure system, the head can be reduced to 182 feet. Using the same type pump, we find that we can achieve the required performance with a 60 horsepower motor. The amount of energy saving is calculated at a differential of 20 horsepower, reducing the cost of power by 25 percent. In addition the cost of the pumps, motor and electrical controls are substantially less.

Conclusion

In conclusion, conditions of limited water supplies and the economics of operation we are faced with today and in the future dictate that we must take positive steps to improve the efficiency of the irrigation process. Factors of restricted infiltration and percolation in the tighter soils we encounter or with the limited waterholding capacity of the free-draining sands we use for formal and high use surfaces, together with the resistance to water penetration of turf plant cover point, dramatically to the requirement for low rates of precipitation.

WATER NO GOOD? USE IT! [1]

Dr. M. Ali Harivandi [2]

[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

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Irrigation water quality plays a major role in the successful management of turfgrasses. However, quality of water means different things to different people. Turfgrass specialists and managers are primarily interested in the effects of irrigation water on turf-soil-water relations and on the soil's chemical and physical properties, particularly as these factors relate to turfgrass quality. Therefore, assuming proper irrigation practices, the concept of irrigation water quality for turfgrass is generally based on interpretations of the chemical analysis of a given water.

All irrigation waters contain appreciable quantities of soluble salts and traces of other materials. These may include sodium, potassium, calcium, magnesium, chloride, bicarbonate, sulfate, nitrate, borate, fluoride, iron, silica, aluminum, and other elements. Because these elements may become concentrated in the soil in quantities which are injurious to turfgrasses, potential problems from the use of irrigation water can sometimes be anticipated by a laboratory chemical analysis. The most important of the items determined in the analysis for judging water quality are: 1) Total salt content; 2) Sodium hazard (permeability); 3) toxic ion levels; 4) bicarbonate; and 5) pH.

1. Total Salt Content

There is a high correlation between the salt concentration in the soil solution and plant growth. Thus, total concentration of soluble salts, or ''salinity'', is generally the most important single criterion for evaluating irrigation water quality. Salinity problems, most pronounced on heavy soils, occur when the salts dissolved in irrigation water accumulate in the grass root zone to levels intolerable to the species being grown. In addition to injury increased by the grasses themselves, since turfgrasses do not absorb appreciable amounts of salt, saline soils also develop from application of poor quality irrigation water, even where drainage is adequate. Use of saline irrigation water may thus have long term effects above and beyond those noted during growth of the turfgrass crop itself.

A high salt level in the soil affects turfgrass by increasing osmotic pressure of the soil solution, thus making water less available to the plants. Where salinity is very high, grass roots which are unable to absorb water wilt and plants may eventually die. Nutritional imbalances and toxicities may also occur at high salinity levels.

Salinity of water most commonly measured by electrical conductivity (ECw), may be reported as millimhos per centimeter (m mhos/cm) or decisiemens per meter (dS/m). The two unit's values are equal; only their names differ. Some laboratories report water salinity in micromhos/cm (mhos/cm). Therefore, the following equivalencies are useful to note:

$$\underline{1}\ \text{dS/m} = \underline{1}\ \text{m mhos/cm} = \underline{1000}\ \mu\ \text{mhos/cm}$$

Water salinity may also be reported as Total Dissolved Salts (TDS) in parts per million (ppm) or milligram per liter (mg/L). The relationship between a water's electrical conductivity (ECw) and its total dissolved salts (TDS) is approximated as:

$$\text{ECw (in m mhos/cm } \underline{\text{or}} \text{ dS/m) X640} = \text{TDS (in mg/L } \underline{\text{or}} \text{ ppm)}$$

As a general rule, salinity problems are associated with irrigation waters with ECw's greater than 0.75 dS/m. Although salinity problems may occur when waters with salinity levels of 0.75-3.0 dS/m are used, severe problems are caused by waters with ECw's greater than 3.0 dS/m. Therefore, water whose salinity exceeds 3.0 dS/m is generally not recommended for irrigation.

The extent of salt uptake and its consequent effects on turf growth is directly related to the salt concentration of the soil solution. In contrast to general case, growth of most turfgrasses is not significantly affected by soil salt levels below 2 dS/m, while at salt levels of 2 to 8 dS/m, the growth of some turfgrasses is restricted. At 8 to 16 dS/m, the growth of most turfgrasses is restricted, and above 16 only very salt-tolerant turfgrasses can persist. Obviously, this categorization provides only the most general guidelines to the effect of salinity on turfgrass growth. Pronounced differences among turfgrass species and cultivars in their tolerance of both individual salts and total salinity, necessitates evaluation of each species with regard to specific water and soil salinity characteristics. The information given in the accompanying table is a general guide to individual turfgrass tolerances.

Approximate Salinity Tolerance of Turfgrasses

Turfgrass	<4	4-8	8-16	>16
Cool season	Kentucky bluegrass	Tall fescue	Creeping bentgrass	Alkaligrass
	Colonial bentgrass	Perennial ryegrass	Western wheatgrass	
	Red fescue	Smooth brome	Tall wheatgrass	
	Meadow fescue	Orchard-grass		
Warm season	Centipede-grass	Blue grama	Bermudagrass	Seashore paspalum
			Zoysiagrass	
			St. Augustine-grass	

Where salinity is a potential problem due to a poor quality water, the following management practices should be considered:

- Blending poor quality water with a less salty water.
- Planting salt-tolerant grasses.
- Applying extra water to leach excess salts.
- Irrigating more frequently to maintain a higher soil moisture content.
- If a hard or clay pan is present, modifying soil profile to improve water percolation.
- If shallow water tables are a problem, installing artificial drainage.

2. Sodium Hazard (Permeability)

Sodium concentration is also a very important criterion of irrigation water quality. Although high levels of sodium may accumulate in grasses and become toxic, it is sodium's indirect effect on turfgrass growth via its deteriorating effect on soil structure which is of concern to the turf manager.

High water sodium content causes deflocculation of the soil colloids which in turn severely reduces both soil aeration and water infiltration into and through the soil. In other words soil permeability is reduced when waters containing high levels of sodium are used for irrigation. Relative permeability is often expressed as SAR (Sodium Adsorption Ratio), the ratio of sodium ion concentration to that of calcium plus magnesium The following formula calculates the approximate SAR of a water where values for sodium (Na), calcium (Ca), and magnesium (Mg) are given in meq/L (miliequivalent per liter):

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

A high SAR (SAR9) can cause severe permeability problems when applied to fine textured turf soils over a period of time. In coarse textured soils permeability problems are less severe and this relatively high SAR can be tolerated.

Typical symptoms of reduced permeability include waterlogging, slow infiltration, crusting, and/or compaction, poor aeration, weed invasion, and disease infestation. All of these effects are detrimental to turfgrass growth and development.

Treatment of water or a turf soil for correcting or preventing permeability problems due to the use of water with high sodium levels may include:

- Blending the water with a water low in sodium content.
- Applying soil amendments such as gypsum, sulfur, or sulfuric acid. These amendments increase the supply of calcium either directly as in case of gypsum, or indirectly as in the case of the other two. Calcium prevents excess accumulation of sodium on clay or organic matter particles. Leaching is then practiced to flush out sodium salts accumulated in the root zone. The amount of amendment used depends on the SAR of the irrigation water, quantity of water used, soil texture, and type of amendment.
- Frequent aerification.

Note. Reduced soil permeability can also occur when the salt content of irrigation water is very low (below 0.5 dS/m). Water with minimal salt content reduces permeability by dissolving calcium and other soluble salts from the soil. Removal of salts then causes the fine soil particles to disperse and fill soil pore space, resulting in impermeability.

3. Toxic Ions

Irrigation water usually contains a wide variety of elements in small concentrations. Problems can occur if certain trace elements accumulate in the soil to levels toxic to turfgrasses and other plants. For example, although chloride is not particularly toxic to turfgrasses, most trees and shrubs are quite sensitive to a chloride content of 10 meq/L (355 ppm).

Boron on the other hand, is a more likely cause of toxicity in turfgrasses. The major symptom of this toxicity is necrosis at leaf tips, where the highest boron concentration occurs. Since turfgrasses are mowed regularly and accumulated boron is thus continuously removed from the leaves, most regularly mowed turfgrass can tolerate high concentrations of boron in irrigation water. However, this high boron content of poor quality irrigation water poses a greater toxicity problem for nonturf plants, e.g., trees, shrubs, ground covers, etc. Most landscape plants show injury when irrigated with water containing more than 1.0 mg/L (ppm) of boron.

Practices that reduce the effective concentration of toxic elements include:

- Blending poor quality water with better quality water.
- Irrigating more frequently.
- Applying additional water for leaching.

4. Bicarbonate HCO_3^-

An irrigation water's bicarbonate content can also affect soil permeability and must be evaluated along with the sodium, calcium and magnesium content of both soil and water. The bicarbonate ion may combine with calcium and precipitate as calcium carbonate (lime). As calcium precipitates out of the soil solution, the SAR of that solution, and consequently the Exchangeable Sodium Percentage (ESP) of the soil, increases. (When dealing with poor quality irrigation water, many analytical laboratories adjust the calculated SAR to include a more correct estimate of the calcium that can be expected to remain in the soil water after an irrigation. This adjusted SAR - called Adj. SAR-reflects the water content of calcium, magnesium, sodium, and bicarbonate, as well as its total salinity.)

In addition to affecting the soil permeability, a high bicarbonate content in water, can increase soil pH to undesirable levels.

Practices that reduce the damaging effects of a water's bicarbonate content include those mentioned earlier to remedy problems caused by a high SAR. The impact of bicarbonate on pH may be reduced by applying acidifying materials to soil and/or water. Water with low bicarbonate concentrations (less than 4meq/L) can be managed by the use of acidifying fertilizers (e.g. ammonium sulfate) in the turf fertilization program The presence of more than 4 meq/L bicarbonate in the water may require more drastic measures (e.g. acidification of irrigation water with sulfuric or phosphoric acids) to correct the problem. Since acid injection into a poor quality irrigation water is a specialized practice and requires special equipment, a turf manager must work closely with a consulting laboratory to determine if acidification is required and if so, how it may best be accomplished.

5. pH (Hydrogen Activity)

The pH of irrigation water is seldom a direct problem by itself, but a pH outside the normal range is a good indicator of an abnormal water situation. Very high or very low pHs are warnings that the water needs further evaluation for other constituents. (The use of pH in evaluating water quality is analogous to use of body temperature when diagnosing an ill individual: just as abnormal temperatures indicate an illness but do not specify its nature, abnormal pHs indicate a problem of some kind exists.) The desirable pH range for turfgrasses is 5.5 to 7.

Irrigating with high bicarbonate water may gradually increase soil pH leading to moderately alkaline conditions (pH 7-8.5). A deficiency of trace elements is likely to occur in turfgrasses grown in soils with these or higher pHs. In the west, naturally high soil pH is one of the major factors causing iron deficiency chlorosis (lime-induced chlorosis). Abnormal soil pHs may be corrected by application of amendments. Liming materials (oxides, hydroxides or carbonates of calcium and magnesium) are used to increase a soil's pH, i.e., to correct an acidity problem. To lower the pH of soils, acidifying amendments such as elemental sulfur, or acidifying fertilizers such as ammonium sulfate are used. The kind and amount of amendments used to correct a specific pH problem are determined by factors such as: soil pH, soil texture, soil percent base saturation, fineness of the amendment material and turfgrass species. Working closely with a soil testing laboratory in correcting soil and water pH problems is highly recommended.

Soil Factors

Water quality, soil quality, turfgrass species and irrigation management practices go hand in hand to establish and maintain a quality turf. Therefore, before establishment of turfgrasses, soil related factors as well as water quality must be evaluated. These include soil texture, soil drainage, soil salt content, Exchangeable Sodium Percentage (ESP), and soil fertility. It is next to impossible to manage turfgrasses (and many other plants) irrigating with a highly saline or sodic water, when using a soil with poor drainage. A fine texture soil (clay) is much more adversely affected by poor quality water than a coarse texture (sandy) soil. In most cases the turfgrass problems associated with the use of poor quality irrigation water can not be properly evaluated or treated without also considering associated soil factors.

Conclusion

Turfgrasses grow in a very complex turf-soil-water system and not in soil or irrigation water alone. Turfgrass problems associated with the use of poor quality irrigation water require attention to a great many factors including water chemistry, soil chemistry, soil physical properties, irrigation practices and turfgrass species grown. Under special circumstances, it may be possible to use a water that under average conditions would be considered unsafe. Conversely, under some conditions it may not be safe to use a ''good'' water. Only by evaluating the specific condition of soil, plant and water characteristics facing him/her, can any turfgrass manager manage his/her crop effectively.

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WATER LIMITED? SAVE IT! [1]

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In the Western United States, water is becoming increasingly scarce and more expensive as the population and variety of water needs increase. Careful turfgrass water use planning is needed throughout the Western United States.

Inefficient irrigation programs, in addition to being wasteful, increases the incidence of diseases and weeds in turf. They also reduce the effectiveness of other turfgrass management practices such as fertilization, mowing, thatch and pest control. Due to the diversity of soil and climatic factors, however, a single set of recommendations defining turf water conservation can not be given. In what follows, primary factors affecting irrigation efficiency are discussed with the hope that a thorough understanding of these factors enables the turf manager to develop an efficient irrigation program tailored to his/her individual conditions.

There are two basic ways to conserve irrigation water: (a) irrigate less or (b) waste less. In my experience, turf and other landscape plants are almost always over irrigated. Without technical data on which to base an irrigation regime, turf and landscape managers are left with the only irrigation philosophy in general use today: "If a little is good, a lot must be better!" Actually, in the case of turf irrigation, the reverse is often true.

Minimizing Water Waste

Water conservation in turf irrigation requires our awareness and active avoidance of those situations in which water is commonly wasted. Attention to the following irrigation practices will greatly reduce water waste:

1. Separate irrigation of slopes, lowspots and other areas where water behaves differently than on flat surfaces.

2. Installation of check valves to eliminate drainage to the low spots within a pipe system once water is turned off.

3. Proper irrigation system design, and/or relocation of sprinkler heads in old systems, to eliminate overflow onto paved areas and sidewalks.

4. Water application that is not too fast, too long, or nonuniform.

5. Where puddling or runoff are problems, modification of irrigation scheduling so that water can be applied in several short repeat cycles instead of a single long irrigation.

6. Irrigation at night or in early morning when wind and evaporation losses are lowest.

7. Reduced irrigation of shaded areas relative to unshaded.

8. Wherever possible, irrigation timing based on inspection of the turf; i.e., on the development of dry spots rather than the passage of a standard amount of time.

9. Application of only enough water to fill (or refill) the soil reservoir (the water storage capacity of the soil where the plant roots are located). In saline soils or where poor quality water is used, slightly more water will be required to leach salts below the root zone.

10. Aerification (by coring or slicing) of compacted soils to permit water and air penetration and thus reduce puddling.

11. Immediate repair of leaky pipes, heads, valves, ,etc.

In addition to the foregoing practices, landscape and irrigation system design, installation and maintenance, are critical to a successful water conservation program. Thus, conservation efforts should include landscape architects and irrigation system designers as well as turf managers.

Minimizing Water Use

Once *water waste* is minimized, the question becomes, ''How much water do turfgrasses really need?'' The answer, not suprisingly, varies between soils, and with climate and turfgrass species. Turfgrasses need water at all stages of growth, from the seedling stage through maturity.

Turfgrasses absorb water primarily through their root systems and after using a minute amount, release most of it through transpiration. If for any reason and to any degree water transpired exceeds water absorbed, growth is retarded. Transpiration in turf is determined almost entirely by temperature, humidity, wind and light. Thus the need for water over a given period of time also depends on these factors. The turf manager must consider these environmental factors when planning a water conserving irrigation program.

Evapotranspiration (ET)

In recent years, evapotranspiration (ET), as calculated from standard evaporation pans, has received much attention and discussion as it relates to turfgrass water conserving irrigation. Water applied to turf is used/lost through evaporation from the soil and plant surfaces and through transpiration, excluding losses through deep percolation and/or runoff. The term ''evapotranspiration'' (ET) has been adopted to represent the sum of evaporation and transpiration losses from a cropped site. A water conserving turfgrass irrigation regime applies water at (or below) the ET rate for a given site. ET rates determined by state agencies are available for many areas of the Western States. Interactions between climate, soil characteristics, plant species and even cultural practices, all influence ET. Results of a recent study at Colorado State University (1), in which researchers evaluated the relative effects on ET of mowing height, nitrogen fertility, shading, turf species, and soil compaction, illustrate this concept. In these experiments, 'Merion' Kentucky Bluegrass (*Poa Pratensis* L.) mowed to a height of 5 centimeters (2 inches) used 15% more water than grass mowed to 2 centimeters (0.8) inch. Thirteen percent more water was used when 4 kilograms per 1,000 square meters of nitrogen (0.8 lb N/l000 ft) were applied each month during spring and summer than when only one application per season was applied in the spring. Evapotranspiration by grass in one year was essentially the same whether growing on a clay soil or on a sand peat mixture. However, a 6% decrease in ET occurred for the soil system the following year. Evapotranspiration increased with increased solar radiation. Kentucky bluegrass and 'Rebel' tall fescue (*Festuca arundinacea* schreb.), cool season grasses, used over 20% more water than 'Tifway' Bermudagrass (*Cynodon dactylon* L. x *C. transvalensis* Davy) and buffalograss (*Buchloe dactyloides* Nutt), which are warm season grasses.

A companion study by the same researchers investigated effects of deficit irrigation on turf quality (2). Kentucky bluegrass decreased about 10% in quality with an irrigation schedule providing up to a 27% ET deficit. Larger deficits resulted in greater relative quality declines. When ET was maintained at greater than 30% deficits, the quality rating of Kentucky bluegrass was lower if mowed at 2 Centimeters (0.8 inches) than when mowed at 5 centimeters (2 inches). When nitrogen fertility was low, maximum ET and maximum quality were decreased. However, the response of tall fescue to deficit irrigation was slightly more desirable than that of Kentucky bluegrass. Buffalograss, a warm season species, had over 20% lower maximum ET rate than Kentucky bluegrass. At levels below 70% of maximum for the cool season grasses, buffalograss response was similar to theirs. However, there was a problem using the quality rating method on buffalograss. At suppressed ET rates, while the quality rating for buffalograss was similar to that of tall fescue, its aesthetic appearance was inferior. (Turf quality was evaluated by color in this study.) In addition, the grass studied was not subjected to traffic. Under traffic, the researchers suggest turf resilience would be expected to decrease as ET was lowered by limited watering. They also suggest that quality vs. ET relations would be expected to differ from those reported in this study.

A recent study at University of California, Riverside (8) addressed the relationship between turf quality and irrigation quantity measured as a percent ET. Included in their objectives were to: 1) investigate the effects of applying reduced amounts of irrigation water calculated as a percentage of evapotranspiration of applied water on cool-season and warm-season turfgrasses; 2) evaluate a below-ground system as a potentially more efficient method of turf irrigation than standard sprinkler application.

The variables tested included: two irrigation methods, sprinkler application of water and a subterranean or buried trickle/drip water application (8-inch depth, 23-inch spacing); three i:rrigation regimes, 100, 80, and 60 percent of calculated evapotranspiration and six commonly used turfgrasses, three cool-season varieties (Kentucky bluegrass, perennial ryegrass, and tall fescue) and three warm-season types (hybrid bermudagrass, zoysiagrass, and seashore paspalum). In this study (8), overhead sprinkler irrigation provided acceptable performance of some turfgrass species, even when less than the optimum amount of water was applied. Subterranean irrigation did not provide acceptable turf with the shallow-rooted cool-season species, at the system depth and spacing used in this study. The very deeply rooted hybrid bermudagrass was the best-performing species with subterranean irrigation.

Under sprinkler irrigation, there was no significant difference in cool-season grass performance between the 100 percent and 80 percent regimes. This could be described as a potential level of water conservation amounting to 21.1 percent savings. The savings could be tenuous, however, because of more weed and disease activity (such as Gerlachia patch on Kentucky bluegrass) when irrigated with less than the optimum amount of water. The 60 percent regime significantly reduced the turf quality of the three cool-season grasses tested.

In the warm-season grasses, the appearance of hybrid bermudagrass and Seashore Paspalum was not significantly different under any of the irrigation regimes. As irrigation amounts were reduced, zoysiagrass appearance ratings declined because of nematode activity observed on the roots. Both 'Santa Ana' hybrid bermudagrass and 'Ada layd' (Excalibre) seashore paspalum had very good color, density, texture, uniformity, and freedom from weeds and diseases, irrespective of irrigation regimes. Clearly there is potential for considerable water savings with these grasses. This study showed a 40 percent reduction in actual water applied between the optimum and lowest irrigation regime.

These University of California researchers (8) concluded that warm-season turfgrasses have a greater potential for water conservation than do cool-season turfgrasses. Under the conditions of their study, sprinkler irrigation was superior to subterranean irrigation for water conservation and turfgrass performance. And lastly, a well-designed, uniform irrigation system is necessary to maximize water conservation in turfgrass management.

Soil Texture

All soils contain three water fractions when saturated. The first, ''gravitational water'', is that fraction which is lost through gravity to deep percolation and is unavailable to turfgrasses. Once this water fraction has drained, soil is described as at ''Field Capacity'' (FC). A second fraction of soil water, also unavailable to turfgrasses, is ''hygroscopic water'' and is very tightly held by soil particles. All water present in soil below the ''Wilting Point'' (WP) belongs to this fraction. The third water fraction, that which the turfgrass plant can absorb, is known as ''Available Water''. All water present in the soil between the WP & FC falls in this category. The proportion of available to unavailable water differs among soil textures; the heavier (more clayey) a soil is, the higher its water holding capacity.

Table 1 shows the appropriate amount of water available under various soil textures at field capacity. Note that a fine-textured soil, such as clay, holds about twice as much water as coarse, sandy soil (6).

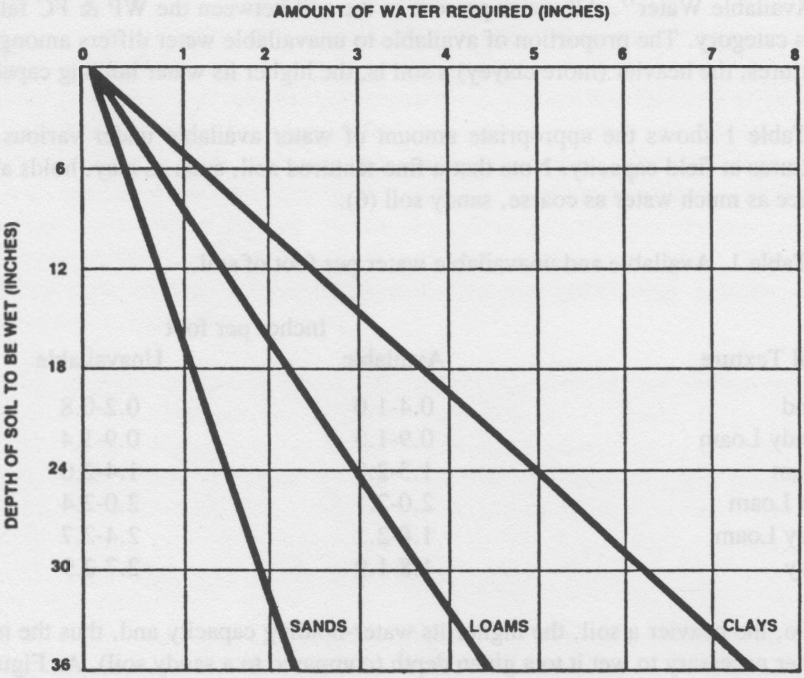
Table 1. Available and unavailable water per foot of soil.

	Inches per foot	
Soil Texture	Available	Unavailable
Sand	0.4-1.0	0.2-0.8
Sandy Loam	0.9-1.3	0.9-1.4
Loam	1.3-2.0	1.4-2.0
Silt Loam	2.0-2.1	2.0-2.4
Clay Loam	1.8-2.1	2.4-2.7
Clay	1.8-1.9	2.7-2.9

So, the heavier a soil, the higher its water-holding capacity and, thus the more water necessary to wet it to a given depth (compared to a sandy soil). As Figure 1 indicates, almost 1.5 inches of water are required to wet loam soil to a depth of 12 inches. The same amount of water wets clay soil to a depth of 7 inches and a sandy soil to a depth of 24 inches.

Figure 1

Relative inches of water required to wet soils to given depths (assuming no runoff).



Once a soil is wetted to the desired depth, the amount of water applied in subsequent irrigations depends upon the rate of plant water use. A proper application will return the soil to 100% of its water-holding capacity. Under certain conditions a little extra water may be applied to leach salts. Obviously, if more water is applied than the amount which can be stored by the soil, some water will be lost through deep percolation. Sandy soils are especially prone to deep percolation. Likewise, if water application rates exceed a given soil's absorption and percolation rates, water is lost through runoff. Heavy and/or compacted soils are especially prone to runoff (3).

Root Depth

Turfgrass species differ in their rooting abilities. Some species have deep root systems, others shallow. Approximate rooting depths of common turfgrasses are given in Table 2. As the table shows, warm season turfgrasses generally produce deep root systems, while almost all cool season turfgrasses have shallow root systems (tall fescue, with an intermediate root system, is an exception). Since it is the objective of a water conserving irrigation program to supply water throughout the root zone, rooting depth as well as soil texture should be considered when determining the rate and amount of water applied.

Table 2. Relative Turfgrass Root Depth Under Normal Use Conditions

Grass Species	Root Depth
Annual bluegrass Creeping bentgrass Colonial bentgrass Perennial ryegrass Creeping red fescue Kentucky bluegrass	Shallow
Tall fescue	Intermediate
St. Augustinegrass Zoysiagrass Bermudagrass	Deep

Although the rooting depth of each turfgrass species is genetically controlled, environmental factors also affect it considerably. Roots, for example, can penetrate deeper in sandy than in clay soils; are generally deeper in fall and spring than in summer and winter; and are deeper when the grass is mowed higher. Other environmental factors affecting turfgrass root depth are irrigation, fertilization, soil compaction, and shade.

The best way to determine turfgrass rooting depth in a specific location is physical inspection. A soil probe or a shovel can be used.

Drought Tolerance

Turfgrass species vary greatly in their tolerance of drought stress. Commonly grown turfgrasses are classified according to their drought tolerance in Table 3 (7). Use of the more drought tolerant turfgrasses should be considered when it is known before turf establishment that an area either will not be irrigated at all or only on a limited basis. It should be noted that although drought tolerance depends in large part, on a turf specie's genetic characteristics, several environmental factors also contribute to such tolerance. Generally, deep-rooted grasses growing in a deep soil with good subsoil moisture remain green for extended periods despite lack of irrigation. Once soil moisture in the root zone is depleted, however, the turfgrass cannot survive for long. Deep-rooted turfgrasses, such as the tall and hard fescues, (Festuca longifolia) growing in dry areas where rain or irrigation may wet only the top few inches of soil, may not exhibit as much drought tolerance as the same grasses grown in a soil with adequate subsoil moisture but infrequent rain and/or irrigation.

It is important to note that a ''drought tolerant'' turfgrass does not necessarily provide a lush green turf under limited irrigation. Most drought tolerant turfgrasses go dormant, lose color and stop growth under droughty situations. They do, however, have the capability to resume growth when moisture becomes available. Non-drought tolerant turfgrasses have a much shorter drought induced dormancy period before they die than do drought-tolerant species.

Table 3. Relative Turfgrasses Drought Tolerance

High	Hybrid bermudagrass
	Zoysiagrass
	Common bermudagrass
	Seashore paspalum
	St. Augustinegrass
	Kikuyugrass
	Tall fescue
	Red fescue
	Kentucky bluegrass
	Perennial ryegrass
	Highland bentgrass
	Creeping bentgrass
	Colonial bentgrass
	Weeping alkaligrass
Low	Dichondra

Reclaimed Water

The use of treated effluent water deserves mention in any discussion of water conservation in turf and landscape irrigation. In the arid and semi-arid West and in highly populated urban areas, the concept of irrigation with reclaimed water is increasingly attractive. Not only do shortages and costs of fresh water increase, but more and better quality treated water is becoming available. Effluent water is already used to irrigate many acres of turf and other landscape plantings in California and the area is expected to increase as turf and landscape managers become more familiar with such water.

The same principles which lead to sound fresh water management can be applied to effluent water with one exception: higher levels of salt in effluent water may require somewhat greater water applications to avoid salt buildup in the soil. Also, tolerance of reclaimed water will vary between plant species and between water sources. In general, turfgrasses may prove to be among the best plants for effluent irrigation since they take up large amounts of the nitrogen, phosphorus, and potash commonly found in such water (4). They can also tolerate large amounts of boron, an element often found in relatively high concentrations in reclaimed water, without toxic reactions.

Soil Salinity

Salt buildup in soils can be a problem not only where reclaimed water is used for irrigation, but also in areas where high quality fresh water is used too efficiently. This is especially likely on inherently saline soils, or where excess fertilization occurs (5). Whatever the cause of the soil salinity problem, over-irrigation can help leach excess salts. As a general rule, if the amount of water applied to the soil (irrigation plus natural precipitation) exceeds evapotranspiration, salt movement in the soil is downward. Therefore, a salinity problem is best prevented by applying water in amounts greater that ET. Accumulated salt is thereby constantly leached downward through the soil profile to below the root zone. Conversely, salt movement is upward if evapotranspiration exceeds the amount of water applied. In the latter case, salt drawn to the soil surface gradually accumulates to levels toxic to plants. In severe cases of salinity, planting a salt tolerant turfgrass should also be considered (Table 4).

Table 4. Approximate salinity tolerance levels of common turfgrasses.

	Electrical Conductivity (dS.m = mhos.cm)			
Turfgrass	**<4**	**4-8**	**8-16**	**>16**
Cool season	Kentucky bluegrass	Tall fescue	Creeping bentgrass	Alkaligrass
	Colonial bentgrass	Perennial ryegrass	Western wheatgrass	
	Red fescue	Smooth brome	Tall wheatgrass	
	Meadow fescue	Orchard-grass		
Warm season	Centipede-grass	Blue grama	Bermudagrass	Seashore paspalum
			Zoysiagrass	
			St. Augustine-grass	

Summary

Developing a turf water conserving irrigation program can be approached from many angles. The turfgrass manager interested in adopting water saving measures must therefore acquire as thorough an understanding of the climate-soil-water-turf relationship as possible. This understanding should extend to the role of water in turfgrass growth and development, the influence of climate and soil factors in water utilization by turf, and to the inherent drought tolerance characteristics of turf grass species grown.

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USE OF COLORANTS FOR TARGETING PESTICIDES [1]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.
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According to the National Agricultural Chemical Association (NACA), 32 per cent or 1.3 billion dollars of all pesticides are purchased and used for non-agricultural purposes in the United States. The use of pesticides and fertilizers on turf grass offers numerous benefits including improving appearance and image, increasing property values, and even reduced injuries on athletic fields. While the benefits are visually recognizable, the subject of pesticide safety or toxicity will most assuredly be highly scrutinized in the future. Regulatory and public opinion pressures are forcing pesticide applicators to adopt safer treatment practices. Pesticide targeting with spray colorants can improve the accuracy and safety of pesticide application.

There are several types of colorants being used for different applications on turf grass and vegetation. To clarify and simplify matters we will make a distinction between:

DYES/PAINTS - which last several days for inorganic dyes to several months for paints and

COLORANTS - which generally comprise of organic dyes and are short lived (several hours to a few days).

Probably the widest use of dyes/paints is on dormant turf grass. For years, superintendents of major sports stadiums and golf courses have used dyes/paints to touch up dormant or off-color turf. For this application, make certain that products are used that, when dry, do not rub off or stain uniforms. The longevity of the dye/paint in dormant grass is several months.

The primary focus of this presentation will be on the benefits of using temporary colorants for "pesticide targeting". Historically, the subject of accurate pesticide application or pesticide targeting has been limited to the spray equipment alone and reference to such things as spray tip size and nozzle pressure and so forth. Today, its appropriate to consider the use of colorants added to the tank mix which would allow the applicator to know exactly where he has applied a pesticide. Before we discuss the benefits of using colorants, a few comments on important characteristics to look for when selecting a brand or type.

WATER SOLUBLE - most colorants are water soluble and readily disperse in pesticide and liquid fertilizer spray solutions. If in doubt, perform a compatibility check with a jar test or even make a small test application with the pesticide to check its efficacy.

TEMPORARY - the color dissipates with rain, dew, or sunlight alone.

NON-TOXIC - and environmentally safe

NON-STAINING - does not permanently stain hands, clothing, or equipment.

CONCENTRATION - ''not all colorants are created equal''. Compare label rates and products side by side under the same conditions.

The benefits of using a colorant for pesticide targeting are many. They include:

- Eliminate skips and overlaps
- Indicates drift to non-target areas
- Indicates clogged nozzles
- Aids in equipment clean up
- Indicates a chemical presence-safety factor
- Enables better supervision of personnel
- Reflects quality work

Using a spray colorant insures that spray applications are uniform with no missed or overlapping areas. It helps applicators apply chemical in a correct, cost, effective and safe manner.

When added to a pesticide, it gives the turf or foliage a stable dark blue/green appearance. This color tells the applicator that he has sprayed the area. At the same time, you do not draw undue attention to the area that has been treated as could occur if a conspicuous color such as red, yellow or violet were used as a spray indicator.

Because of the blue/green appearance shows where the spray is being applied, colorants help eliminate costly overspraying. It takes the guess work out of pesticide application. Overlaps alone can cause you to use 1/4 to 1/3 more of a chemical than is really necessary, not to mention the cost of reseeding and reworking damaged areas.

In virtually eliminating missed areas, the applicator avoids the expense of retreating missed areas at a later date.

Colorants aids in detecting partially plugged nozzles as well as the overall operation of equipment. Colorants aid in equipment clean up. It is easy to tell when all the solution has been thoroughly flushed from the tank and lines. In addition it indicates when the solution reaches the nozzles when the sprayer is first started. This is especially helpful when hoses have been flushed with clean water in previous cleaning.

The use of colorants makes it easy to detect drift of the pesticide, adding a safety factor to the application of chemicals. It is also useful in detecting applicator exposure to chemicals. If the operator inadvertently comes into contact with the spray chemical, he must wash until the blue color is removed to be sure that the pesticide is removed.

Colorants can be an excellent supervisory tool because it shows what areas have been treated. It helps determine that proper coverage has been achieved. And it clearly delineates starting and stopping points on partially completed areas so that spraying can be resumed without expensive over spraying or missed areas.

Targeting with colorants could be applied to the lawn care industry to enhance a lawn care operator's efforts at targeting pesticides to specific trouble spots on a home lawn. In addition, the use of colorants can be helpful in training new lawn care operators.

Colorants can be added directly to a pesticide concentrate tank in an injector/ proportioner system to confirm that the pesticide is being properly metered.

In this era of lawn pesticide regulations, the ability to demonstrate to your customer that you know exactly what you are doing can be an effective sales tool. Quality work retains customers .

Colorants enhance the effective use of chemicals in today's turf management programs. Colorants help applicators apply chemicals in a correct, cost effective and safe manner.

LESCO SPREADER CALIBRATION RECOMMENDATIONS [1]

Art Wick [2]

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Two aspects of product application must be considered when calibrating any spreader. First is the product application rate, i.e. the amount of product that is to be applied per thousand square feet. The application rate is particularly important because over-application can be costly and may cause plant injury; under-application may substantially reduce the effectiveness of the product.

Second, and of equal importance, is the distribution pattern of the spreader. The pattern of a rotary spreader is dependent on impeller characteristics (height, angle, speed, shape, roughness); ground speed; drop point of the product on the impeller; product density and shape; and environmental factors (temperature and humidity). The operator does not have control of all of these factors, but we will discuss those aspects of spreader operation the operator must consider for proper spreader calibration.

LABEL SETTINGS on any product should only be used as the initial setting for trial runs, by the operator, prior to large scale use of the spreader. Calibration should be checked periodically—at least once a month, or more often when the spreader is used frequently. The operator may follow these steps for correct spreader calibration:

A. **Check spreader discharge holes** with operating lever in the closed position. If the discharge holes are not fully closed, thread the upper locknut on the operating lever rod further up the rod. Retighten lower jam nut and recheck. Repeat procedure until holes are fully close.

B. **Adjust ''pattern slide''** to provide a uniform product distribution across the full pattern. A quick pattern check can be made by operating the spreader over a paved area and observing the pattern. A more accurate method is to lay out shallow boxes or pans in a row on a line perpendicular to the direction of spreader travel. Boxes 2″ high placed on one-foot centers work well. To conduct the test, begin with the ''pattern slide'' completely open. Close the operating lever and set the rate adjustment at ''S''. Make three passes over the boxes, operating in the same direction each time. The material caught in each box may be evaluated (weighing is the most accurate method) to determine uniformity. An easy method is to pour the contents of each box into a small vial or bottle, setting them side by side in order. The pattern variation, using this method, is quite visible. To reduce the amount of discharge to the righthand side (operator's right), with products such as LESCO) Sulfur-Coated Fertilizers it may be necessary to completely close the ''pattern slide'' to provide a uniform pattern.

C. **Determine application rate adjustment** as follows:

1. Set rate adjustment at approximate setting.
2. Make a trial run to determine the effective width of the pattern using the collection boxes. The effective pattern width is twice (2X) the distance to the point where the rate drops to one-half the average rate at the center. Example: If the material in the vials in the center boxes averages two inches in depth, count out to the vial which has one inch of material. If this is the fifth vial from the center (boxes were on one-foot centers), the effective pattern width is 10′ (5 × 2).
3. Now, knowing the effective pattern width (10′), measure out a lineal distance to equal 1,000 sq. ft. (100′ × 10′ = 1000).
4. Weigh some of the product (20 lbs.), empty it into the spreader and have the operator spread the product over the distance (see number 3) necessary to equal 1,000 sq. ft. Then weigh the product again to determine the actual rate of delivery. Adjust the rate adjustment up or down as needed and repeat this process until the correct application rate is achieved.

D. **Basic Do's and Don'ts:**

1. Always push the spreader; do not pull.
2. Push the spreader at a consistent speed (approximately 3 mph is recommended).
3. Always close the operating lever before filling hopper.
4. Be sure screen is in place.
5. Always start walking forward before opening ports; close ports before forward motion is stopped.
6. Hold handle at a height that will keep the impeller level.
7. Empty spreader after each use. Wash spreader thoroughly and allow to dry. Keep impeller blades clean.
8. Lubricate all moving parts.

CAN POA ANNUA SUPPRESS BENT? [1]

Dr. A. Douglas Brede [2]

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After graduating with my undergraduate turf degree, my first job was as assistant superintendent for a 27-hole country club outside Pittsburgh. The course boasted three separate 9-hole courses of solid bentgrass, tee to green. Needless to say, annual bluegrass (Poa annua) was our worst weed problem. After a few months on the job, my boss suggested that we verticut in some Penncross seed into the fairways to increase the bent populations. At that time the fairways were about 30 to 40 percent annual bluegrass. I had the crew verticut 27 fairways and seed 2 lb./M of Penncross into the slits. Lo and behold, after two weeks of delicate watering, we noticed slivers of grass emerging. Another week brought even more seedlings, until after 4 weeks, we had a stand that we were proud of. By 5 weeks the individual seedlings were starting to tiller. At that time, while showing off to a neighboring superintendent, I took a closer look at our new seedlings. Nearly every one of the seedlings was Poa! It's times like that that keeps a man humble. But it also planted a question in my mind: What happened to the bentgrass seedlings? When we'd noticed the seedlings starting to emerge, we saw a good amount of genuine bent coming up. A few weeks later, it was gone. Years later, after receiving my doctoral degree and a research job at Oklahoma State University, I decided the time had come to learn the reason behind my failed overseeding attempt. This paper describes our efforts to learn the secrets of bentgrass-Poa annua competition. Four years of lab and field studies were conducted on a large scale to ascertain an answer.

* * *

Poa annua comes in many forms. Researchers have long noted the diversity in Poa: Strains of Poa have been found with stolons, with perennial growth habits, yet all with the ability to flower, set seed, and grow under a putting green cutting height. This diversity contributes to the difficulty in studying the species. My first effort in studying Poa was to collect typical putting green "ecotypes." An ecotype is a strain of a plant uniquely adapted to a specific environment (e.g., close mowing). We found Poa's with long running stolons. We found Poa's that were dense, dark green, and which produced little or no seedheads. Interestingly, the "creeping Poa's" (the ones with stolons) did their creeping in mid summer, at just the time when the bent was in summer depression. I would normally think that Poa would be more susceptible to summer temperatures than bent. But not so of these ecotypes. They spread fastest when air temperatures were in the 90's—a credit to a unique and diverse species of plants.

I feel that the key to understanding Poa is first to understand Poa as a seedling competitor. Since Poa is (supposedly) an annual, its seedling germination phase is a vital portion of its life cycle. We performed a series of experiments in which early Poa growth was studied in the field. In the first experiment, we planted Poa and bent into established sods. This would be analogous to the overseeding situation mentioned earlier. Later experiments also examined Poa-bentgrass competition in which both were established simultaneously from seed; however, these studies will not be discussed herein. In the sod seeding study, bent was planted into 1-inch holes in a mature sod of Poa. The 1-inch holes were made with a soil probe. The holes were filled with sterile soil, and the bent seeds planted on top. All combinations of Poa and bent were tried: Poa planted into bent sod, bent into Poa sod, Poa into Poa sod, and bent into bent sod. Germination and growth of the seedlings were monitored for 5 months. Concurrent with this sod seeding study, I established Poa and bent on a neighboring bare seedbed, to test their tillering capabilities when unimpeded by competition. On the bare seedbed, Poa and bent established rapidly. At 5 weeks, bent had a slight advantage in tiller numbers over Poa. This shows that bent genetically has the potential to overwhelm Poa with numbers of tillers. But in a competitive situation, this does not happen. In the sod seeding study, an interesting interaction was occurring. Bent seeds in the Poa sod germinated rapidly. In fact, seedlings in the sod emerged several days before the seedlings on the bare seedbed, due to the sheltering effect of the surrounding sod. But shortly after emergence, the spindly bent seedlings in the sod began to deteriorate. Unable to reach incoming sunlight, the bent seedlings rapidly died. Poa sod was significantly more inhibitory to bent seedlings than was bent sod. More than three times the number of seedlings and eight times the number of tillers of bent were found within the bent sod than within the Poa sod.

IN	OUT	SEEDLINGS	SHOOTS
Bent	Bent	7	16
Poa		9	30
Bent	Poa	2	2
Poa		5	5
Bent	None	19	240
Poa		19	181

The foregoing interactions suggested that allelopathy might be a factor in Poa-bent competition. Allelopathy is the effect of one plant on another resulting from the transfer of a chemical agent—a natural herbicide, if you will.

To determine the existance of allelopathy, we decided that a large scale effort was needed. We constructed two, identical sand-based putting greens, each 3300 sq. ft. One was planted to Penncross and the other to the Poa ecotypes mentioned above. Water that passed through these greens was shuttled via the drainage system to a third green. The third green was planted to Penncross. It was divided into 16 separate greens in a Purr-wick subirrigation style; some plots received Poa effluents, other bent effluents, and still others tap water as a check. This was done to allow effluents from the large ''source'' greens to supply water (and any suspended allelopathic chemicals) to the test green. An automated water system kept close track of moisture needs in the test green to equalize watering.

The test green was monitored for two years. At the conclusion of the study, data was analyzed, and one conclusion was reached: No significant effect of the Poa water could be detected. In other words, Penncross that received all of its irrigation water filtered through Poa grew no worse than Penncross watered directly from tap water. The question arose: Why would we see significant effects of Poa on bent on a closely planted, seedling study but not see it in a large field experiment? It took some precise germinator studies to suggest an answer.

A germinator is an environmental growth chamber, capable of simulating any environment the researcher can devise. We used a germinator to grow Poa and bent in petri dishes, similar to the method used when seedlots are routinely tested for germination percent in the state seed lab. Except in our test, we planted Poa and bent in the same dish. First we planted 100 Poa seedling, allowed them to germinate, and then flipped over the blotter paper on which the Poa seedlings were growing. Bent was then planted on top of the blotter (with Poa still growing underneath). In this series of tests, we found significant inhibition of the bent from the Poa, even though the two species were not in physical contact. This confirmed our suspicions that allelopathy was indeed at work. Inhibition of bent responded to the classical dose-response curve—the more Poa seeds we grew, the more they inhibited the bent. Yet, in one test, we were able to detect a statistically significant disturbance of the bent's growth by the proximity of only one seed of Poa.

Still unanswered, though, was the lack of response in our large field trial. This question was answered quite by accident. To demonstrate our new phenomenon to college students in our advanced turf management class, we had them duplicate our experiment. Except, in this case, for the sake of simplicity, we germinated Poa and bent on the same surface of the blotter paper—not above and below as in the first experiment. Poa and bent in the student's study were physically separated by about 1/2 inch on the blotter paper. Whereas in our previous studies, the separation of Poa and bent was only the 1/64th inch thickness of the blotter paper.

The student's experiment did not show the sweeping responses that our earlier study had shown. To verify that we had simply not ''screwed up'' on our earlier experiment, we duplicated the experiment and found the same results.

Evidently the chemical released from Poa seedlings does not move very far in water. Perhaps it is a water insoluble or oil-based chemical. This would explain why no responses were found in the large field experiment: Water (and chemicals) had to move over 50 feet to reach the test green. A water insoluble chemical would not transfer under these conditions.

Obviously we have not answered every question on Poa-bent competition. It would take a lifetime of research to fully understand this complex interaction. But we have begun to understand the principals behind the often strange occurrences golf course superintendents observe on their greens and fairways with Poa annua and bentgrass.

OVERSEED TO COMPETE WITH POA ANNUA? [1]

Dr. A. Douglas Brede [2]

[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Research Director, Jacklin Seed Company, Post Falls, ID

Sometimes even the best cared for turf can turn bad. In spite of careful irrigation, mowing, traffic control, fertilization, and pest control, turf can sometimes deteriorate to the point where a decision is needed: Does the expense of maintaining a deteriorating turf out-weigh the expense of replanting? Today, with renovation chemicals available such as Roundup, methyl bromide, or plant growth regulators, it is easier than ever to make the decision to renovate. Moreover, renovation is much simpler than tillage. Regrading, rock picking, and even transit leveling are often required following tillage. This adds to the expense and bother in renewing a lawn, and were major objections to renovation in the past.

Renovation today is surprisingly simple. Numerous trade magazine articles describe the chemicals and methods of successful renovation. Renovation of an average home lawn can be done often in less than a day. The homeowner can be mowing the new lawn in a matter of weeks.

Throughout the humid Northwest, a major reason for turf renovation is Poa annua (annual bluegrass). Geographical areas with high rainfall coupled with mild winters and summers are usually plagued with Poa. Poa becomes established because the growth conditions in the lawn make Poa more competitive than the desired lawngrass species. Put more directly, Poa can literally grow faster than other lawngrasses under our conditions.

Throughout my research career, I've had the opportunity to study Poa from three different geographic locations: Pennsylvania (cool, humid), Oklahoma (warm, dry), and Idaho (cool, dry). Each location has its own unique problems and solutions with Poa. To date, no one has solved the Poa problem. But by understanding how Poa competes with other grasses, the informed turf manager can make decisions that will help minimize Poa problems in his turf.

Plants compete for three basic requisites of life: sunlight, soil nutrients, and water. A plant that can get one of the three requisites faster or better than the other will survive. Obviously this is a simplistic view of plant interaction (since other factors such as mowing, compaction, wear, etc. come into play), but the bottom line for plants is which one gets to the "food" first. Our management regimes effect the relative health and vigor of our lawngrasses and may make a competing weed more suited to seeking "food."

A few years ago I developed a specialized research technique by which seedling research could be readily accomplished. The mechanics of this technique are not important for purposes of this discussion. However, the implications of the technique were that turf seedlings could be essentially stuck in place on a seedbed with no lateral movement. This opened the door for critical studies on how one plant responds over time to competition from its neighbors.

Using this technique, we studied seedling plant interaction on an acute scale. We examined plant competition from three standpoints:

1. **Sod seeding**—planting seed into a stand of existing turf. Holes were punched in mature sod: the holes were filled with sterile soil and planted to a test species; the sod represented the competing species. A wire ring delineated the microplot from the surrounding sod. Germination and growth were monitored over time, usually for 3 to 6 months.

2. **Simultaneous seeding**—competing species sown on a sterile seedbed adjacent to one another. Usually we planted the test species in 1 inch circles within areas seeded to a competitor. Seeding rates of the test species and competitor could be varied in different plots to determine the effect of population density on competition. Wire circles were again used for demarkation of plots.

3. **Spaced planting**—different species sown spaced apart to determine their growth potential. We usually planted 20 seeds into 1 inch circles spaced 6 inches apart on a sterile seedbed. The ultimate growth potential was estimated by the tillering rate over time. Grasses that tillered fast were regarded as potentially good competitors. These tests usually remained in study for 6 weeks.

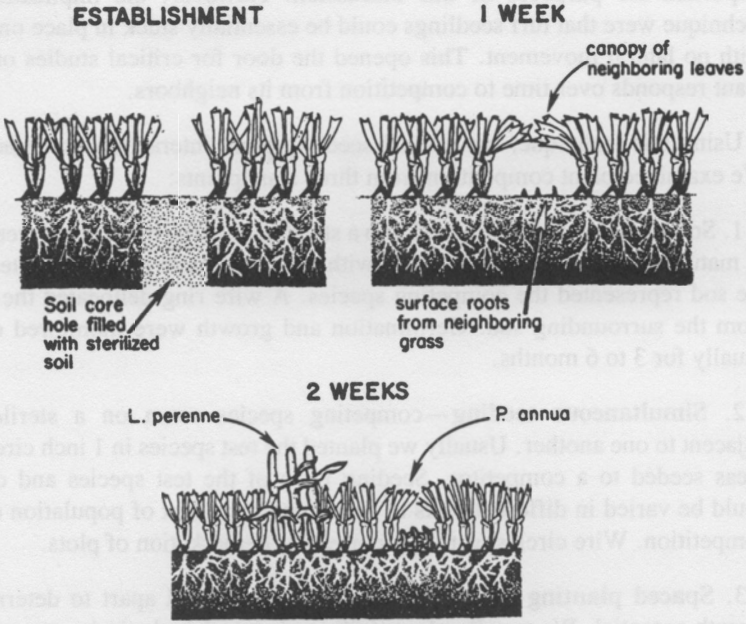
Most of our overseeding tests have been confined to Kentucky bluegrass, perennial ryegrass, and annual bluegrass, although we've done a little work with a few other species. Without question, perennial ryegrass was easiest to overseed. Perennial ryegrass seedlings have a high vertical growth rate. On several occasions we saw leaves of perennial ryegrass pertruding above the sod. This vertical growth habit allowed ryegrass to obtain light when other grasses withered and died in the dense shade of neighboring plants.

Here are some other important findings from this series of overseeding studies:

1. Perennial ryegrass was followed in competitive ability by annual bluegrass. Kentucky bluegrass was a distant third in the competition.

2. The species of the sod into which seeds were planted was generally unimportant. Ryegrass could be seeded into Poa sod as readily as into Kentucky bluegrass sod. Although there was a slight tendency for ryegrass sod to be the toughest competitor against ryegrass seedlings (i.e. , likes repel).

3. Anything you can do to disturb the existing sod will benefit the overseeded seedlings. Of course Roundup treatment of the sod prior to overseeding is ideal.



SOD SEEDING – @6 WKS.

Seed	Seedlings	Tillers
Ryegrass	12	3
Poa annua	7	2
Ky. Blue	4	1

Sod Species Unimportant

HEAVY DOLLARSPOT AND RED THREAD DISEASE

	Severity
Pure Ryegrass	20%
50-50 Mix	5%
Pure Ky. Blue	18%

But if this is not possible, try scalping or heavily verticutting (dethatching) just prior to overseeding. This will weaken the sod and give the seedlings their best chance. Trade journal articles have even described the use of plant growth regulators to suppress the sod in advance of overseeding.

4. Season of planting is important. Poa grows best during early spring and early fall. Overseeding at other times of the year will stretch the grass-to-Poa ratio in favor of the grass. Mid summer establishment favored ryegrass over Poa by a large amount, because Poa likes lower temperatures and because Poa ''had its mind on other things'' during that time—it wanted to go to flower. Poa germinating during June and early July has the impulse to go to flower rather than growing vegetatively. That weakens it as a competitor.

5. Choosing the best variety and seedlot is important. A weak or unadapted variety will not be a good competitor in the seedbed or a good turf in the long run. Likewise, a seedlot with low germination rate is weak and will not be a good competitor.

With Kentucky bluegrass, varietal selection is very important in overseeding. Varieties that perform best nationally don't always perform best in our unique Northwest climate. Top Oregon varieties are Eclipse, Majestic, Columbia, Challenger, and Summit (Nallo). Top Washington varieties are Classic, Midnight, Haga, Mona, and Summit. Top Idaho varieties are Ram I, Bristol, Midnight, Challenger, and Summit (data source: 1980-1985 National Test Trials). Ryegrass variety is slightly less important than bluegrass variety in overseeding, but it is important for a nice, attractive appearance to the mature turf. All*Star, Palmer, and Gator are excellent ryegrasses for the Northwest.

LAWN DISEASES AND CONTROL OPTIONS [1]

Dr. Richard W. Smiley [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

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Residential and commercial lawns in the Pacific Northwest consist largely of blends of Kentucky bluegrass cultivars, or of mixtures of this grass with fineleaf fescues or perennial ryegrasses. Lawns in areas west of the Cascade Mountains and excessively watered lawns in drier regions are often also infested with annual bluegrass and/or bentgrasses. Seven diseases account for most of the control problems encountered on the principle grass species that occur on lawns in this region. This paper considers only the control strategies useful in combatting the effects of seven diseases on lawns. For information regarding the identity, biology and control of these and over 40 other diseases please refer to the Compendium of Turfgrass Diseases, written by me and published in 1983 by The American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121 (102 pages plus 185 color prints; cost is $20.00; order by mail or telephone - (1-800-328-7560).

IMPORTANT FOLIAR DISEASES OF LAWN GRASSES

These are diseases of the turfgrass foliage. It is, therefore, important to concentrate the attention and control efforts on the foliar environment. Make sure that there is an adequate leaf growth rate to allow infected tissue to be mowed off. This can be done by maintaining adequate soil fertility that is balanced according to the needs of turfgrasses. Follow standard recommendations for your region. Applications of nitrogen, if it is needed, can be of special assistance in reducing these diseases. However, excessive nitrogen, with respect to the total amount available and to the balance of nitrogen to phosphorus and potassium, can aggravate the occurrence of several foliar diseases. Avoid drought stress by watering to thoroughly wet the root zone, but do so as infrequently as possible (once or twice per week is best) and do not water from late afternoon through the middle of the night. These suggestions are intended to reduce the humidity and leaf-wetting duration in the foliage during the night. If light penetration and air movement are impeded by a thick canopy of trees and/or shrubs, it is often possible to reduce the disease potential on the grass by thinning the ornamentals that contribute to high humidity at the grass surface. Do not mow at a height less than that recommended for the grass on your lawn. Mow frequently to reduce the stress on the grass and to interrupt the development of fungal fruiting structures in or on the upper grass blade. When turfgrass growth slows during mid-summer, it may be advisable to collect the clippings to remove the pathogen inoculum that develops on the upper ends of leaves. However, for most purposes, the benefits of leaving the clippings on the lawn far outweigh the ability to reduce disease by removing clippings. Many cultivars of Kentucky bluegrass, perennial ryegrass and fine-leaf fescue are rather resistant to the pathogens that cause these diseases. Consult with your county extension agent to get such information from your University's turfgrass specialist. More specific comments about four diseases follow.

RED THREAD (**Laetisaria fuciformis**)

Fungicides for reducing or eliminating red thread from lawns include Thiram, Dyrene, Daconil, Fore, and Chipco 26019. All are listed in the 1987 PNW Plant Disease Control Handbook. Fungicides that are also labelled for this use and are recommended in some other states include Bayleton and Vorlan.

RUSTS (**Puccinia spp.**)

Fungicides recommended in the 1987 PNW Plant Disease Control Handbook include Bayleton, Fore, and Plantvax. Others labelled for this use include Daconil, Dyrene, and products containing PCNB. It is very important to avoid the use of fungicides that contain benomyl (Tersan 1991, Benlate, etc.) or thiophanates (Fungo, Cleary's 3336, etc.) on rust-affected lawns, as these products often aggravate the occurrence of the rust diseases.

LEAF SPOTS AND BLIGHTS (**Drechslera [= Helminthosporium]** spp.) The most damaging of these leaf spots in the Pacific Northwest appears to be Brown Blight of Perennial Ryegrass, caused by Drechslera siccans. As with the rusts, avoid using the systemically translocated fungicides benomyl and thiophanate on areas where these leaf spots and blights are present, or have caused concern in the past. Fungicides recommended in the 1987 PNW Plant Disease Control Handbook include Daconil, Dyrene, Fore, and Chipco 26019. The Handbook also lists two fungicides that I do not agree with; it is my suggestion that they be avoided, in accordance with the first sentence of this paragraph. The fungicides in question are Cleary's 3336 and Duosan, both of which contain thiophanate as an active ingredient.

FUSARIUM PATCH (**Microdochium nivalis [= Gerlachia nivalis, = Fusarium nivalel]**)

This disease may be especially damaging to bentgrasses, perennial ryegrasses and fine-leaf fescues. The affects of this cool-season disease can be minimized by avoiding heavy applications of fertilizers late in the autumn in areas where the grasses do not go into true winter dormancy, and in the six weeks before dormancy in eastern areas of the region. Fertilizers can be applied before this period, or after the leaf blades are no longer extending during the winter. Slowly released forms of fertilizer are also recommended to avoid lush growth just prior to winter dormancy. The disease tends to be less damaging on acid soils; use care in applying lime because heavy applications can aggravate the occurrence of Fusarium patch. Do not let the grasses get longer in the winter than they are maintained during other seasons. If the damage occurs late in winter it is often sufficient to simply rake the matted plants and encrusted patches to encourage rapid drying of the plant crowns and stem bases during the day. This will also increase the accumulation of heat in the underlying soil, thereby increasing the growth rate of the plant (plant growth is totally dominated by root temperature, not leaf or air temperature). Light applications of fertilizer in the spring will also encourage sufficient growth to assist in healing the patches. Fungicides recommended in the 1987 PNW Plant Disease Control Handbook include Tersan 1991, Spot Kleen, Bromosan, Cleary's 3336, Fungo, Duosan, Fore, and Chipco 26019. Also labelled for this purpose, and often very effective, are Bayleton, Vorlan, and the fungicides containing PCNB.

IMPORTANT ROOT DISEASES OF LAWN GRASSES

Most of the strategies suggested for controlling foliar diseases are also applicable to root diseases. This is especially true for the management of soil fertility, water, and mowing. Additionally, it is important that adequate air exchange exists in the root environment, and this may call for periodic disruption of soil compaction by the use of core cultivation procedures. Coring will also assist in the decomposition of thatch, since the cores of mineral soil deposited on the lawn surface are usually broken up by a drag mat, thus having the effect of a top-dressing and encouraging the activity of microorganisms responsible for decomposing the thatch. Other methods of thatch reduction, such as vertical mowing, can also be helpful when thatch depths become excessive. Additional specific control measures for important root diseases follow.

NECROTIC RING SPOT (Leptosphaeria korrae)

Necrotic ring spot is a disease that was until recently considered a part of the Fusarium blight syndrome. It mostly affects Kentucky bluegrass but may also damage fine-leaf fescue lawns. Other grasses are more tolerant (not resistant) to the affects of this disease. Resistant cultivars of Kentucky bluegrass have been identified and should be used for new plantings. They should also be requested as a component of the sod being purchased for installation in eastern Oregon and Washington, and northern Idaho. The level of damage to bluegrasses can be greatly diminished by mixing perennial ryegrass with the bluegrass seed, or by overseeding affected bluegrass lawns with perennial ryegrass. Fungicides are not recommended in the 1987 PNW Plant Disease Control Handbook, but Rubigan is labelled for this use and has been valuable for suppressing or eliminating this disease in most instances where it is used on an ongoing basis.

TAKE-ALL PATCH (Gaeumannomyces graminis)

Take-all patch causes significant deterioration only on bentgrasses. Where this occurs, it is recommended that acidifying fertilizers such as ammonium sulfate or ammonium chloride be used as the nitrogen source. Acidification of the turf can also be accomplished with several applications of wettable sulfur, at 1.25 lb per 1000 sq. ft. The applications should be made in the spring and spaced 30 days apart. In areas where acidic soils must be limed, use coarse grades of lime to prevent sudden shifts in soil and thatch pH. Applications of smaller amounts of coarse lime particles over several years are preferable to larger applications of finely divided lime. Another means for avoiding difficulties with this disease in drier climatic regions is to assure that watering practices are adjusted to preclude the development of bentgrass clones in lawns. The bentgrasses can then be removed and will not reappear if watering is performed as suggested earlier in this paper. Fungicides are not recommended in tbe 1987 PNW Plant Disease Control Handbook. However, Rubigan is labelled for this use and provides satisfactory control in many instances.

SEEDLING DISEASES (**Pythium, Fusarium, Microdochium and Rhizoctonia spp.**)

These ''damping-off'' diseases occur mostly when temperature, moisture, and light become further from those that are optimal for seed germination and seedling establishment. Prevention of the problem requires that surface and subsurface drainage and aeration be adequate in the seedbed. Plant the seeds at the recommended depth when the soil is cool and dry. Ensure that the seed soil contact is good so that germination will be rapid, and make all attempts to avoid planting in areas where air movement is greatly restricted by trees, shrubs and other barriers. Avoid overwatering the new seedbed. Seed can also be treated before planting with a fungicide such as Captan or Thiram, or new seedings exhibiting damage may be sprayed with Fore and/or Subdue, depending upon the species of fungi causing the seedling disease.

THE BIOLOGY OF THATCH [1]

Dr. Richard W. Smiley [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

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Thatch is an important property of turfgrasses. It behooves each of us to understand what causes it to occur so we can develop more programmed control measures. Several key introductions to the technical literature are noted to assist those who wish to study these processes in more detail.

DEFINITION OF THATCH

Most definitions of thatch agree that it is comprised of a layer of dead and living stems (tillers, stolons, and rhizomes) and roots that develops above the soil surface and below the leafy foliage. Leaf clippings generally form a pseudothatch, which is a less-densely packed layer above the thatch. Turfgrasses are not unique in possessing these layers; they are also found in grasslands, pastures, forests, and other ecosystems. Since thatch is composed of organic litter and is a definable biological entity, its management involves the manipulation of biological processes which are very similar to those occurring in other ecosystems. Research conducted in other grasslands is often directly applicable to our understanding of turfgrass thatch. Some of the following discussion is derived from studies of grassland ecology. The results seemingly explain many observed responses of turfgrass thatch to various environmental and management variables.

TISSUE PRODUCTION VS. DECOMPOSITION

Plants produce tissues in cyclical patterns. Cool-season grasses, for instance, typically produce most leaf growth in the spring and autumn, and most root growth in the autumn and winter. The life of each leaf, tiller, rhizome, and root is relatively short, and a continuous cycle of tissue production and death occurs to perpetuate these perennial species. Tissue decomposition also depends upon seasonal cycles and the prevailing environmental conditions. Thatch results when tissue production proceeds at a rate more rapid than tissue decomposition. This balance depends upon a multitude of interacting biological processes.

FACTORS AFFECTING THATCH ACCUMULATION

The tendency for thatch to accumulate depends mostly upon plant growth rate, composition of plant tissues, amounts and types of pesticides used, and fertility, pH, aeration, temperature, and moisture in the thatch environment. Each of these factors can be expected to fluctuate widely and independently. The long-term overall balance is therefore more important than conditions at any specific time.

PLANT GROWTH RATES

Plants which produce the most extensive root and stem systems are likely to become more thatched than those with limited amounts of these slow-to-decompose tissues. Varieties within a species can differ in both the composition and amount of these tissues (Shearman et al., 1983). All procedures that improve turfgrass growth will by definition increase the amount of tissue being produced and may cause an increase in thatch accumulation. Some conditions will increase the rates of production and decomposition, and others will increase production without affecting decomposition. The most important of the factors are discussed below.

PLANT COMPOSITION

An appreciation of thatch must include an understanding of plant chemistry. Numerous chemicals in plants occur either in small quantities or are easily decomposed by microorganisms, or both, and contribute little to thatch. Constituents that are very resistant to decomposition processes and are also abundant in plants are the primary compounds found in thatch. Most of these compounds are necessary to provide strength to the grass plant, e.g., they give the plant its superstructure.

Waite and Gorrod (1959) analyzed the compounds of immature and mature ryegrass plants (Table 1). The most persistent compounds are ash, fats, waxes, phenolic compounds, lignin, hemicelluloses, and cellulose. Ash is the term designating the mineral elements (calcium, potassium, etc.) that are in the tissue. Decomposition rates differ for each of the resistant compounds. The half-life period (e.g., that time in which 1/2 of the material is decomposed) is about two weeks for hemicelluloses and celluloses, one year for lignind, 2.5 years for waxes, and 6.5 years for phenolic compounds (Clark and Paul, 1970). Half life is essentially the same for all plant litter (e.g., grass leaves or roots, oak leaves, etc.) in which these compounds occur. For most purposes, lignin is the single most important component of thatch, since it best satisfies the conditions of resistance to decomposition and relatively high concentrations in the tissues in question.

Resistant components (excluding ash) comprised 42% of the young and 74% of the mature ryegrass plant (Table 1). Clark and Paul (1970) and Whitehead et al. (1979) have each reported that under ideal conditions the time required for a 50% loss (e.g., the 1/2-life) of ryegrass leaf or root weight (excluding water) in soil was 20 weeks (Fig. 1A). At this rate, only about 80% of the original leaf weight will be mineralized (decomposed) to carbon dioxide, mineral elements, and other primary compounds during the first year.

Beard (1976) compared the amounts of resistant components in several turfgrass species. Table 2 reports the composition of leaves, stems and roots of bentgrass, bluegrass and fescue. No major differences in root tissue compositions were reported. Fescue stems had twice as much lignin as the other grasses. The data suggest that leaves of grasses should decompose much more rapidly than roots, that fescue stems should decompose as slowly as roots, and that stems of bentgrass should decompose almost as rapidly as leaves. The modifying effects of cellulose and hemicellulose presumably reduce the decomposition rate for bluegrass stems (including rhizomes) much more than for bentgrass stems (including stolons).

WHAT CAUSES TISSUE DECOMPOSITION?

Decomposition of plant tissue is performed by microorganisms, microfauna (small animals, including insects), and macrofauna (larger animals) in the soil. Numbers and types of organisms involved are very large, and their interactions are complex. Precise sequences of events apparently differ from one habitat to another.

Individual species of soil microorganisms do not possess all of the enzymes and other characteristics necessary to decompose more than a few of the components of higher plants. Mukhopadhyay and Nandi (1979) have shown that Fusarium and Penicillium species decompose lignin much more readily than cellulose, whereas the reverse was true for Helminthosporium and Curvularia. Successions of microorganisms are necessary to totally decompose plant tissues; each group feeds on the residues remaining from a previous group's activities. Most soil animals, including earthworms, do not produce the enzymes needed to decompose plant tissues (Waid, 1974). Fauna assist decomposition by physically tearing tissue apart to allow microbes access to larger amounts of surface area (Lofty, 1974).

Detailed soil ecology research indicates that microorganisms are the most important organisms for decomposition of plant litter. Inhibition of the fauna in grassland ecosystems has been of only minor consequence to subsequent rates of tissue decomposition. Tribe (1960) studied successions of organisms and found that fungi initiated the decay of cellulose in soil. Bacteria became involved later, and then nematodes began feeding on the bacteria and fungi. Later stages of decay involved larger fauna, including mites, collembolans, and enchytraeid worms. Clark and Paul (1970) and Waid (1974) concur with this general sequence for decomposition of grass roots. Curry (1969) used nylon bags of various small mesh sizes to screen out variously sized groups of soil fauna from bentgrass and fescue leaves and stems that were buried or were left on the surface of a grassland (Fig. 1A). He concluded that fauna contributed almost nothing to the rate of decay and disappearance of the foliar litter on the soil surface, and did not accelerate its decay in the soil. Malone and Reichle (1973) used chemical toxicants to eradicate different faunal groups in a fescue meadow, and reached the same conclusions as Curry. However, in contrast to the results with foliar litter, these scientists also showed that the fauna slightly accelerated decomposition of buried roots.

PESTICIDES

Some pesticides alter the rate of production of turfgrass tissues and some alter the rate of decomposition, but these effects are often dependent upon application rates and/or frequencies and on environmental conditions. Overall effects of pesticides on thatch accumulation are very complex. Excessive accumulation of thatch on turf that is regularly treated with certain fungicides, herbicides, and insecticides is well documented (Beard, 1973; Beard, 1976; Smiley and Craven, 1978), but an explanation of how these processes occurred is far from complete. For example, the effects of pesticides on the soil microflora and fauna are not well defined because of the complexity of these investigations (Beard, 1973; King and Dale, 1977; Meyer et al., 1971; Smiley and Craven, 1979).

I and my colleagues evaluated the specific effects of fungicide applications on tissue production and decomposition processes, and on thatchiness, in turfgrasses over a 10-year period (Smiley et al., 1985; Smiley and Fowler, 1986). Many of the tested fungicides did not cause significant increases in thatchiness, and those that did so only demonstrated this trait when applied very frequently for many years. Contrary to what had been anticipated, we found that modern fungicides which cause thatch to accumulate do so by increasing the rate of tissue production without changing the rate of tissue decomposition. This result indicates that thatchiness where fungicides are applied is caused by the same process that occurs when thatching tendencies vary among turfgrass varieties or species independently of fungicide application (Shearman et al., 1980; 1983).

FERTILITY

Nitrogen is essential for decomposition of organic litter. Microorganisms require a carbon-to-nitrogen ratio of at least 25:1 for effective decomposition (Beard, 1973). Organic litter is rich in carbon and lean in nitrogen. Furthermore, nitrogen is quickly and easily leached out of thatch (Hunt, 1978), and the C:N ratio of thatch can therefore become rather high. Litter decomposition is independent of the nitrogen in soil below the thatch because this nitrogen is out of reach for the microbes in thatch (Hunt, 1978). Thatch decomposition is accelerated when soil is incorporated into the thatch layer (by coring and matting, or by soil faunal activity) and when frequent, light applications of fertilizer are applied (Beard, 1973). The biological basis for such observations are explained in detail by Hunt (1978) and Smith (1979). Beard (1976) explained that the nitrogen application frequency and the type of carrier must be manipulated to maintain the nitrogen concentration above a critical level in the thatch. It is possible, for instance, to increase the nitrogen concentration in the soil but not in the thatch, thereby encouraging plant growth but limiting tissue decomposition. Smith (1979) used eloquent mathematical models to predict that litter decomposition will be most efficient when split applications of water-soluble nitrogen are made, or when a single annual application of water-insoluble (slow release) nitrogen is made. The data from Hunt (1978) illustrates (Fig. 2A) how decomposition can be slowed whenever nitrogen concentrations in the thatch are reduced. Topsoil (but not sand) incorporated into thatch will help to elevate or prolong the available nitrogen supply (Beard, 1973).

Care must also be taken to avoid excessive fertility levels which can increase tissue production rates without matching increases in decomposition rates. Within limits, however, the actual rate of nitrogen application in well-maintained turfgrasses does not result in differences in thatchiness (Shearman et al., 1983).

THATCH pH

Litter decomposition proceeds most rapidly at pH 6.0 (Beard, 1976), and the rate decreases rapidly as either the acidity or the alkalinity is increased (Fig. 2B). If lime or neutral to alkaline topdressing soil are not added to turf, the alkaline components of litter may be leached downward, and the thatch will necessary in some regions to maintain a proper pH in thatch (Beard, 1973). Infrequent heavy applications of lime appear capable of reducing the rate of thatch decomposition.

TEMPERATURE

All biological activities are temperature dependent. Production of tissues may be reduced or stopped during cold winters and hot summers. Shoot and leaf production are retarded earlier and more positively than root production (Beard, 1973). Tissue decomposition occurs at its maximum rate (Fig. 2C) at 38°C (100°F) and is completely stopped at 0°C (32°F) and 45°C (113°F) (Hunt, 1978). Thatch temperature is quite responsive to air temperature and to the cooling or heating that is governed by radiation and by evaporation of water. Temperatures presumably limit litter decomposition rates very commonly, and certainly separate the seasons of maximum tissue production from maximum tissue decomposition. If water, pH, nitrogen fertility or other environmental factors in the thatch layer are unfavorable during the summer when decomposition can occur most rapidly, then thatch is likely to accumulate.

MOISTURE AND AERATION

Poor aeration (excess water) and surface drying are associated with thatch accumulation (Beard, 1973). Ulehlova (1973) indicated that decomposition processes are essentially stopped in dry litter. She also indicated that decomposition proceeds for only a short time during overly wet conditions, because of the accumulation of toxins produced when decomposition occurs under conditions of low oxygen. Toxins persist for some time even after aeration is re-established, and thus act to extend the time of inhibition. Hunt (1978) described the moisture conditions which limit decomposition (Fig. 2D). Peak levels for decomposition are narrow (ca. -1 to -5 bars). These limits are stated in terms of water energy units, and are therefore difficult to portray in terms of water content. Suffice it to say that thatch that appears even slightly dry will probably be in the -15 to -100 bar range, and thatch which glistens with moisture when squeezed tightly will be in the 0 to -1 bar range. Turf is fully capable of growth when thatch is extremely dry, because the roots extract water from lower in the soil profile. However, moisture can limit thatch decomposition in turf during wet or dry periods.

SUMMARY

Thatch is commonly associated with the use of intensive management practices on turfgrasses, because thatchiness is often indicative of the vigor of growth for that grass. Many times, however, thatch accumulates on turfs that receive very low levels of management. These turf areas are seldom irrigated, limed, or fertilized, and are therefore often inhospitable to the activities of microorganisms in the thatch layer. Low management turfs often have lower levels of leaf, stem and root production than found in high management turfs. Smith (1979) predicted that, at tissue production rates below a certain broad minimum, the amounts of decomposer microorganisms will become restricted by insufficient carbon, and plant litter will begin to accumulate. When tissue production levels are above the minimum, amounts produced simply outstrip the ability of the microorganisms to keep it decomposed. These principles, illustrated in Fig. 1B, indicate that a moderate level of management may be best adapted for control of turfgrass thatch. More research is obviously necessary, but there appears to be no reason to believe that thatch is only a high management problem.

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Table 1. Compositions of young and mature ryegrass foliage (Waite and Gorrod, 1959).

Component	Percent of Dry Matter: Young	Percent of Dry Matter: Mature
Fats and Waxes	3.9	1.9
Organic Acids	3.6	2.0
Water Soluble Carbohydrates	29.5	4.6
Phenolic Compounds	0.4	1.1
Pectins	3.1	4.1
Crude Protein	7.5	3.4
Lignin	3.5	11.3
Hemicelluloses	14.0	25.7
Cellulose	20.2	33.8
Acetyl	0.9	2.0
Ash	7.5	4.9
Unidentified	3.3	3.0
Unaccounted for	3.0	2.3

Table 2. Partial compositions (%) of tissues in creeping bentgrass, Kentucky bluegrass, and red fescue (Beard, 1976).

Plant Structure	Plant Species	Hemi-cellulose (H)	Cellulose (C)	Lignin (L)	(H $ C)/L Ratio
Leaves	Bentgrass	34	19	4	13
	Bluegrass	26	18	2	22
	Fescue	27	21	3	16
Stems	Bentgrass	30	23	4	13
	Bluegrass	39	28	5	13
	Fescue	29	35	11	6
Roots	Bentgrass	36	27	14	5
	Bluegrass	34	27	10	6
	Fescue	34	33	13	5

Figure 1. Decomposition of plant tissues: A. Composite of ryegrass roots (Whitehead et al., 1979) and bentgrass foliage (Curry, 1969), in nylon bags of various mesh sizes, implanted into soil or left on the soil surface; B. Relationship between tissue production rates, amounts of microorganisms, and plant litter accumulation (Smith, 1979).

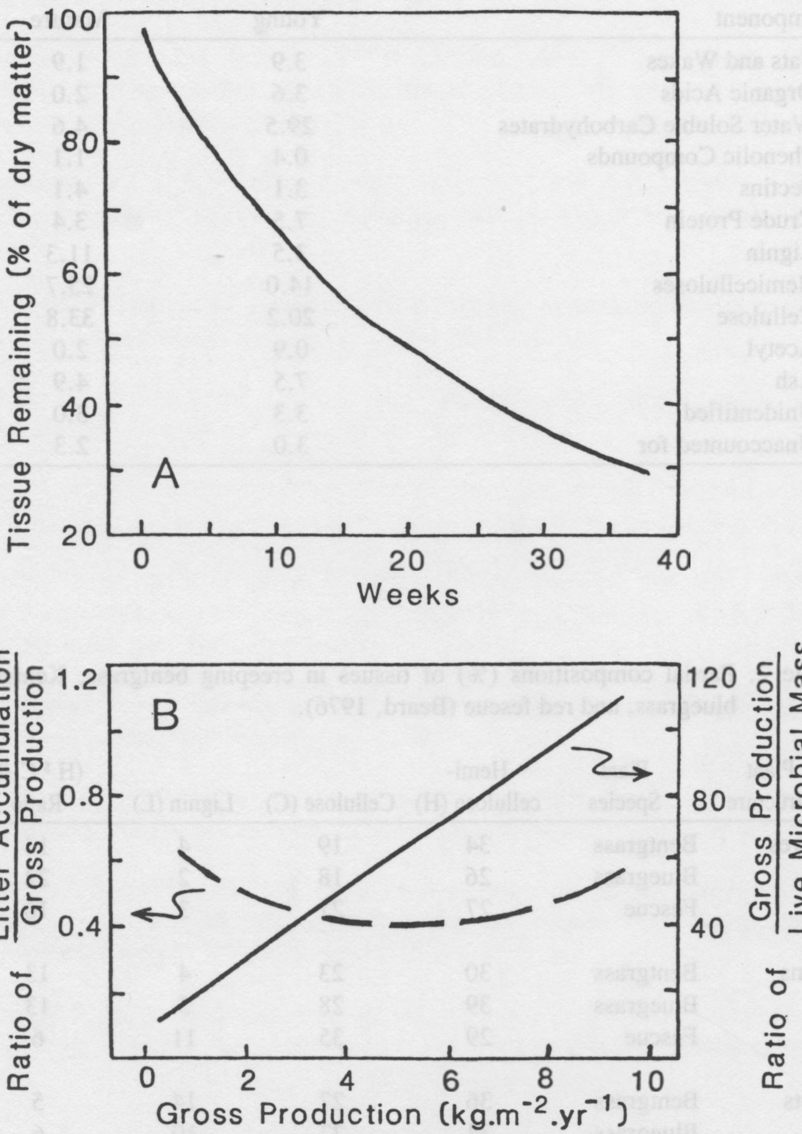
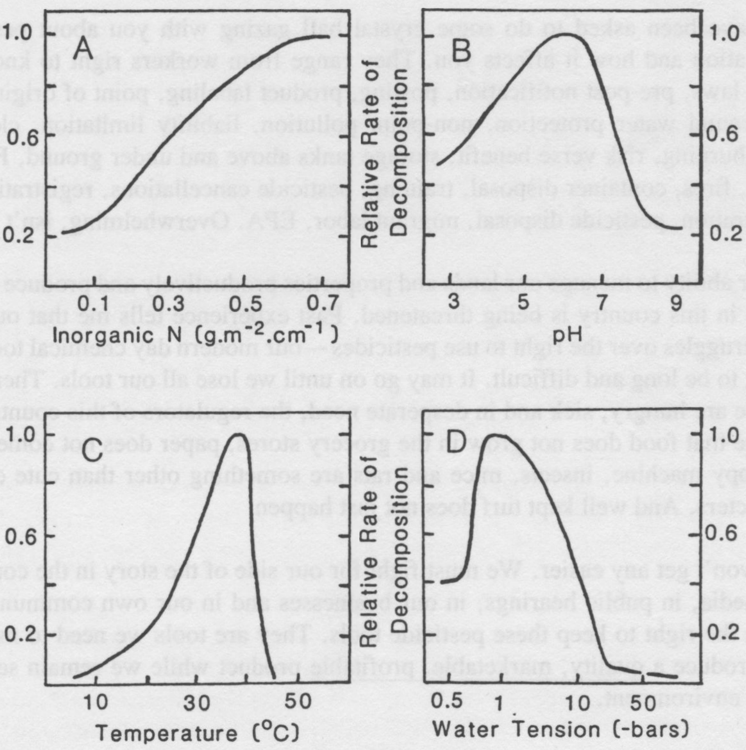


Figure 2. Influences of environmental parameters in organic litter layers on the decomposition of plant tissues: A. Nitrogen (Hunt, 1978); B. pH (Bear, 1976); C. Temperature (Hunt, 1978); D. Water (Hunt, 1978).



ENVIRONMENTAL ISSUES OF TODAY [1]

Sandra H. Ely [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

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A farmer was arrested and hauled before the judge and charged with child abuse because he gave his kid the farm.

I have been asked to do some crystal ball gazing with you about pesticides legislation and how it affects you. They range from workers right to know, re-entry laws, pre-post notification, posting, product labeling, point of origin, Prop 65 ground water protection, non-point pollution, liability limitation, clean air acts, burning, risk verse benefit, storage tanks above and under ground, FIFRA, spills, fires, container disposal, training, pesticide cancellations, registration, re-registration, pesticide disposal, migrant labor, EPA. Overwhelming, isn't it?

Our ability to manage our lands and properties productively and produce quality crops in this country is being threatened. Past experience tells me that our fight and struggles over the right to use pesticides — our modern day chemical tools — is going to be long and difficult. It may go on until we lose all our tools. Then when people are hungry, sick and in desperate need, the regulators of this country may realize that food does not grow in the grocery stores, paper does not come out of the copy machine, insects, mice and rats are something other than cute cartoon characters. And well kept turf does not just happen.

It won't get any easier. We must fight for our side of the story in the courts, in the media, in public hearings, in our businesses and in our own communities to retain the right to keep these pesticide tools. They are tools we need to maintain and produce a quality, marketable, profitable product while we remain sensitive to the environment.

Let's start at **home** on our lawns, golf courses, shops and businesses. We must insist in our own businesses and organizations that:

* anyone who uses a pesticide uses it wisely.

* we know exactly what we are controlling and the best time in the life cycle to control the pest.

* we use the vast store of knowledge and technology to manage our crops with the fewest and safest chemicals.

* we know exactly where **each** and **every** drop of a pesticide application lands.

* we lead the way in properly training our people to ensure they use the safety equipment necessary to protect themselves and you from a potential lawsuit.

* we become wise and judicious stewards of the land so that when we turn over ‘‘our farms’’ to our kids, we will not be accused of child abuse.

Sometimes we make mistakes and deserve the criticism we get. Sometimes we are careless in applications. Sometimes we do not read and follow label directions. I’m sure each of you could tell you own horror story.

TRAINING

You should have the most **extensively trained and licensed, safety conscious employee in charge of and applying your pesticides.** (This may be your highest paid person, not the newest employee who claims to have used pesticides at home.) This person — and maybe it should be you because a cited owner or manager could serve jail time — must track the course that every drop of pesticide takes; see the label is read, understood and followed and the chemicals are properly mixed; be sure containers are correctly triple rinsed; check that the sprayer is calibrated and that the wind and temperature conditions are correct; be certain you have correctly identified the pest you are trying to control and know that the product you are using will solve the problem; be sure the container is disposed of correctly and that applicators are protecting themselves from splashes on their clothes and skin and from breathing the product; and determine that the environment is enhanced by the choices you have made.

EPA is working on certification and training requirements. Our voices and practical experiences need to be part of those regulations. Attend the public hearings and submit your written comments to the appropriate government agency.

PESTICIDE REGULATION

Pesticides are regulated on the federal, state, county and city level. What is being done **to** us instead of **for** us by these various entities is something we should be aware of and be able to confront as the need arises.

Many states have pesticide users groups like Washington Pest Management Council that you should become involved in — to unite your voice in meeting these issues head on. **Environmental groups do not appreciate our presence in the battles.**

We must make a **clear statement to Congress** over **FIFRA.** We want one federal act to govern the registration and use of pesticides instead of alloding every town, city, state to require their own set of tests and standards. Registering a pesticide for market today under the present FIFRA rules is time consuming and terribly expensive.

As a minor crop user of pesticides and clearly a non-food, non-feed user you should be concerned. Registration economics dictates that if we are too strict we will end up wiping all those products off the market. No manufacturer will spend millions of dollars on tests to earn $20,000 in annual sales.

Some judicial battles have been won. The Ninth Federal Court recently upheld the right of FIFRA to be the federal law that dictates the registration of pesticide products.

Ground water issues, non-point source pollution issues and clean air act issues will increasingly continue to apply to how you do business. Washington State's Superfund and Hazardous Waste Initiative are an on-going battle. What ever you do don't sign the initiative. The proposed compromise legislation is a much better way to go.

State legislatures are considering ground water protection. This effort is massively fueled by Proposition 65 in California. Proposition 65 is called "The Toxic Enforcement and Safe Drinking Water Act of 1986."

Where is **prop 65 today**? The question of **where do you do the testing for these compounds** is being debated. Do you test: as it comes out the end of the spray nozzle, as residue on the edge of the field after a rain or in the ground water?

It is a very complicated issue now being sorted out in the courts of California. One thing to remember about a proposition like 65 is that it cannot be made null or void by the legislature. The one good thing about the prop is it can't be made anymore restrictive than it all ready is.

Health departments are writing regulations for underground storage tanks and demanding **thirty years of insurance guaranteeing** the clean up of property. **How clean is clean?** No insurance company is providing that kind of long term insurance.

Think about **your own property.** What kind of hazardous materials have you stored or deposited on your property that may take it unusable and unsalable under these new regulations?

By early 1988 agri-chemical dealers and their customers will face a new hurdle: tough new pesticide restrictions aimed at protecting **ENDANGERED SPECIES OF ANIMALS.** The restrictions are spelled out in county-specific bulletins that protect the animals by limiting the use of 64 different pesticides' active ingredients. The reason for this accelerated timetable is to bring FIFRA into compliance with the Endangered Species Act (ESA).

Industry observers have expressed surprise at the magnitude of the new restrictions and the speed with which they are being put into effect. If current EPA goals are met, label restrictions to comply with ESA will become effective before the 1988 spring planting. Many observers say the program will have more impact than the highly publicized Delaney Clause report or California's Proposition 65.

So why has this plan—which in addition to restricting **64 different crop pesticides,** restricts the use of **29 rangelands** pesticides, **24 forest** pesticides and **nine mosquito** pesticides—gone unnoticed? Perhaps because EPA has been calling it a "label improvement program" rather than a pesticide restriction effort. As developed, the regulations will affect **45** endangered species in **135** counties of **18** states.

Some of the cropland chemicals that are being limited in use by the regulation include. **2,4-d.** acephate (orthene), atrazine, diazinon, disyston, **malathion, carbaryl (sevin)** etc.

Fear of the unknown—the "what ifs" are extrememly difficult to counter, but your side of tbe story has to be told by someone knowledgeable.

FOREST SERVICE EIS

Some judicial trends have been good for us, but the fight goes on and on. In Oregon and Washington the people have been consistently harassed for five years on whether herbicides can be used on federally own land, including forests, grazing land, farms and office building lawns. Right now if the Forest Service wants to spray its lawn. They can't. That is because the forest service hasn't written an environmental impact statement on all possible consequences of using herbicides. Millions of dollars are being spent on environmental impact statements (EIS). The Region Six FS EIS will take at least two more years to complete. In the meantime tbese lands aren't being taken care of properly because they're being nit-picked to death by environmental groups backed up by the court order. The draft EIS is to be released soon, and you should obtain the summary or the document and comment about the planned management of our public lands.

Why should this concern you as turf growers? Because many of the forest herbicides are the **same active ingredient products** you use. If forestry loses the product, who do you suppose is the next target? The environmental agenda calls for the **elimination of all uses of pesticides.** Period. If the market for all those banned products is dramatically reduced, the chemical companies cannot afford to produce products only for a minor use crop.

RISK/BENEFIT ISSUES

We also have to answer the risk issue.

The public has a great fear of the unknown. William Ruckelshaus suggested recently that scientists must help people to overcome their fear of the unknwon.

We have a populace that **complains about the risks**, and yet they go to the grocery store and demand the perfect blemish free Washington apple, squash that is spot free, corn without worms, and turf with no weeds, disease, pests or undesirable grasses. Their attitude about mice, ants, roaches and weeds are shaped by cartoon television ads that don't reflect the serious problems we face.

We must provide a **benefit picture in tbe use of our pesticide tools.** FIFRA demands a risk/benefit balance. Because we have failed too often to outline the benefits, the scale has tipped only to portray the risk. The turf industry is considered by many environmentalists to be a luxury item for the well-to-do. They advocate that a few weeds in your lawn are acceptable and desiring a blemish free yard or business lawn is almost anti-patriotic. They claim profit and budgets are your only goal.

What are **you doing in your advertisements** to educate the public on why you manage turf? Does turf filter pollutants from the ground water? Does it prevent soil erosions? Discuss the benefits. When only risks are considered, we are always in jeopardy.

So we have a lot of issues that need to be dealt with in that regulatory arena. We need to do our duty to provide industries perspective. Political involvement with your elected representatives and senators is imperative.

Another challenge we face is this: Who should regulate procedures in event of spills, fires or accidents?

The federal government has mandated a new law under the new Superfund Amendment and Re-authorization Act called **SARA.** SARA has a new title 3, called the "Emergency Response and Community Right-To-Know". What this will mandate is that our governments will have to set out procedures to address any spills or accident or any potential spills or accidents from your use of hazardous materials. In addition, the **"Community Right to Know Act"** mandates that local governments plan for identification of hazardous materials used on work sites. They will plan for identification of releases on those work sites and will plan for accidents that may impact those work sites.

Local, regional and state governments will have to incorporate an operative system to protect the people. Who's going to pay? You're going to pay for it. One issue is: How is it going to happen and how are you going to pay for it? And more importantly, in my opinion, how will it help protect your property and right to do business in the horrible event you have a fire or a spill?

The fall is the target deadline for SARA's implementation. Many local planning agencies already have their SARA plans developed. Do you really want to know what is going to happen with the SARA legislation? **You may not.**

First you will go through your place of business and collect all your MSDS sheets and take them down to the local fire department where they will be filed. If you have a spill or a fire, officials may bring the file to the scene.

I can appreciate the apprehension that fire departments have with "hazardous materials" incidents.

Firemen are currently being trained to do the following:

* Go slow. (The old theory was to dash in and put out the fire quickly.)

* Stay way back. Set up your conmand station. Look through binoculars a quarter of a mile away to assess the problem, determine what public health damage would be done.

* Use as little water as possible.

* Notify at least 10 different state and local agencies.

Nowhere in their training regulations are **any requirements to call the owners or operators** of the involved facility. In fact, because you may be considered the offending party responsible for any clean up or environment damage caused by the spill of "toxic" materials, they are not to follow your advice.

Every day the newspaper carries a story of people being routed out of their homes and jobs because of a "toxic" fire. Our public agencies will always act on the side of extreme caution when public health is concerned. What those media stories fail to tell you are the real stories behind the headlines.

You may think I am a real pessimist. But let me tell you of a recent incident.

PESTICIDE FIRE

In 1975 we built a state of the art office and shop complex for our urban spray business, working closely with every agency who wanted to regulate us. We built three-hour fire walls around our pesticide storage and passed regular fire inspections, receiving praise from the officials. My husband taught pesticide safety courses for the local fire departments. We sold that business in 1984, and last fall we heard that a spray service building on Interstate 5 was on fire. We dashed toward the building to offer assistance. We tried two routes into the site, but we were stopped by officials even though we told them we had built the building and knew where the pesticides were stored. We were told they had enough help. The spray service manager tried the same thing and they kept escorting him back behind the fire line.

In the meantime, the fire burned unchecked in the shop and truck area of the building. Fire fighters would not put any water on the fire because they were afraid of contaminating the ground water. The building burned for more than an hour until the overhead plastic water pipes melted through and sprayed water on the fire. If the firemen had waited a little longer, they would have had a pesticide fire. A small clothes dryer fire escalated into a loss of thousands of dollars because those qualified to assist were turned away.

HOW CAN YOU BE PREPARED TO AVOID SUCH A DISASTER?

ORTHO-CHEVRON has produced a booklet called a PRE-FIRE PLAN FOR AGRI-CHEMICAL FIRES. Use this plan to evaluate your total application of pesticides as you manage your turf. Ask yourself, **''Where will every drop of my expensive tool, pesticides, be utilized?''**

Four Steps for a Pre-Fire Plan

1. Prepare a pre-fire plan of who would be involved.

2. Prepare a sketch of your facility and immediate surroundings.

3. Plan for a disaster and where the contaminated runoff could be controlled.

4. List the agencies to be notified.

Go home and **ask your fire departments some very hard specific questions** about how a spill or fire would be handled in your pesticide storage area. Have the pre-fire plan in writing. Establish a **good working relationship** with your fire department so you can be part of the **decision to let your storage facility** burn to the ground for the good of the public who live around you. You may want to **reconsider** how you presently store your pesticides.

WACA—Western Ag Chemical Association—has produced a 2 ½ hour **training video on Fire Prevention, Safety & Emergency Response Pre-Fire Planning** that you or your state organizations may want to rent or purchase. **Handout information** is available.

As Winston Churchill said, **''Never, never, never give up the fight!''** The way you continue the pesticide battle is with your expertise and dollars and with involvement in state pro-pesticide organizations. Many people think all we request is money, but public involvement is just as important as financial involvement. You've got to have both to get something done. You have to attend those local public pesticide hearings and tell your local elected officials what will work for your company and your land, your stewardship. Write your Congressman. We are not dealing with a scientific debate in the long run but an emotional one.

Your financial support of Wa Pest Management Council, soon to be called Friends of Farms and Forests, will be appreciated. You can spend your time **raising money** for the fight or you can spend your time **addressing the issues.**

SUMMARY

Let's review what we need to do:

1. Tell your product story in a positive manner.

2. Train your employees in safe practices.

3. Use the pesticides according to the label.

4. Keep accurate records of all pesticide use.

5. Involve your elected officials, and keep involving and informing them.

6. Reconsider renewing your subscriptions to Audubon, Friends of the Earth, the Sierra Club. The dues you pay to them are used against you. Also track your donations to some main line religious organizations that use your money to produce films against pesticides.

7. Take preventive measures in case of a fire or a spill.

8. Become actively involved in a pesticide users coalition group. WE NEED YOUR DOLLARS AS WELL AS YOUR TIME. THANK YOU.

PENETRANTS-WHAT THEY DO AND WHY [1]

Robert Oechsle [2]

[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.
[2] Owner, Montco Products Corporation, Ambler, PA

Prologue

I looked over the Conference Lodging Facilities and found a Sea Gypsy Motel, Beachcombers Haven, Holiday Surf Lodge, Whale Cove Inn. What kind of an operation are you running here? I had to pack my puptent, the air mattress, and bed down on your beach with a portable battery and neon sign flashing THE SURF-SIDE MOTEL! I hung out a VACANCY sign hoping for a mermaid but ended up with two drunken turfgrass specialists who couldn't carry a tune.

I knew I needed help in this identity crisis and so I called three gentlemen back East. Who ever heard of this peddler and do name golf courses actually use wetting agents. I asked all three of them for a quick fix on the phone for the talk I am delivering today:

Joe Flaherty, Golf Course Superintendent, Baltusrol GC "Prior to the LPGA Open in 1986 we treated all 18 fairways with Surf-Side #37. There was a striking difference in turf quality between the two 18 hole courses."

Armin Suny, Golf Course Superintendent, Castle Pines GC and home for the International Tournament. I think it sets the standard for beauty and turfgrass quality on color TV. "Don't forget the basics . . . we aerify greens in spring and start with 1-qt/M of Surf-Side #37. It's a must for sand greens!"

Richie Valentine, Golf Course Superintendent, Merion GC "Very beneficial using the Injection System and Surf-Side #37 on bent greens, tees, and fairways. It helped with our limited irrigation system on the East Course."

I owe a great deal to many superintendents you never heard of, but jointly, we all know the beast . . . this world we live in!

PENETRANTS - WHAT THEY DO AND WHY

Before I commence to self-destruct in this talk I'd like to mention Larry Fletcher, an old friend, who in the 1950's received a patent for the use of non-ionics in soils. He is now retired and living in Lancaster, PA. For purposes of this talk history tells us where we have been. The original formulation has seen several minor changes to increase flowability at 100% active. This surf-actant blend got the ball rolling but has always played to mixed reviews. The early years were spent in just trying to keep an idea alive. In 1975 I formed Montco Products Corporation and commenced an investigation into what type of surfactants the plant likes. It's one thing to test surfactants in sand, soil, and organic matter for their wetting characteristics and quite another to take a living plant and subject it - the rooting profile - to this environment. The result was the cultural Surf-Side blends I'm going to speak about today.

Several years ago I received a 25 year pin from GCSAA. History had some ugly moments . . . inhibiting root initation, root pruning, tip-burn, discoloring many a green. I've sent more poa annua packing than you can shake a stick at . . . I was the creator of mystery diseases that no one understood . . . in many cases nemotodes took the rap. It was a game of Russian Roulette . . . but in those early years there was no way to turn. We thought we knew everything and with several hundred university papers on the books we had created a monster . . . an ongoing monster that even today keeps feeding on itself. The logical thing would have been to ask the grass plant in the beginning what it enjoys in the way of surfactants, but with pre-ordained concepts about surface active agents the focus in industry and academia centered on a shallow range of materials that were effective in soils an good at emulsifying and saponifying hydrocarbons - chemicals used in spray programs - a detergency oriented philosophy that is great if you desire to flush bacon grease down the drain, but it is well to remember that the carbohydrates in the plant world are just as susceptible to being flushed down the drain! Rate and manner of application with this bracket of low mole blends are important. You must tie these phytotoxic blends up on surfaces . . . picked up by the plant when actively growing and you are in trouble. Sand will not give you the same safety factor as an organic mix. Dr. Eliot Roberts said in 1962 that 8 ounces of surfactant applied to 1000 sq. ft. is tied up in the top ⅛ inch of a silt-loam soil. We can argue location and method of application but Eliot's work does give us some idea of the high affinity for surfaces of these materials in soils and the shallow slice of treated profile. My talk today is on cultural surfactants - blends based on what the plant can tolerate, and enjoy, at extreme rates deep within the rooting profile. They are, at this juncture, the outer limits . . . rates beyond anything you would ever conceive of. One current University article states, "Like all chemicals, wetting agents have their place." This remark is the problem . . . just where in the pecking order do wetting agents, and more specifically, cultural wetting agents, belong? I think it will be another 10 to 20 years before that is settled, but the jury is out . . . the jury being the golf course superintendent who will ultimately decide the issue!

In this jar are two types of Surf-Side Blends . . . possibly you can hear them clunking around . . . one is a soft paste surfactant and the other a hard paste surfactant. The molten point of the pastes range from 85°F to 120°F. They are packaged at 70% active, the blends containing 30% water. Adding water the paste blends increases viscosity, allowing them to be poured from a container and into a solution in the spray tank. From the podium and in advertising we are frequently told that water in blends separates the good guys from the bad guys . . . that

100% active blends are made in Heaven . . . the pitch lacks class, but it works. The facts, however, are different. The hottest, most phytotoxic blends on the market today in the chemical class of nonyphenols, octylphenols, primary and secondary alcohols in the low mole range all flow at 100% active ingredient . . . individual components at a chilling 22°F.

There are products on the market today not included in the above chemical classes that are solids at 100%. The Golf Course Superintendent and Turf Grass Student deserve better press. Water is not the issue . . . we must adjust our concepts of turfgrass culture to the surfactant in use. The surfactant jungle needs restructuring by the Universities. The textbooks are inadequate because the role of surfactants in turfgrass culture is still in dispute. You can't put a quart or two of a cultural surfactant on 1000 sq. ft. of a green with or without a fertilizer, insecticide, or systematic, and expect a textbook result . . . it just doesn't happen! You must revamp the whole system. We are not geared to having current turfgrass textbooks take a back seat to cultural surfactants, but for the superintendent starting to investigate their use the application rate and leachate available to the plant provide a new tool with this controversial issue . . . you must deal with your fellow Golf Course Superintendents . . . those in this audience that are embarking on the issue of where in the pecking order cultural surfactants belong.

One issue is how we research at the University level. The Turfgrass Associations in the individual States have provided needed funding and political clout and and defined the economic importance of our industry. However, you can't test for surfactants on a University test plot and cover the marketing waterfront. I speak today on the art of greenkeeping . . . I cannot apply normal cost factors where the hot, low mole surfactant blends do an excellent job, at low economical rates, and extreme dilution, with herbicides or fungicides on highway, municipal, and landscape applications. On the fairway and green these products are effective at the proper dilution and when tied up on surfaces. Just don't overload the rooting profile and let the grass plant start drinking them under stress or when actively growing. Most of you are familiar with tip burn, discoloration, or loss of grass. The toxic effect is subtle . . . often slow to mature . . . and your readout of the turf condition can be incorrect . . . you proceed to put more surfactant on a localized dry spot or wilt prone area when it is already suffering from the phytotoxic effects of the wetting agent. The art of greenkeeping with the Surf-Side blends is a total reversal of the historic use of wetting agents. You can tailor application rates and cure individual problems on the green, tee, or fairway at the height of the season, if necessary. Superintendents tell me they are under budget with these materials . . . what happens is that you readjust the use of other chemicals . . . again, you must establish a pecking order.

In 1976 it became evident in test work that these pasty high mole surfactants selectively lost the ability to emulsify and saponify hydrocarbons and yet retained good wetting characteristics. Because of the high rates of application possible with these products in soils and deposited on the leaf & crown we enter a world where we can change the environment within and without the grass plant. Every cell in nature, every cell in your body, has a balanced hydrophobic/hydrophilic area. If I surround you with a surfactant solution that is not phytotoxic, one that will not dissolve the cell wall, one that will not burn, discolor, root prune, inhibit root initation, then you will react to the imbalance of the surfactant blend in your environment. You will think the way I desire you to think - grow the way I desire you to grow. You will live in a world of extreme water solubility and react to nutrients and chemicals differently than ever before in the history of horticulture. Univeristy test plots don't cover heavy rates of cultural surfactants on the leaf & crown and drenching with available leachates deep within the rooting profile . . . that's somewhere down the road! But the Golf Course Superintendent using these products must put on his own thinking cap, make his own observations, and remember what he is doing is a world apart.

Sticking to the textbook and using accepted agronomic principles and plain water will always be a personal challenge. But I'd rather enjoy the freedom these cultural surfactants give you . . . why bother with the grass if you don't have to! One curious factor is - who's growing the grass . . . you or the surfactant? You can't avoid this question . . . you can't change the way the grass plant thinks and assume all the cards are in your favor. Knowledgeable superintendents will tell you - keep some portion of the course on a yearly program. That grass plant, that leaf blade, may not be your own . . . don't go back to ground zero and start over . . . keep an ace in the hole. I have seen courses run out of steam in mid-season for lack of wetting agent. The carry-over from previous years won't last forever. If you get no advance warning, keep no portion of the golf course as a check . . . then a return to textbook maintenance and plain water can be abrupt and ugly depending on summer weather conditions.

Individual differences on greens, tees, and fairways require individual dosage rates. Working with cultural surfactants at rates of 4 to 12 ounces a month may only apply to a new USGA green. Your irrigation system delivers twice the amount of water to 45 to 55% of the green surface. Aside from differences in soil texture you are superimposing all this free moisture of textbook conditions. Just how long you desire to have this gravitation moisture hung up in the rooting profile is up to you. At low surfactant rates you are doing more than moving water through the crust of the green. Once through the treated crust the free moisture is faced with whatever soil composition it comes in contact with. By super-imposing surfactant drenches to individual problem areas you lower the soil treated interface to a point where the gravitational moisture, once on its own, can move, without restraint, out of the rootzone. On an older green a wilt prone area next to a bunker may require a drench 5 to 8 inches through the sand layer to get good moisture control and aeration. After spring aerification and topdressing a quart per 1000 sq. ft. on a good green and two quarts on a poor green provides a starting base for controlling moisture and providing some surfactant in leachate form to the plant. This is not going to control or cure persistant dry spots and wilt prone areas that crop up at the height of the season. If you've got dry powder an inch or two down in a collar - soak it. Eliminate all these areas that require individual attention early in the game. By midseason get all the greens marching to the same drummer. Here's where the total time spent at maximum aeration is so imporant to the quality of the turf and for disease control. Also remember that free moisture must have some place to go . . . an elevated green with internal drainage is OK but a low green with a water table problem is a bummer.

Getting over the fear of these heavier Surf-Side applications can take years or just a few days. Put 1 ounce in a gallon sprinkling can and drench 10 sq. ft. on the practice green. Do it when all hell is breaking loose . . . it's two o'clock in the afternoon and 90°F in the shade. Walk away and lose a night's sleep! Now, 1 ounce on 10 sq. ft. is about 4 gallons on a 5000 sq. ft. green. Treat another 10 sq. ft. at 2 ounces in 1 gallon water. That's 8 gallons on 5000 sq. ft. And remember, it is very difficult getting a golf course superintendent with real problems to put 1 gallon on a green and start the comeback trail. Two years ago Tom Dale, Superintendent at Radnor Valley GC, had a bad oil spill on two 90° bent greens 6 to 7000 sq. ft. Nine stripes on one green 12 inches wide and seven on the other green plus a circle. It was over 80°F and he was not aware of the situation for an hour andhalf. He power washed the stripes using a total of 20 gals. Surf-Side. Each of four 100 gallon loads had five gallons surfactant. That's ten gallons material - on the stripes - on each green. He irrigated heavily, applied charcoal, and came out a winner. In 1987 he had one stripe on a green and power washed the stripe - not the green - with 5 gallons Surf-Side in 100 gallons water. No problem! I am not here to advocate this amount of material for this use . . . perhaps 2 or 3 gallons would be enough . . . but the superintendent had not fear of the surfactant. It pays to learn how to use this new tool and see if your weekends can be spent with the family . . . make those 10 to 12 weeks of summer average days.

Being in the Northwest Territory I feel compelled to mention seed germination. The important thing is to set the seed coat initially with the treating solution. In deep seeding 1 to 3 gallons in 100 gallons of water works fine. Cover 4 to 6 greens at the higher rate.

Dr. Robert Shearman, University of Nebraska, spoke on "Light, frequent, sand topdressing influences on putting green quality." His comments on the use of Surf-Side #37 were that the incidence of both Pythium and Brown Patch declined when yearly treatments exceeded 16 ounces a.i. per 1000 sq. ft. for a total of 8 topdressing applications. He further states, "The surfactant treatments decreased soil surface water content and increased infiltration rates, thus reducing necessary free moisture for disease development." You learn to appreciate a professor who throws you a life preserver. However, leachate availability and depth of profile treatment are not a factor at these rates . . . this represents one side of the coin . . . rates several times this amount are a flip side we know little about.

There are more worlds to conquer . . . one is getting control chemicals into the pest environment. Low mole wetting agents spend so much time wetting & spreading that they get tied up on surfaces along with the insecticide. At a 1% solution the high mole materials can penetrate 10 to 15% faster . . . they are just not as busy wetting the mat & thatch . . . they penetrate. George Pierpoint, superintendent at the Ardsley CC in White Plains, uses the following treatment for Hyperodes Weevil and White Grubs. In a 200 gallon spray tank he puts 5 gallons Dursban (2 quarts per acre) and 20 gallons Surf-Side #37. He applies this to 10 acres every 5 weeks. Three applications were made in 1987 and more will be applied if needed. The application is made to early morning dew followed by a 7½ minute watering per head. George is one of the oldest users I know and I appreciate his sharing these rates with us as well as all other superintendents mentioned. George is not only getting a good treatment - two gallons per acre of the surfactant - on the fairways but at rates unheard of for getting the control chemical to the pest environment. His general maintenance spray using standard rates of Bayleton or 3336 is 5 gallons Surf-Side #37 in 200 gallons water plus control chemical. He applies this to 10 acres every 3 weeks for a total of 4 sprays per year.

Henry Wetzel, superintendent at St. Davids GC in the Delwaware Valley uses a 300 gallon spray tank and treats 6 acres on a monthly program. His tank mix is 6 gallons Surf-Side #37, 6 gallons Ferromec, and one ounce of Bayleton per 1000 sq. ft. Henry halved the rate on the Ferromec and Surf-Side #37 in mid-summer but is not sure it was necessary. The application is usually made on a Friday to give a few days before being mowed. In the rough summer of 1987 the program was a winner.

I know you've got plenty of Poa Annua in this Northwest Territory, and it is often referred to as a week. But poa, in my book, can be beautiful! The grass on the greens can be dense, tight, upright, an thin bladed . . . I heard one old timer refer to is as "a new grass." On Friday before this talk I spoke with Bob DeMarco, superintendent at the Powelton Club in Newburgh, NY, who has been on a Surf-Side program for six years. He calls 1987 a great year from tee to green. He cuts the poa fairways at ⅝ inch six days a week. He syringed one day in late August. It is interesting to note that Bob uses Bayleton in his spray program in July and August for the umbrella condition labeled Poa Decline. Not all were so lucky using the surfactant . . . but then, programs and conditions vary.

Into each life some rain must fall . . . it seems I've been wearing galoshes most of my life, therefore, it's appropriate at this time to speak on "What's Good For The Goose Is Good For The Gander." In the last ten years isolated reports have surfaced from superintendents that indicate a pathogen can enjoy the cultural surfactants just as much as the grass plant . . . this makes sense . . . why not! Chemical controls have proven adequate in all cases. However, my observation on the use of systematics in the above programs is they put a cap on the resident disease community, and the grass plant, under stress, turns in a good report card. I leave it up to you to be the Judge and Jury.

There have been numerous rates of application mentioned in this talk. We take no responsibility for these rates other than to report what is being done so the individual superintendent can adapt the concept to his own program.

I'm going to show a few slides on a Surf-Side pumper for injecting the surfactant into the discharge side of your irrigation pump. For several years I was negative on this because of the spray pattern from the heads on fairway irrigation but the convenience of the systems fit a busy superintendent's style. When the chips are down you can pump the surfactant out every day . . . the dilution works . . . and after the summer of 1987 I'm a believer! It is a positive displacement pump with a number of advantages: (1) Ease of priming (2) Discharge rate is unaffected by line pressure (3) Repeatable and variable volume control (4) Suction side can have 20 or 30 feet of hose for drawing from a container outside the pump house or from a parked spray tank (5) pumpheads are available in standard 5.1 GPH and 1.9 GPH. A combination of both or a single head. The 1.9 GPH head allows for accurate deliveries of small quantities of chemicals.

The first slide is at the old pumphouse on the East course at Merion GC. The second few slides are at Aronomink GC, Steve Campbell, superintendent. the shots of the bentgrass fairways were taken in mid-August of this year . . . even in a good year I don't think you could grown better grass.

I wish to thank you again, for the invitation to speak, and my best to you all . . .

INNOVATIVE WATER PLAY IN PARKS [1]

Gunter Edel [2]

[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Landscape Architect, Parks Director, New Westminster Parks and Recreation Department, New Westminster, B. C., Canada

Innovative water play is actually nothing new. It was created centuries ago throughout Europe in the Parks and Gardens of the wealthy endowed class who displayed large fountains and cascading water in many forms to entertain the visual senses of their guests. Fountains were lit to dramatize the water's effect in the darkness.

Architects throughout Europe and later in North America designed fountains in villages and city squares and public parks. These early creative designs did not have children in mind. These playful water designs were strictly out-of-bounds for children and the general public. They were designed to delight the eyes and feelings of the viewer.

Innovative water play is the natural summer fun for children - ''A place where a child can let go''. Psychologists use both water and sand to soothe disturbed children.

Water play has an irresistible fascination for young children. Water is one of the few natural resources available for exploration by city children. It provides a wide variety of activities and experimentation.

''Rachel Carson'' the well known child psychologist, in her book ''The Sense of Wonder'' talks about the sense of wonder of water, a gift that is so indestructible that it would last throughout life as an unfailing antidote against the burden and disenchantment of later years.

The Spray Pool is a unique and exciting addition to the parks in New Westminster. It has provoked an irrestible attraction for water play for all participants. The success of spray pools captures the attraction for people of all ages.

WHY SPRAY POOLS HAVE BECOME POPULAR?

1. Spray pools provide many months of water play.
2. The water can be instantly activated and stopped.
3. Chemicals do not have to be added to the free flowing water.

4. The water drains continuously out of the pool into a catch basin which is connected to the city's drainage system.

5. The water is pollution free, with a purity the children can drink without harming them.

6. The water does not get more than a few inches deep so there is no fear of drowning.

7. Spray pools provide for flowing water, falling water, still water, spraying water, dancing water, and cascading water.

8. Spray pools in New Westminster are accessible by all young, old, handicapped or non-handicapped.

New Westminster experienced the participation of blind children joining in on the water fun. For most of thcse children it was the first time in their life to experience the severity of water excitement.

9. Spray pools have the sound of water.

10. The water is soothing. Whether you are watching or participating in water play you can feel a sense of peace and happiness because it connects the human being with the natural element water projects in nature.

11. Children can let go of their pent up emotions, often inflicted by our structured society, by shouting and screaming with joy.

12. Spray pools offer companionship and a happy atmosphere.

13. Spray pools offer unstructured free play and continuous play with a creative outlet for children to make their own games.

14. Spray pools create an adventurous summer atmosphere.

15. Spray pools are inviting for a family outing with picnicking and water play creating a perfect atmosphere where even grandma and grandpa can join in the fun and sense the feeling of being young and lively again.

HISTORY AND DEVELOPMRNT

In 1982 New Westminster Parks and Recreation Department designed and constructed a small spray pool in Moody Park, to replace an existing wading pool which proved to be a very unsuitable place to enjoy summer water play. Wading pools have proven over the years in operation to be a very short lived and used summer water play area. These reasons will explain why:

1. They are empty most of the year hence the short usage period.
2. They are expensive to build and maintain.
3. They need constant supervision while in operation.
4. They have to be filled with water and emptied on a daily basis, under supervision.
5. Pools have to be chlorinated daily to meet health specifications.
6. Wading pools limit water play.

The small spray pool was the forerunner of other spray pools in New Westminster. Its instant success of providing an innovative water play area warranted the elimination of a wading pool.

CONSTRUCTION

The spray pools were constructed by the New Westminster Parks crew.

Construction of the Queen's Park Spray Pool started in June 1984 with the grand opening September 1984.

Construction of the Ryall Park Spray Pool started in May 1985 with the grand opening in May 1986. It is in regular operation from May 16 to September 15.

The Spray Pool design plans consist of a general layout plan and a construction detail plan.

- The Spray Pool design is layed out on the construction ground to blend into the existing park surroundings.

- The Spray Pool site is excavated. All areas should have a 4% slope towards the drain to eliminate water standing when the pool is not in operation and to have constant drainage.

- All spray elements are installed such as fireboat, spray cannons, fire hydrants etc. prior to placing road base material evenly over the entire spray pool site. The road base material is compacted with a pressure roller.

- Two layers of asphalt are then layed down over the gravel road base and molded and compacted. It is important to take special care in the asphalt content.

The high percentage of moisture content as well as wear and tear on surface can lead to potential flaws in the asphalt if the asphalt content is not of the correct quality.

Once the asphalt is molded and compacted all around the spray elements and pool bottom and streams, etc. the surface is painted with brilliant colors with designs reflecting an image of waves and water. Then other fixtures and play apparatus are painted with colors of excitement accenting the aesthetics of the water facility.

- The surrounding landscaped grass area is carried up to the pool side to make the access to the pool easy and convenient and safe.

COST

QUEENS PARK

$35,000 to build, of which $5,000 was used to upgrade a main water line. The Spray Pool was funded by the New Westminster Rotary Club and the water line upgrading was funded by the City of New Westminster.

RYALL PARK

$40,000 to design and construct the Spray Pool. Funding was supplied by the City of New Westminster.

THE DESIGN

It is the philosophy of the New Westminster Parks and Recreation Department to use the imagination of its personnel to provide innovative play areas. The Spray Pools became the opportunity to do just that, create something new, something for everyone and FREE for the participant.

The architect, having an understanding of children and considering all aspects of play, carefully researched and designed an appropriate Spray Pool to meet the needs of the participants and fit into the setting of the New Westminster parks.

WATER FEATURES

The Spray Pool features water sprays from fire hydrants, old-fashioned water pumps and a water cannon. Water sprays from under large round rock boulders and from spray post. Children can manipulate valves to change spray patterns and water pressure. Ankle-deep water flows gently over the wave-painted pool bottom in which the surface minimizes slipping. The water is dispersed continuously through a river-like canal then out to the city drainage system.

ACCESSIBILITY

The Spray Pools are easily accessible to the handicapped or children of all ages. The pools are not fenced in. The pool's bottom gently slopes from the outside edge to the middle allowing for wheelchair accessibility. There are no curbs or obstacles to enter and entrance is possible from any direction.

OPERATION

In addition to the delightfulness of these water play facilities, the Spray Pool is relatively easy to maintain. It requires a half hour in the morning to activate the pool and a half hour in the evening to close the pool down. In these half hour time periods a good sweeping of the pool is required and removal and placement of the brass fixtures that have to be kept in storage overnight takes place. The ease of maintenance holds a lot of value in the success of the Spray Pools.

SAFETY AND PRECAUTIONS

The Spray Pool is particularly safe for children because the sprays are gentle and the water depth does not reach more than four inches. The natural setting amongst trees and lawns encourages parents to relax by the edge of the pool and watch their children enjoy the water. Park benches and picnic tables with sun umbrellas are close by for use by the public.

It was the first objective of the designer of the Spray Pools to design a safe playful environment for the general public. The elements of concern include:

1. The surface of the pool is coated with non-slip paint.

2. The water does not get deep, therefore, drowning is not possible.

3. The water pressure is controlled by water valves so participants will not become injured by high water pressure.

4. Fixtures are stationary but can be manipulated by turning taps.

5. Wooden apparatus is of salt pressure treated wood and of lasting quality with a smooth surface to prevent slivers.

6. Metal elements are well painted to prevent rust.

7. Bridges are treated with a gritty non-slip surface.

8. At high usage time supervision is available to guard over play injuries.

HEALTH STANDARD

The design and completed facility had to be approved by the City Health Inspector. Items of concern were:

- water collecting and becoming too deep

- apparatus is stationary
- surface is of a non-slip coating
- water purification

RECOGNITION

The Spray Pools in New Westminster were designed by Gunter Edel, Landscape Architect and Parks Director with the City of New Westminster. The design reflects the understanding the architect has of children and of people. One must provide something for everyone, something that is free, fun, exciting and innovative, offer a play facility that provides the challenges that we once wanted to do as children — be a fireman, operate fire hydrants, shoot cannons, play with boats, etc. These can be made to happen in play, in water play.

CONCLUSION

Spray Pools are a colorful addition to New Westminster Parks. They have enhanced the atmosphere of the parks and their success is reflected in the excited eyes of the participants. The introduction of this unique water play experience provides an exciting new leisure opportunity through a blend of the creativity of man and the natural environment of water.

CREATIVE IDEAS IN HORTICULTURE [1]

Gunter Edel [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Landscape Architect, Parks Director, New Westminster Parks and Recreation Department, New Westminster, B.C., Canada

Parks landscaping must be inspired by good design, good plant material and ample color. Good selection of plant material and groupings of plants are often neglected in our parks landscapes.

Every park's landscape should project something unique and functional and should bear a touch of magic, to which people are consciously and subconsciously being drawn.

It is most important to design public park areas to meet the local needs. A park design must always have in mind the practical needs for the user esthetically presented and practically designed.

We must, as parks professionals, be conscious of the fact that public parks should serve people of all ages and a diversity of interests.

With the great emphasis on organized sport activities and public fitness, often the passive park visitor looking for peace and tranquility is short-changed.

The challenge all we parks professionals and park designers and landscape architects face today is to design and to maintain public park areas which serve the passive and the impassive park users.

Unlike active recreation, the passive benefits derived by the visitors to our parks is often difficult to measure. The mental peace and tranquil psychological effect and the appreciation of nature is priceless to the mental and physical well-being of the passive park visitor.

Many landscape architects and park designers in the past found it very difficult to justify active sport facilities in our parks. Naturalized landscape developments were very suited to passive and semi-passive types of recreation. They were decidedly difficult to justify for active sport facilities to staff them into the rural mold.

Concurrently, recreation areas of today are often left with the vestiges of a historic hangover, unattractively designed and often totally alienated from other park activities.

Behaviourists maintain that surroundings consciously or subconsciously shape our attitudes, breeding tranquility or tension, pleasure or dissatisfaction, increasing the already hectic stress of job, home and every modern life.

How lasting is the momentary relief of a well designed park if one must return to face that which in such great proportions drives people to escape in the first place? Parks can no longer be thought of primarily as vehicles of escape. Rather, they should be developed to serve as examples of what is possible in terms of soul satisfying environment and should help in promoting higher works in other types of developments, toward the day when everything which man builds contributes to positive physical surroundings in our urban environment.

Often the landscape materials used within cities and city parks are totally absent from the landscape outside our city bounds. Native plants and other native landscape materials such as: rock boulders, land contouring water and lawns and flowers should be incorporated when planning or beautifying our parks and city landscapes. They should form an integral part of the total environment and should provide the esthetics to stress the importance of the landscape. We must help to protect and plant trees and shrubs and flowers and lawns that surround our cities.

Our park landscape designs should be so designed to emphasize a natural look, always keeping low maintenance and affordable maintenance in mind. One must always guard against the tendency, especially amongst specialized horticulturists, to become facist, favouring plant material that has strong personal appeal, often at the expense of what could be a much more effective and functional planting to the masses of park visitors.

To provide and maintain esthetic, low maintenance parks, we must strive to have landscape architects and horticulturists working as a team. The trend to eliminate in many of our existing parks and newly created parks, the horticultural beauty is often experienced. The mass planting of shrubs, trees and groundcover often takes its place to reduce the higher maintenance cost of horticultural beauty.

In good park design, horticulture should not be absent. It is often the flowers which give a touch of magic to our parks and appeal most to the senses of the park visitor.

The challenge for us is to place horticulture in our park areas in strategic places where they can be most appreciated by the visitors.

The following are a few basics which can be useful to create and maintain esthetic and low maintenance landscaping.

1. Parks and landscaping must have a sense of balance.
2. Planting should consist of an abundance of native plant material.

3. Parks must have a relationship to the surrounding areas.
4. Parks should give the park user a sense of freedom where a person feels removed from everyday life.
5. Parks should provide well designed plantings and an abundance of color to project magic.
6. Plants should be placed in large groupings with specimen plant material interplanted for interesting mass visual effect.
7. Flower borders should be created in curvacious shapes with shrubs and trees planted as a back ground. Flower borders do not have to be much wider than three feet, winding around evergreen shrub borders. They are most effective and reduce high maintenance costs of large, single flower beds.
8. Every large show park should have an especially colorful floral display in a size larger than can be created in a residential garden. Such floral beds appeal to the public and become the pride of the city or town.
9. Floral carpet bedding using an ever changing floral design fitting to the season and special events can depict a visual theme logo or attractive form. The use of plant material and silica rock or certernalite rock reduces cost and produces an esthetic effect to the finished product which can be most pleasing.
10. Parks should provide colorful planting areas which should be created and maintained by competent personnel. Good, colorful combinations reflect public appreciation.
11. A horticulture and park design must provide for easy care and mowing of grass areas.
12. Horticulture in parks only projects its best effect if surrounding lawn areas are well cared for.
13. Avoid dead corners and steep banks in park design which have to be mowed with hand mowers or weed eaters. These corners and banks can be attractively designed for shrubs and flower borders.
14. The use of bark mulch as shrub surface material placed two to three inches deep helps considerably to curb weed growth and helps to retain soil moisture. It also gives an esthetic look to the landscape.
15. Good horticulture design should highlight the use of water when available. Some of the most spectacular landscapes are centered around water in one of its many forms.

16. Landscapes should be designed to provide ease of maintenance. Elaborate landscapes can become mediocre through lack of proper maintenance.

17. Always make certain when planting trees or shrubs that the size of planting holes you dig are large enough to provide ample food and water holding properties to allow them to reach the size they were intended. The planting hole for any plant should always be one third larger in size than the root system of the plant to be planted.

18. Plants, like people, are influenced by environment and strive best while located in an area that is conducive to their requirements. It is, therefore, important that we understand family groups, cultural climatic conditions, relationships of one plant to another and the influence of sun and shade. Color of flowers and foliage pattern of trees and their ultimate size and spread all play an important part in the ultimate design of a good park landscape.

19. The use of colorful annuals to lure the public into the park is most important to compliment the green lawns with flower beds planted with red, yellow and white blooming annuals for summer color such as salvias, marigolds, margeurites and white allysum. Dusty miller interplanted with salvias or as border planting is very effective in parks.

20. Pastel colors make beds look larger. In sunny locations plant large groupings of petunias in pastel colors. Your effort will be well rewarded by the park visitors.

21. When planting for spring color use early flowering bulbs in large groupings with late flowering bulbs to stretch the spring blooming season.

22. Violets, blue and white in color make excellent flower borders around rose beds. Roses often do not flower too well prior to the month of June whereas violets bloom in early spring with lasting color into very late spring to early summer.

23. Make good use of the most reliable annuals in your parks such as: marigolds, salvias, ageratum, impatiens, tagetes, verbina venosa, marguerites and pansies. All the above named annuals are not easily influenced by unpredictable weather conditions, but always show their best of color.

24. All flower beds must conform to the theme of the park.

25. All flower beds should be pleasantly shaped, pleasant to the eye. Curved lines are very pleasing.

26. Flower beds should be seen from a distance. This can be achieved by burming a floral bed or planting annuals on a sloping ground contour.

27. Plant the flowers to lure the visitors into the park, namely, the entrances of a park the corners of a park.

28. Make use of an artist's color chart and blend your annuals well into the flower beds.

29. Read good books on the subject of flowers for parks and gardens. I have found that the Ortho Chemical Company produces garden books on the subject of annuals and perennials, shrubs and gardens which I have found to be excellent for horticulturists and landscape architects to help us produce vivid and colorful landscapes.

The American philosopher, Will Rogers, gave us an important message when he wrote, ''The Good Lord is makin' more people, but he ain't makin' no more land''.

The message should remind all parks professionals that we must provide the public with park areas that are well ornamented and colorful and economically designed and maintained.

CURRENT RESEARCH ON NECROTIC RING SPOT [1]

Dr. Gary A. Chastagner and Bill Hammer [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Associate Plant Pathologist and Graduate Research Assistant, respectively, Western Washington Research and Extension Center, Washington State University, Puyallup, WA

NECROTIC RING SPOT

Necrotic ring spot, caused by Leptosphaeria korrae, is causing severe damage to bluegrass turf in the Pacific Northwest. Although the disease can occur on turf established by seeding, most affected turf was established as sod and initial symptoms generally appeared 1 to 3 years after establishment. Symptoms appear in late spring or early summer as chlorotic spots or patches with a thinning and/or dying of the grass. Donut-shaped rings or patches from several inches to 1-2 feet in diameter are formed as symptoms develop and active rings have margins which are a light reddish brown in color. The centers of rings are usually invaded by broadleaf weeds and grasses.

Our current research on necrotic ring spot consists of 1) developing methods to produce fruiting bodies of L. korrae under laboratory conditions, 2) determining the susceptibility of bluegrass cultivars to NRS under field conditions, 3) determining the effect of dethatching and aerification on disease development, 4) evaluating the potential usefulness of overseeding as a means to provide long term disease control, and 5) evaluating fungicides for disease control.

Methods have been developed to produce fruiting bodies and spores of L. korrae under laboratory conditions. These methods have been used to compare isolates of L. korrae from Washington to isolates from California, Utah, Michigan and New York. The ability to produce spores also makes it possible to determine the role of these spores in disease spread.

The identification of turfgrass cultivars with resistance to NRS is an important step in the development of long term control of this disease. Greenhouse Studies have indicated there are differences in susceptibility between turfgrass species and between cultivars within a given species. Limited information, however, is available regarding the susceptibility of turfgrass species and cultivars to this disease under field conditions.

Using three highly pathogenic isolates of L. korrae, we have inoculated the 72 cultivars of bluegrass in the 1985 National trials at Puyallup and Prosser, WA to determine their susceptibility to NRS. This work is being done in cooperation with Drs. Stan Brauen, Bill Johnston and Dave Evans.

In cooperation with Dr. Johnston, we have established a plot in Spokane to determine the effect of yearly dethatching and aerification on the development of NRS. We also established a plot in May to determine the potential for renovating and overseeding diseased turf as a means to provide long term control of NRS. We have used information from Dr. Gayle Worf at the University of Wisconsin to select bluegrass cultivars with varying levels of susceptibility to NRS for use in this test. Dr. Worf's data indicate that Adelphi, Midnight, Eclipse and Park are resistant, Baron is intermediate in susceptibility, and Sydsport and Ram I are Sdsceptible to NRS. Ryegrasses we have included in this test are: Allstar, Manhattan, Birdie II and Dasher. Each of the bluegrass and ryegrass cultivars has been dsed alone and we included three treatments consisting of 50/50 mixtures of Adelphi with each of the following ryegrasses: Allstar, Birdie II and Manhattan. Although greenhouse tests indicate that NRS symptom development is limited on ryegrass, symptoms were present on the Manhattan and Allstar cultivars this September.

Our research has shown that necrotic ring spot can be controlled using fungicides. Applications of Rubigan, Banner, Spotless and Fungo in the spring have controlled necrotic ringspot development during late summer and fall. We have not observed any difference between a single application in either April or May. Similar results were obtained during 1987. Effective control of this disease requires yearly applications of these fungicides.

SETTING UP FOR THE PGA TOUR [1]

R. Terry Buchen, CGCS [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Golf Course Superintendent, Broadmoor Golf Club, Seattle, WA

Golf Course Conditioning Guidelines

The condition of the course is the most important element in a tournament in the player's view. A well prepared course gives the players the best opportunity to display their skill. A good playing surface tends to reward good play, and thus helps to produce a good winner. Good courses, properly maintained, are likely to attract strong fields of players. It also assures their return in following years.

In an effort to provide the best possible playing conditions for each event, the PGA TOUR is providing this set of Golf Course Conditioning Guidelines.

The Guidelines are just that—guidelines. Because of the wide variety of golf courses and types of grasses used on the courses, there will be situations where the Guidelines cannot be met exactly. When this situation occurs, the PGA TOUR Agronomist and/or the PGA TOUR field staff representative will authorize any changes.

These Guidelines are intended for the use of the golf course superintendent and the tournament sponsor. Although they are written for use at a PGA TOUR event, we feel they are useful in the day-to-day conditioning of the golf course.

The preparation of the golf course should begin early in the year to avoid any short term programs which may not be in the best interest of the golf course and the playing conditions. The PGA TOUR Agronomy Department is available to offer any assistance that is necessary for the preparation of the golf course.

When golf courses are well prepared on a daily basis, it is much easier to provide quality playing conditions during the PGA TOUR event. The guidelines for the specific areas of the golf course and grounds are as follows:

Teeing Grounds

Level and close-cropped tees are best for tournament play. The tournament tees should be protected from normal play for several weeks prior to the tournament. Secure several rolls of erosion control netting or plastic mesh to cover the central areas of the teeing grounds on par 3 and short par 4 holes during practice rounds.

Follow a regular program of aerating and vetticutting and nitrogen control to eliminate thatch. Spongy turf presents a real problem for the player. Regular maintenance practices should be followed on the tournament tees. Some clubs do not use the tournament tees for regular play. If this is the case at your club, extra attention must be paid to the tees.

Fairways

The importance of close-cropped fairway turf cannot be over-emphasized. Fluffiness in fairway turf is undesirable. The fairways should be firm, with a tight turf. Avoid overwatering. Mowing heights for tournament play should be established weeks in advance. Last minute reductions in mowing heights can cause ''scalping'' and uneven cuts.

Fairways should be cross-cut prior to the event. During the week of the tournament, fairways should be mowed daily (usually in the late afternoon) when the grass is dry. Mow clockwise and counterclockwise; do not stripe the fairways.

Drag dew from fairways prior to play each morning.

Putting Greens

Firm, keen, dry greens provide the best test, for both approach shots and putts. A sound program of water control (using as little water as possible) will help produce championship greens.

The great tendency is to over-water. Over-watering is bad for the long-term health of the turf. Soft greens do not reward the skillful shot and are more difficult to maintain in top quality condition.

Establish a program of protecting areas of the greens to be used for cup settings for the tournament. Use front of greens for member play and centers of greens for practice rounds.

Repair all old hole plugs that have been raised or sunken 1-2 weeks prior to the event. Hole changing is a most important part of tournament preparation. The person changing the holes should be the best on the maintenance crew. Great care should be taken to make all plugs even.

Roughs

If the tournament is to provide a true test, it is very important that roughs be established in accordance with our cutting heights. Roughs should be fertilized, if necessary, to achieve this condition. They should be consistent in height; clumps of grass are undesirable.

Walk Paths

Five to six-foot wide walk paths should be mowed between the tournament tees and the start of the fairways.

Practice Areas

Practice areas should be maintained similarly to comparable areas on the course. Practice tees should be mowed daily at the same height as fairways.

Because of their heavy use, institute a program of top dressing and seeding divots during the event.

For several weeks in advance of the tournament, arrange to locate practice play away from the areas to be used during tournament week.

Cutting Heights and Widths

Following are average heights and widths of cut which we require; density sometimes can be more important than height:

	Height		Width
	Non-Bermuda	Bermuda	
Tees:	Not over ½ inch (prefer lower)	Not over ½ inch	
Fairway Areas:			
Fairway	½ to ¾ inches	½ inch	25-35 yds.
Collar off fairway (light rough)	2 inches	1½ inch	4-6 feet
Rough-heavy	4 inches when mowed with rotary, 3 inches when mowed with reel mowers	3 inches when mowed with rotary, 2½ when mowed with reel mowers	
Putting Green Areas:			
Putting Green	9-10 feet when measured with a stimpmeter	9-10 feet when measured with a stimpmeter	
Collar off green	½ inch (Prefer lower)	½ inch	30-48 in.
Light rough off collar	1½ - 2 inches	1½ inches	4-6 feet
Rough-heavy	4 inches when mowed with rotary, 3 inches when mowed with reel mowers	3 inches when mowed with rotary, 2½ when mowed with reel mowers	

Bunkers

Any fresh sand needed in bunkers should be put in three months in advance of the tournament so that it will settle; if there is inadequate rain to pack it, water it artificially. Do not add sand that has rounded particles.

Suitable sand includes what is known as plasterer's sand, mason's sand or brick sand. Sand which will pass through a one-eighth inch sieve opening and which has had silt and very fine sand particles removed by washing will resist packing. Sand particles which are rounded in shape tend to shift under a player's feet, whereas sand with angular particles is more suitable. Bunkers should not contain stones.

Sand in the face of the bunkers must be no more than 2 inches in depth. This will prevent a ball from being lost.

Rakes that will not leave large furrows should be provided at each bunker. Bunkers will be maintained by hand raking during the tournament.

Rakes should be placed outside the bunkers away from play.

Players should not be able to putt out of greenside bunkers. To prevent this, establish a "lip" about two to four inches high on the greenside edges of the bunker. There should be no lip on sides or rear of bunkers. There should be no lips on fairway bunkers.

Flags and Flagsticks

Standardization of flagsticks and flags among tournament sites is important to the player who must play a different course every week. Please provide flagsticks of the following specifications:

Material:	Fiberglass
Height:	Eight feet
Diameter:	One-half inch from top to bottom - no taper
Color:	Bright yellow. Solid.
Color of Flag:	Bright yellow. Solid.

Cup Liners

Please provide aluminum cup liners that are in good condition so that the flagstick will stand straight in the hole.

In the event the tournament is televised, please supply a small can of latex base white paint, and a one-inch brush, so that the inside of the cup can be painted at the televised holes.

Filling Divots

Certain areas of the course, particularly short holes, require the filling of divots. A mixture of sand, seed and top soil should be used to fill divots. Care should be taken to ensure the filled divot is level with the surrounding ground. A bad lie in a repaired divot will generate complaints from players.

Riding Greens Mowers

We prefer the use of hand mowers for our tournaments rather than the use of triplex equipment. However, if riding units are used, the perimeter cut of the green should be made with a hand mower.

Rain Preparations

It is important, and vital to the tournament schedule, that equipment be available to remove water from greens when play is delayed by rain. It is often necessary to remove water from the teeing grounds as well. Each sponsor should have twelve squeegees available for each course used in the tournament.

Trees

Fill tree basins (or wells) around trees with soil or mulch. Also, remove support wires and tree wrappings.

Prune low hanging branches to facilitate gallery movement and where they might interfere in the playing of a shot. Tees should especially be trimmed near the teeing ground and greens.

Ground Crew

Discuss hours of work to conform with starting and finishing times for the tournament.

Workers are not to wear heavy cleated shoes or boots while working on greens.

Vehicles

Control vehicles on course and limit to necessary work. Suggest times and routes to avoid congestion and noise while play is in progress. Recommend routes for vehicles used by concessionaires, TV, etc.

Careful attention is necessary when the course is soft or wet, as course damage will result from traffic.

Extra Maintenance Equipment

Two fairway mowing units are a must. Often we encounter weather problems which give little time for mowing. The time of year and the use of two tees for starting are big factors for this requirement.

Signs Identifying Tees and Greens

Identify all holes with hole number, yardage and par on both sides of signs to be located at exits of greens and entrances to tees. Signs should be mounted on a pole to extend eight feet above the ground and made of ½″ x ½″ or 2″ x 2″ lumber. Signs should be 12″ high and 15″ wide. If possible, mount poles in metal pipe or sleeve for easy removal.

Course Design Changes

The PGA TOUR should be notified immediately of any proposed change in the golf course, any flood damage or any work that requires taking a hole out of play or that effects the playability of the golf course.

Water Coolers

Water coolers should be provided on all tees starting Tuesday of tournament week.

Toilets for Contestants/Caddies

A toilet for contestants and caddies only should be provided at approximately the middle of the front and back nines and inside the ropes.

Equipment Requirements for Tournament Preparation

Two (2) mowers for cutting tees.

Two (2) fairway mowing units.

Five (5) single mowings units, or

Two (2) Triplex greens mowers with back-up.

One (1) mower for cutting secondary rough.

Two (2) mowers for cutting primary rough.

Two (2) sets of cup change equipment, extra hammers, stakes, flags, flagsticks, tee markers and adequate paint and spray guns.

It is important that the above equipment be in good working order. All mowing equipment should be sharp, adjusted properly and set at specified heights of cut.

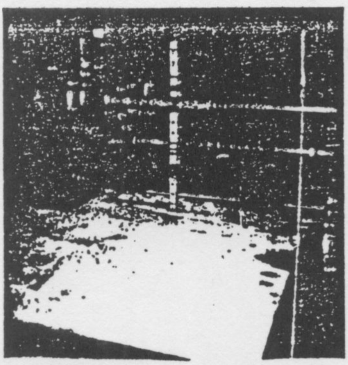
If brushes or combs are used on greens mowers prior to the tournament, they should be removed from the units one week before the tournament play begins. The use of whiele or grooved rollers is acceptable.

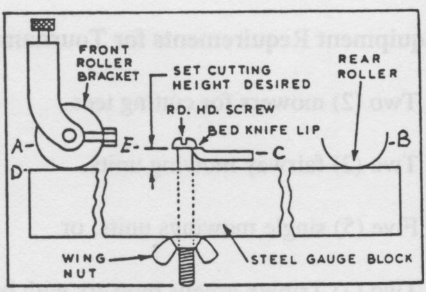
Cup changing equipment should be sharpened before the tournament to insure clean cut, even holes.

Determining Height of Cut

A reel mower operates in the same manner as a pair of scissors. The revolving blades form one cutting edge and the stationary blade (bed knife) forms the other. Height of cut for fairway and rough mowers is determined by placing the unit on a solid flat surface and measuring to the top of the bed knife with a ruler.

To check height of cut on greens mowing equipment, a gauge is used. This is a flat piece of steel with a screw threaded through it. The gauge is placed under the front roller (A) and the rear roller (B) and the crew adjusted until it slides over the bed knife (C). The distance from the top of the piece of steel (D) to the bottom of the screw head (E) is the height of cut.





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This unit rolls excess water off Golf Greens, Tennis Courses and other playing surfaces quickly and easily. The specially formulated seamless neoprene foam rubber roller is abrasion and tear resistant and does not retain water. This eliminates the need for drying to prevent mildew and odor problems.

The balance of the unit is of all metal construction, a hi-strength heat treated and tempered Aluminum alloy. Fasteners and shafts are made from stainless steel and the roller turns in "Oilite" bronze bearings. Handle and crossarm are Gold Anodized.

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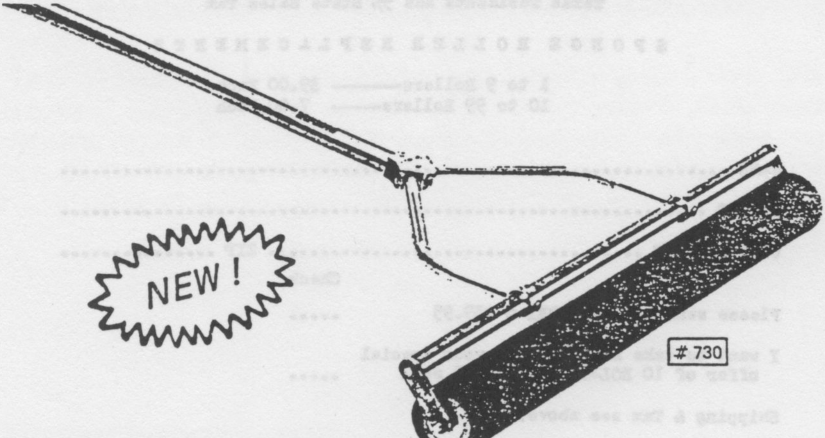

MODEL NO.	ROLLER WIDTH	HANDLE DIA.	OVERALL LENGTH	PRICE EACH
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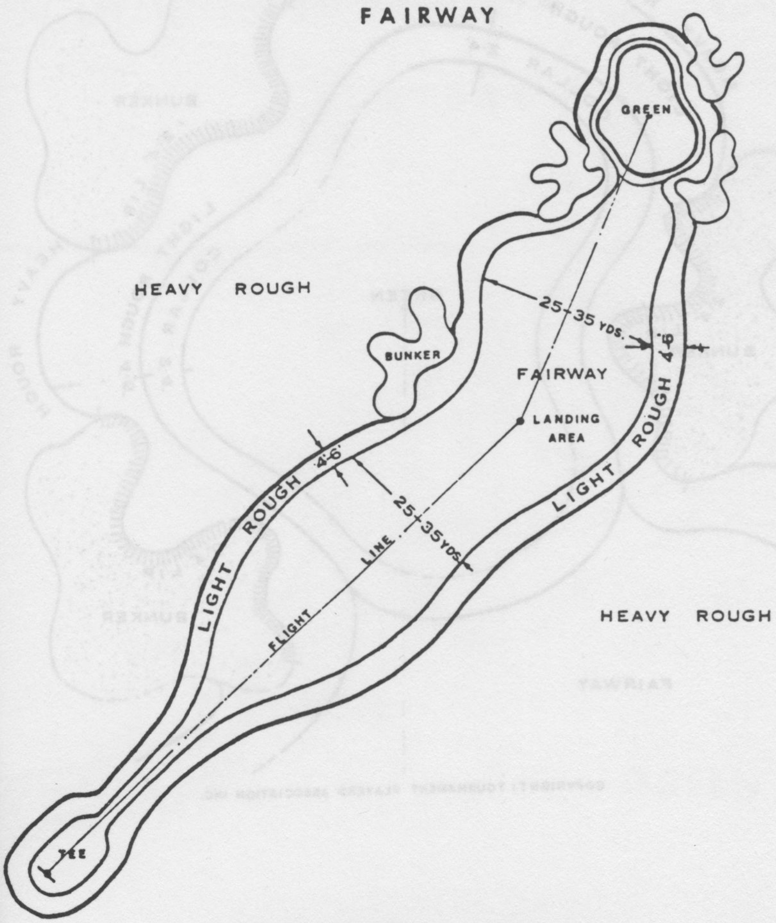
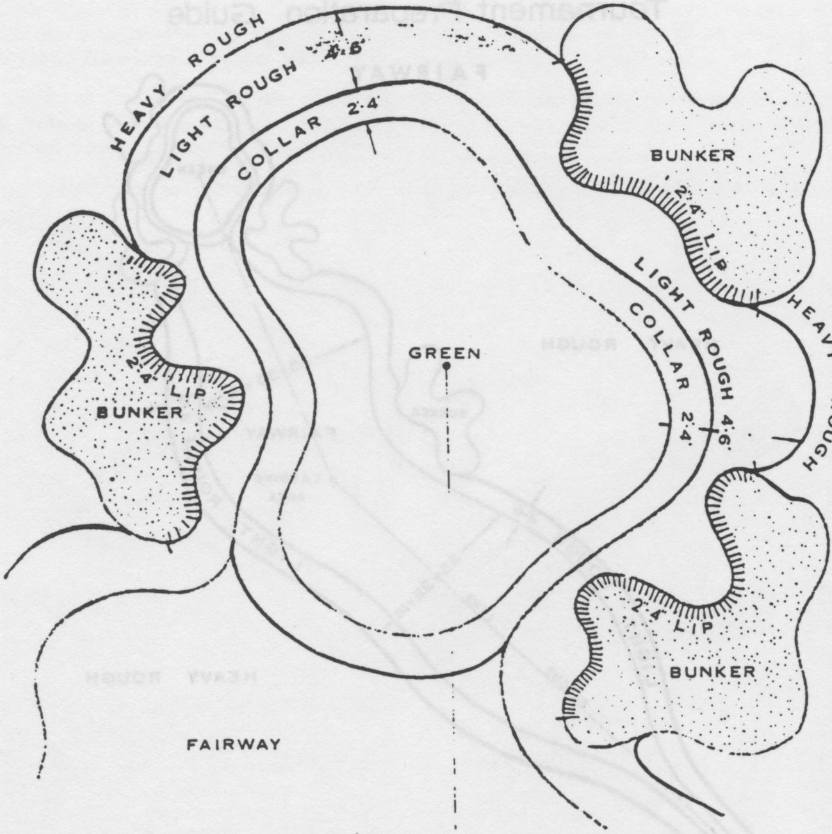


PGA TOUR

Tournament Preparation Guide

GREEN



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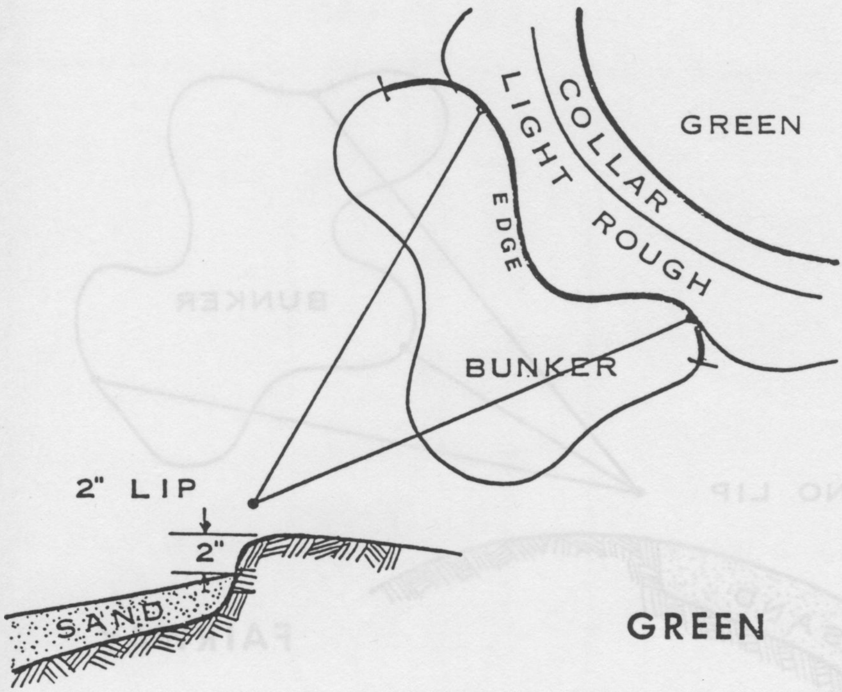
BUNKERS



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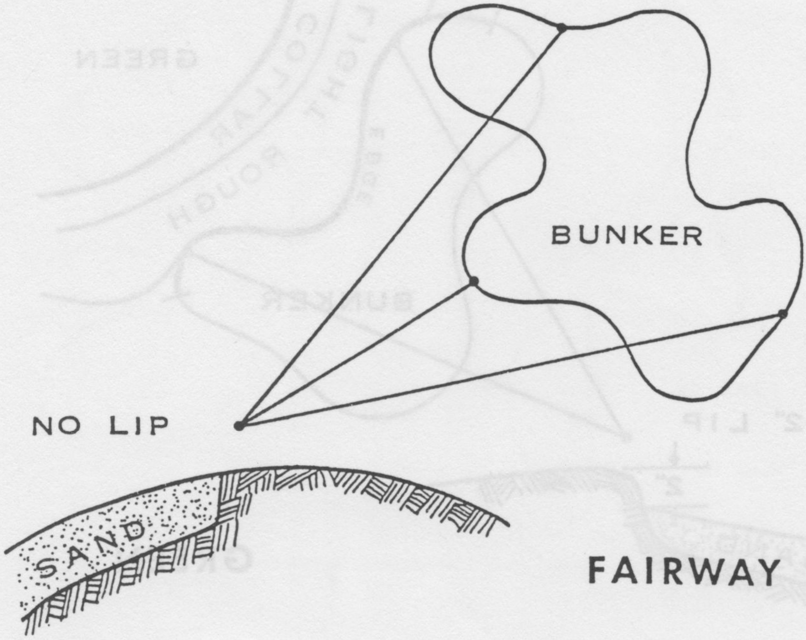
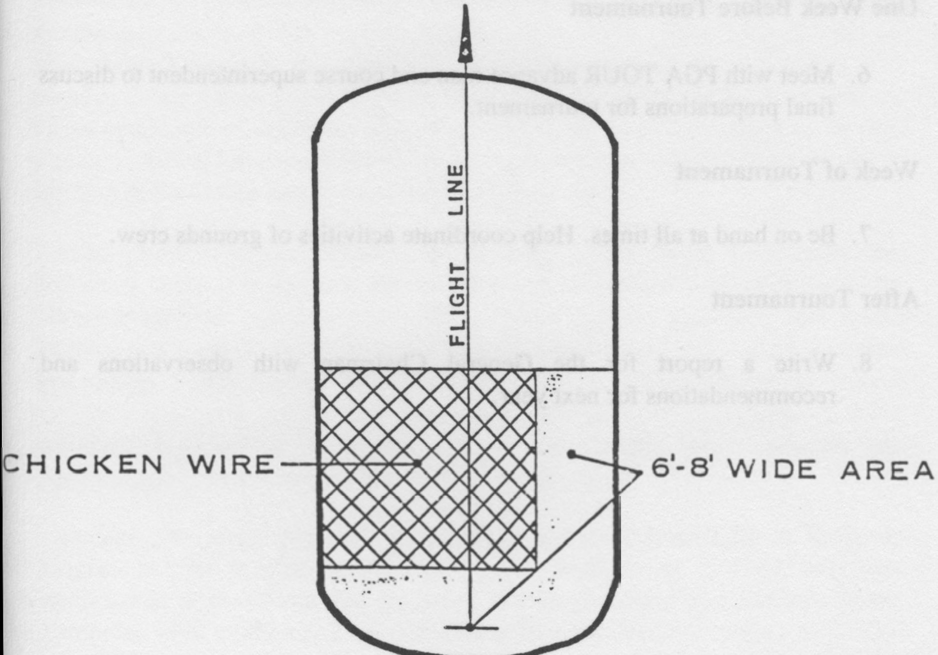
BUNKERS



PGA TOUR

Tournament Preparation Guide

PAR 3 TEES



GOLF COURSE CONDITIONING - CHAIRMAN'S CHECKLIST

Early

1. Organize committee.

2. Meet with golf course superintendent and discuss implementation of PGA TOUR guidelines.

3. Arrange for PGA TOUR Agronomist to visit golf course 3-4 months in advance of event.

One Month Before Tournament

5. Begin periodic inspections of golf course to make sure PGA TOUR requirements are being adhered to with regard to cutting, watering, etc.

One Week Before Tournament

6. Meet with PGA TOUR advance man and course superintendent to discuss final preparations for tournament.

Week of Tournament

7. Be on hand at all times. Help coordinate activities of grounds crew.

After Tournament

8. Write a report for the General Chairman with observations and recommendations for next year.

CRABGRASS CONTROL WITH 'ACCLAIM' (FENOXAPROP-ETHYL) [1]

Dr. William J. Johnston and Charles Golob [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Assistant Professor and Research Technician, respectively, Department of Agronomy and Soils, Washington State University, Pullman, WA

'Acclaim' (fenoxaprop-ethyl) manufactured by Hoechst-Roussel Agri-Vet is a new selective postemergence herbicide that has shown excellent potential for the control of crabgrass (Digitaria ischaemum and D. sanguinalis) in trials in eastern Washington and northern Idaho. Acclaim 1EC is a postemergence herbicide with translocation properties. It is translocated from the site of contact to meristematic tissues (growing points) where it interferes with lipid biosynthesis. This ultimately leads to the death of the target plant.

Although Acclaim will translocate within the plant from the point of contact to meristematic tissue, it will not translocate from one tiller to another tiller on the same plant. Therefore, in controlling crabgrass with more than one tiller, it is essential to get excellent coverage of the plant's leaf surface with the herbicide. Visual symptoms of crabgrass control are expressed as a chlorosis, 4 to 10 days after application, followed within 12 to 21 days after application of a reddening or purpling of the leaves and eventual death of plant tissue.

Although tested only on Kentucky bluegrass (poa pratensis) in Washington State University trials, it is reported that Acclaim can be applied to all cultivars of the following turfgrass species: perennial ryegrass (Lolium perenne), fine fescue (Festuca rubra spp.), tall fescue (Festuca arundinaceae), and annual bluegrass (Poa annua). Weeds reported controlled are: goosegrass (Eleusine indica), smooth crabgrass (Digitaria ischaemum), hairy crabgrass (Digitaria sanguinalis), barnyardgrass (Echinochloa crus-galli), foxtain spp. (Setaria spp.), panicum spp. (Panicum spp.), and Johnsongrass (Sorghum halepense).

Acclaim was tested for crabgrass control and/or phytotoxicity to Kentucky bluegrass in 1986 at Walla Walla and Yakima, Washington. In 1987, tests were conducted at Walla Walla and Pullman, Washington, and at Lewiston, Idaho. Herbicides were applied at 25 to 30 GPA with a $C0_2$ bicycle sprayer with 8002 tips. Crabgrass was generally between the 2-leaf and 2-tiller state of growth during time of herbicide application in these studies.

In 1986 at Walla Walla, Acclaim applied alone or in combination with preemergence herbicides gave excellent control of crabgrass (Table 1). However, slight phytotoxicity was noted on bluegrass (Table 2). Phytotoxicity tended to increase with higher rates and multiple applications of Acclaim. It was observed during the test that Acclaim was very much more phytotoxic on bentgrass (Agrostis spp.) than on bluegrass. Acclaim is not recommended for use on bentgrass turf.

Since Acclaim has no effect on broadleaf weeds, it would be desirable to tank mix Acclaim with broadleaf herbicides. Tank mix treatments of Acclaim were initiated in 1986 at Yakima to determine the effects of several herbicide combinations on crabgrass control. Acclaim alone at 0.18 lb ai/A gave excellent crabgrass control (Table 3). However, when tank mixed with broadleaf herbicides the efficacy was reduced. This reduced efficacy was only statistically true in 1986 for the Acclaim plus Harmony treatment.

Thus, following testing in 1986, several conclusions could be drawn: (1) Acclaim gave excellent crabgrass control, (2) there was potentially some phytotoxicity when Acclaim was applied to Kentucky bluegrass, and (3) some broadleaf herbicides lowered the efficacy of Acclaim to control crabgrass. Further testing was done in 1987 to see if (1) nitrogen and iron (N from 'Fluf' 18-0-0, a regisered product of W. A. Cleary Chemical Corporation, and Fe from a chealated iron Sequestrene-330 Fe, a registered product of Ciba-Geigy Corporation) could reduce Acclaim phytotoxicity to bluegrass without reducing crabgrass control, and (2) there was antagonism between certain broadleaf herbicides and Acclaim that reduced the control of crabgrass by Acclaim.

Phytotoxicity mitigation on Kentucky bluegrass with N and Fe was studied in 1987 at Walla Walla (Table 4) and Pullman (Table 5), Washington. When N and Fe were tank mixed with Acclaim, phytotoxic levels that were slight but noticable and objectionable in a fine turf (levels greater than 2.5), were reduced to approximately 1.0 (Tables 4 and 5). This reduced level of phytotoxicity would not be Roticable in a turf situation unless one had side-by-side treatment comparisons. Also, the tank mix of N plus Fe with Acclaim caused no reduction in crabgrass control (Table 6).

It would appear from data presented in Table 7 that, as in 1986 at Yakima, there was antagonism between certain broadleaf herbicides and Acclaim. At Lewiston, Idaho, there was a general trend toward reduced crabgrass control with all broadleaf herbicides; however, Trimec was the only treatment that was statistically different from the Acclaim alone teatment.

Further testing of Acclaim is warranted in the Pacific Northwest. Based on two years of study of Acclaim by Washington State University the following conclusions could be drawn:

1. Acclaim provided excellent postemergence control of crabgrass.

2. Acclaim caused slight phytotoxicity to bluegrass and fairly severe injury to bentgrass.

3. The level of phytotoxicity by Acclaim on Kentucky bluegrass could be reduced with the use of N and Fe as a tank mix with Acclaim.

4. Tank mixing Acclaim with broadleaf herbicides may cause a reduction in crabgrass control.

This research was supported in part by grants from Hoechst-Roussel Agri-Vet Company Agricultural Chemicals, the Northwest Turfgrass Association, and the Inland Empire Golf Course Superintendents' Association.

Table 1. Crabgrass control of Acclaim plus grassy weed herbicides on bluegrass (with some bentgrass) at Walla Walla, Washington in 1986.

Treatment	lb ai/A	7/11/86	7/25/86
		%	%
CHECK	——	0	0
Acclaim	0.18	97	94
Acclaim + bensulide	0.18 + 15.0	95	95
Acclaim + dacthal	0.18 + 12.0	92	98
Acclaim + pendimethalin	0.18 + 2.5	93	98
Acclaim	0.12	94	97
Accliam + bensulide	0.12 + 15.0	86	86
Acclaim + dacthal	0.12 + 12.0	89	94
Acclaim + pendimethalin	0.12 + 2.5	96	98
Accliam / Acclaim	0.12 / 0.12	94	96
Acclaim / Acclaim	0.18 / 0.18	94	98
LSD (0.05)		10	7

Applied 6/27/86; split application 7/11/86.

Table 2. Phytotoxicity of Acclaim plus grassy weed herbicides on bluegrass (with some bentgrass) at Walla Walla, Washington in 1986.

Treatment	lb ai/A	7/11/86	7/25/86
CHECK	——	0 *	0
Acclaim	0.18	0.7	3.0
Acclaim + bensulide	0.18 + 15.0	0.7	2.7
Acclaim + dacthal	0.18 + 12.0	1.3	3.7
Acclaim + pendimethalin	0.18 + 2.5	0.7	3.0
Acclaim	0.12	0.7	2.0
Accliam + bensulide	0.12 + 15.0	0.7	1.7
Acclaim + dacthal	0.12 + 12.0	0.3	2.3
Acclaim + pendimethalin	0.12 + 2.5	0	1.7
Accliam / Acclaim	0.12 / 0.12	0.7	3.7
Acclaim / Acclaim	0.18 / 0.18	0.7	4.3
LSD (0.05)		1.1	2.4

* 0 to 10; 0 = no injury, 10 = dead turf.
Applied 6/27/86; split application 7/11/86.

Table 3. Crabgrass control of Acclaim plus broadleaf herbicides on bluegrass at Yakima, Washington in 1986.

Treatment	lb ai/A	7/7/86	7/18/86
		%	%
CHECK	——	0	0
Acclaim	0.18	73	95
Acclaim +	0.18 +		
bromoxynil +	0.25 +		
2,4-D	0.25	70	87
Acclaim + Turflon	0.18 + 0.375	83	87
Acclaim + Trimec	0.18 + 1.	77	85
Acclaim + Harmony	0.18 + 0.012	73	52
Acclaim + Matrix	0.18 + 0.016 +	67	77
MSMA	2.0	67	75
MSMA	4.0	70	92
LSD (0.05)		28	34

Applied 6/20/86.

Table 4. Phytotoxicity of Acclaim plus safeners on bluegrass at Walla Walla, Washington in 1987.

Treatment	lb ai/A	6/24	7/1	7/8
CHECK	——	0*	0	0
Acclaim	0.18	0	2.3	2.7
Acclaim + N + Fe	0.18 + 21 + 0.5	0	0	1.3
LSD (0.05)		ns	1.7	1.1

0 to 9; 0 = no injury, 9 = dead turf.
ns = no significant difference among treatments.
Applied 6/17/87.

Table 5. Phytotoxicity of Acclaim plus safeners on bluegrass at Pullman, Washington in 1987.

Treatment	lb ai/A	7/7	7/14	7/21
CHECK	——	0*	0	0
Acclaim	0.18	2.3	3.0	3.3
Acclaim + N + Fe	0.18 + 21 + 0.5	0	0.3	1.0
LSD (0.05)		0.9	1.0	0.9

* 0 to 9; 0 = no injury, 9 = dead turf.
Applied 6/30/87.

Table 6. Crabgrass control of Acclaim plus safeners on bluegrass at Walla Walla, Washington in 1987.

Treatment	lb ai/A	6/24	7/1	7/8
		%	%	%
CHECK	— —	0	0	0
Acclaim	0.18	0	90	90
Acclaim + N + Fe	0.18 + 21 + 0.5	0	92	91
LSD (0.05)		ns	7	7

ns = no significant difference among treatments.
Applied 6/17/87.

Table 7. Crabgrass control of Acclaim plus broadleaf berbicides on bluegrass at Lewiston, Idaho in 1987.

Treatment	lb ai/A	7/1	7/15
		%	%
CHECK	— —	0 *	0
Acclaim	0.18	97	95
Acclaim + Turflon	0.18 + 0.375	93	88
Acclaim + Trimec	0.18 + 1.4	84	67
Acclaim + Starane	0.18 + 0.25	98	97
Acclaim + bromoxynil	0.18 + 1.0	91	82
LSD (0.05)		11	24

Applied 6/17/87.

CHEMICALS USED

Name or Designator	Trade Name	Company
Fenoxaprop-ethyl	Acclaim	Hoechst-Roussel Agri-Vet
Bensulide	Prefar	Stauffer
DCPA	Dacthal	SDS Biotech
Bromoxynil	Buctril	Rhone-Poulenc
2,4-D	several	several
2,4-D + Triclopyr	Turflon	Dow Chemical
2,4-D + MCPP + Dicamba	Trimec	P.B.I. Gordon
DPX-M6316	Harmony	E. I. DuPont de Nemours
DPX-R9674	Matrix	E. I. DuPont de Nemours
Pendimethalin	Pre-M	Lesco

FACTORS INFLUENCING WATER USE [1]

Dr. Victor A. Gibeault [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.
[2] Director and Extension Environmental Horticulturist, Cooperative Extension, University of California, Riverside, CA

Nationally, the total water resources are more than adequate for the current and forseeable population, however, locally, and in certain regions that are largely dependent on decreasing groundwater reserves, water availability, water cost and water quality can be issues of concern. In all areas, the correct use of water resources for turfgrass irrigation makes sense because of the importance of too much or too little water on turfgrass growth and development, and on other primary and secondary maintenance practices performed by turf managers.

Irrigation is normally needed to insure the uniform growth and appearance of turf swards throughout the seasons of use. As a result, a large industry and considerable body of knowledge is devoted to the manufacture, sales and installation of turf irrigation equipment. The technology involved has become highly sophisticated with complex automatic controllers, remote control valves, and specialized heads. This industry and the implementation of the technology should be dependent, from a maintenance viewpoint, on the factors that influence water use by turfgrasses.

Water Use by Turfgrass

Water is absorbed by plant roots translocated through the plant to the leaves and is in large part evaporated into the atmosphere (from plant leaves the process is referred to as transpiration). Water is also evaporated directly from the soil surface. Some water that enters turfgrass is used for growth and development of the plant. The water use rate, therefore, can be defined as the total water used per unit time by plant growth, plus transpirational water use, plus water evaporated from soil. Because water used in plant growth is a very small percentage of the total, most often turfgrass water use is considered to be water evaporated from the soil (E) and water used by plant transpiration (T), or evapotranspiration (ET).

Factors that affect ET can be categorized as environmental aspects, cultural aspects and plant growth characteristics. Environmental factors include the total radiant energy that reaches the turf sward, temperature, wind and relative humidity. Other environmental factors such as the amount of soil moisture, soil aeration and the water transfer characteristics of the soil also influence water use. Cultural practices such as nitrogen fertilization, mowing height and frequency, and the amount of pest activity affects water use rates as does the irrigation practices performed by the turf manager.

Plant growth responses can influence water use rates dramatically. Aspects such as shoot density, the degree of horizontal leaf orientation and leaf extension rate and area are important in this regard.

Turfgrass Water Requirements

Turfgrass species differ in their water requirements. A study recently conducted and completed at the University of California South Coast Field Station attempted to define minimum water requirements of commonly used California turfgrass species. Specifically, it was desired to investigate the effects of applying reduced amounts of irrigation water (100%, 80% and 60% of calculated ET) on cool and warm season turfgrasses. Also, it was desired to evaluate a subterranean irrigation system as a potentially more efficient method of turf irrigation, as compared to standard sprinkler application.

This study showed that overhead sprinkler irrigation provided acceptable turfgrass performance even under regimes of less than optimum water applied with certain turfgrass species. In contrast, subterranean irrigation did not provide acceptable turf, especially with the shallow-rooted cool season species, when used at the depth and spacing in this study. The very deeply rooted hybrid bermudagrass was the best performing species with subterranean irrigation. Significantly less weed invasion was measured on the cool season grasses irrigated with the subterranean system. In conclusion, subterranean irrigation method did not indicate the probability of water savings, or conservation, with this system in comparison to sprinkler irrigation. Instead, most turfgrasses performed better with the sprinkler method when irrigated at less than optimum regimes.

Irrigation by the sprinkler method, cool season and warm season turfgrass appearance ratings, and the water application for the duration of the study (August, 1981 to December, 1983) are presented in Table 1. This table clearly shows the amount of water that was applied to obtain a given performance level of the commonly used turfgrass species. There was no significant difference in cool season grass performance between the 100 percent and 80 percent regimes, although there is a downward trend apparent, which indicates that cool season grasses do have some ''buffer'' in their appearance with less than optimum water applications. This could be described as a potential level of water conservation amounting to a 21.1 percent savings (104.4 inches vs. 82.4 inches). This savings could be tenuous, however, because of more weed activity, disease activity (i.e., Fusarium blight on Kentucky bluegrass), and reduced recuperative potential that could be expected with cool season turfgrasses irrigated at a less than optimum amount of water. Sixty percent of ET significantly reduces the turf quality grass significantly reduces the turf quality of the three cool season grasses.

Hybrid bermudagrass and Seashore Paspalum appearance was not significantly different at 100 percent, 80 percent and 60 percent ET_{grass}. Zoysiagrass did have reduced appearance as irrigation amounts were reduced (note: nematode activity on zoysia roots affected zoysia performance). It appears that both Santa Ana hybrid bermudagrass and Adalayd (Excalibre) Seashore Paspalum were ''buffered'' from less than optimum irrigation regimes. In fact, these grasses had very good diseases, irrespective of irrigation regimes. Clearly, there is potential for considerable water savings with these grasses. This study indicates a 40.4 percent reduction in actual water applied between the optimum and lowest irrigation regime (88.4 inches vs. 52.7 inches).

Because of the field plot design that was necessary for this study, it is not possible to statistically compare turf performance results between the warm season and cool season grasses. However, it is possible to note that hybrid bermuda and Seashore Paspalum performed very well with 52.7 inches of water applied (60% ET_{grass} regime), whereas, the cool season grasses required at least 82.4 inches (80% ET_{grass} regimes). Water savings of 36 percent were noted with the indicated warm season species in comparison to the cool season species. The comparison between 60 percent ET warm season applied water (52.7 grass warm season applied water 52.7 inches) and 100 percent ET_{grass} cool season applied water (104.4) resulted in a 49.5 percent water savings.

Finally, the difference in the actual water applied compared to the ET_{grass} should be noted in Table 1. ET_{grass} is the water in inches that was used by the cool and warm season grasses at the UC South Coast Field Station during this trial period. It is a site and time-specific amount of applied water that is required. The difference between the ET_{grass} and the actual applied water is due to the uniformity of the irrigation system in this study. Actually, the coefficient of uniformity in this study was very high (cu = 87%). Even so, to have a given amount of water applied to 90 percent of the plot area, 35 percent more water had to be applied (Extra Water Factor $_{90}$ = 1.35). This clearly points out the importance of a well-designed, uniform irrigation system when concerned with water conservation on turfgrass sites.

Table 1. A summary of the cool and warm season turfgrass appearance ratings and the water applied for the duration of the study. Performance rating 1-9, with 9 best.

Irrigation Regime	Turf Appearance 8/81 - 12/83			Water Applied (in.)[1] Actual	ET_{grass}
Cool season	Ken. blue	Per. rye	Tall fesc.		
100% ET	5.5 y*	6.2 y	5.8 y	104.4	77.3
80% ET	5.3 y	5.9 y	5.7 yz	82.4	61.0
60% ET	4.8 z	5.0 z	5.3 z	62.7	46.4
Warm season	Bermuda	Paspalum	Zoysia		
100% ET	6.5 ns**	5.8 NS	5.6 x	88.4	65.5
80% ET	6.5	5.8	4.8 y	69.4	51.4
60% ET	6.4	5.4	4.2 z	52.7	39.0

[1] ET_{grass} equals the actual applied water divided by the Extra Water Factor (EWF_{90}) which is 1.35.

* Values folowed by common letters are not significantly different at the five percent unit of probability.

** No significant difference.

In conclusion,, warm season turfgrasses have a greater potential for water conservation than do cool season turfgrasses. Under conditions of this study, sprinkler irrigation was superior to subterranean irrigation for water conservation. And lastly, a well-designed, uniform irrigation system is necessary to maximize water conservation efforts in turfgrass management.

TRENDS IN THE TURFGRASS INDUSTRY [1]

Dr. Victor A. Gibeault [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Director and Extension Environmental Horticulturist, Cooperative Extension, University of California, Riverside, CA

The turfgrass industry in the United States is made up of individuals and groups involved in the design, installation, maintenance, sales and service of turfgrass, and the educational and developmental aspects of this industry. Its expansion has largely occurred since World War II and can be attributed to the continued urbanization of the U.S. population, and to increases in leisure time, discretionary income, demand for (and ability to pay for) amenities, and population.

FACTORS INFLUENCING TURFGRASS INCREASE

Urbanization. During the past one hundred years, the United States has shifted from an agricultural society, with most residents living on farms, to an industrial society, with most residents living in urban, suburban, or small town locations. We are now entering an informational society which will also have an urban, suburban, or small town population structure. Although few people have been ''freed'' from the toil of an agricultural society, they are now removed from intimate contact with nature.

Leisure Time. Human life, as related to time, can be viewed in three categories: existence time, subsistence time, and leisure or discretionary time.

Existence time. Time spent to stay alive—eating, sleeping, and caring for one's health—is existence time. As a percentage of total human time, it has not changed much throughout human history.

Subsistence time. In contrast, subsistence time has greatly decreased, especially in the last few decades. Subsistence time is that time spent making a living or preparing to make a living. Not only has the total number of work hours per week declined, but the arrangement of work time has been influenced by such concepts as flextime, work sharing, time-income tradeoffs, leaves without pay, sabbatical leaves, and graduated retirement.

Leisure/discretionary time. As susbsistence time has decreased and changed, leisure time has increased. Leisure time is defined as spare time we are free to use for rest or do with what we choose. The growth and size of the turfgrass industry is closely associated with the availability of true leisure or discretionary time for a large percentage of the population.

Discretionary income. In addition to discretionary time, discretionary income has increased substantially for the average citizen. Discretionary income—money left after necessary expenses have been paid—results from real growth in salaries, increases in two-income households, or the instituting of social programs based on income redistribution. The result has been the availability of more money for spending in a discretionary manner. Spending this money for recreational pursuits or beautification of property has had a large impact on the turfgrass industry.

Desire for amenities. With urbanization and increased discretionary time and money, a general desire for positive surroundings has evolved. Turfgrass within the total planned landscape is a significant aspect of the amenity value of an environment.

Population increase. The amount of turfgrass acreage apparently coincides with population size. As the United States population continues to increase, so, too, will the amount of turfgrass acreage.

FUNCTIONS OF TURF

Many recreational facilities depend on a uniform, well-maintained turf sward as a medium of play. Common examples include golf courses, bowling greens, picnic areas and parks, soccer, lacrosse, polo, baseball and football fields, and school grounds. Turfgrass provides the smooth surface required for many of these recreational activities and sites and also provides a safety "cushion."

Additionally, turfgrass along with trees, shrubs, groundcovers and flowers is an important part of public and private gardens. Because gardening is a popular leisure-time activity, lawn maintenance can be a constant source of challenge and pride for those who enjoy this activity. And, finally, turf affects peoples' lives when used in an ornamental setting to create the desired aesthetic appearance.

Turfgrass not only influences our lifestyles but also our environment. Turfs and other plant material reduce discomforting glare, especially in urban areas with buildings, metal, and concrete. Likewise, turfgrass, along with properly placed trees and shrubs, can considerably reduce traffic noise. Soil erosion is reduced or controlled by turf, and chemical and particulate air pollution is decreased at the turfgrass surface. Because of transpirational cooling, turf modifies high temperature by heat dissipation. (The obviously different temperature felt when standing on an asphalt pavement in comparison to a nearby turfed site is recognized by all.)

Certainly turfgrass is an important, positive modifier of our environment, and the turfgrass industry is an obvious source of economic activity. Recreational facilities and general lawns require regular maintenance, a sizeable category of economic activity. A second category of economic involvement is manufacturing—the production of equipment, fertilizer, chemicals, seed, sod, and other supplies. A service category includes individuals, groups, or firms— distributors, architects, contractors, and consultants—who provide services for the facility and manufacturing categories. Lastly, an institutional category involves those who conduct research and education to support the industry.

Trends that now appear to be a lasting influence on this turfgrass industry include the following:

- Increased facility use: Two or more professional income families have high earning potential and spending capability. They want high quality recreational facilities and are able to pay for them. Oppositely, low income, service jobs are plentiful. Available discretionary time will result in the heavy use of public facilities such as parks and school grounds. This economically polarized society will heavily use turfed facilities, and wear tolerance of turfgrasses will become a major issue as will the safety aspects of facility construction and maintenance.

- Minimum maintenance: Because of the questionable availability of water and adequate budgets, the concept of minimum maintenance will be adapted widely. Research programs currently underway (supported by the USGA, GCSAA and other private funding sources) are aimed at the improvement of turf grasses that will use half the water and require reduced maintenance inputs. Closely associated with this concept will be the increased use of alternative plant materials, including natives, in ornamental or non-play areas in our turfed landscape.

- Advances in technology: Fortunately, we can expect a continuation of technological advancement in plant improvement (with use of biotechnology), Integrated Pest Management, cost and fuel efficient equipment, irrigation equipment improvement and real-time water use determination, and the continued integration of the computer into turf maintenance operations.

- Education: The continued education of turf personnel will be essential given the increased complexity and dynamic rate of change of our industry. It is expected that educational opportunities from the public and private sector will continue to increase.

In summary, current trends indicate the turfgrass industry will be composed of facilities that are heavily used, that the industry will have rapid technological advances and a dynamic nature relative to change, that less natural resources will be available and resources and personnel will cost more. Continuing education for turf managers will be important.

ON BEHALF OF AN ENDANGERED RESOURCE [1]

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I'm speaking briefly today on behalf of an endangered resource - *water!* While we can waste water and energy in a variety of ways, I'll confine my remarks to what we - you and I can do - in the industry in which we make our living. I should go further to say that I know water and energy may be a little bit more abundant and less expensive here than Southern California, for example, but the need to conserve is still critical here as in other areas.

The irrigation industry has a responsibility both to "society", the environment, and itself to continually work toward the conservation of both water and energy. There are many ways to waste water and energy in irrigation system design and operation, but the three areas with the greatest potential for waste are:

1. High Application Rates

2. Poor Distribution

3. Poor Scheduling

High Application Rates

Most soils have a moisture intake rate of less than .2″/Hr., yet many sprinkler systems apply water at rates well above 1″/Hr. If such a system were scheduled to apply .25″ of water per day in a single daily application, the 15 minute running time would allow only .05″ or 20% of the water applied to penetrate the ground. 80% would be wasted as run-off. The only solution to this problem without changing sprinklers is to schedule five 3 minute applications spaced 1 hour apart. This is far too much to expect from a manual operator of the system. It is beyond the capabilities of most automatic control systems, and such scheduling is rarely used, even when the capability exists.

A far better and more economical solution to the problem is to use equipment and system designs that apply water at the same rate as the intake rate of the soil.

Poor Distribution

When the precipitation rate of the sprinkler system is matched with the intake rate of the soil, system uniformity of distribution becames a great factor in water and energy waste.

The theoretical precipitation rate for any system is easily calculated using the flow rate through the sprinkler relative to the amount of area covered. This, however, is the AVERAGE precipitation rate for the system. In reality, most areas of the system will have precipitation rates either lower or higher than the theoretical rate.

In order to avoid dead or stressed areas on turf or landscaping, the sprinkler system must be operated long enough to apply sufficient water to the areas of the system with the lowest precipitation rate. For example, consider a system with a theoretical or average precipitation rate of .5″/Hr. If .5″ of water were required, and if the distribution were perfect, obviously, you would run the system for one hour. However, should the driest spot in the system have a precipitation rate of only .25″/Hr. (which is quite common in systems today), in order to get a minimum of .5'' of water applied to the entire lawn, the system would have to be run for two hours, and fully half of the water applied would be wasted. This ratio of the average precipitation rate to the lowest precipitation rate within the system is called the SCHEDULING CO-EFFICIENT. In this case the scheduling co-efficient is 2.0. It is incumbent on the manufacturer and the designer to do everything in their power to assure that the scheduling co-efficient is as low as possible.

Poor Scheduling

The final key in the conservation equation is proper scheduling. A system with the proper precipitation rate and an outstanding scheduling co-efficient will still waste water if it is not operated properly. The ''guess work'' must be eliminated from the scheduling problem, and many people and companies are working very hard on the problem. Consequently, there are many approaches to the problem.

The goal of proper SCHEDULING, very simply, is to replace the moisture in the soil lost to evapo-transpiration. This big word simply combines moisture lost through evaporation (evapo) and the moisture used by plant material (transpiration). Two general approaches are presently being pursued to measure evapotranspiration. One measures weather activity, and the other measures the actual moisture in the soil. Both are capable of accomplishing the task, though it remains to be seen which is the better approach.

Weather activity (precipitation, temperature, humidity, and wind) certainly is directly related to scheduling requirements, but measurement of this activity can be complicated and expensive and therefore out of reach for many smaller irrigation installations.

Soil moisture has historically been difficult to measure both automatically and reliably, and proper incorporation of soil moisture content information into automatic controller operation is lacking. Also, many moisture measuring systems do not actually measure the moisture available for plant consumption.

This is extremely important, because, for example, clay soils can hold tremendous amounts of water, but plants can extract only a small percentage of that moisture. This contrasts with sand which can hold much less moisture, but most of it is available for plant consumption.

Much work is being done on these problems, however, and the day will come when scheduling matched with evapotranspiration will be taken for granted. The sooner, the better.

Now, to one of the projects we are working on at Hunter Industries in addition to manufacturing turf sprinkler heads. This project involves a water distribution software package in final stages of development which provides the capability to analyze water distribution with the precision necessary to determine the most efficient use of water. The basic unit of analysis for water distribution is the sprinkler discharge profile, and precise water distribution analysis requires accurate representation of these profiles. In order to facilitate accurate representation of water distribution, Hunter Industries will develop and continually update a comprehensive library of profiles which will be made available to water distribution software users on a subscription basis. Profile data will be produced in Hunter's new water test facility with additional testing and verification performed at the Center for Irrigation Technology (C.I.T.) at California State University, Fresno.

The water distribution software is a ''stand-alone'' program that will run on any IBM compatible PC using a math coprocessor chip and a standard monochrome (640x200 pixels) or EGA color (640x350 pixels) monitor. The following are a few of the program highlights:

* A user friendly interface employing pull down menus.

* The ability to create, edit, store, retrieve, and print sprinkler profiles.

* The ability to enter sprinkler profiles in any unit of measure and then normalize the data to Inches/Hour.

* The ability to provide a graphical representation and statistical analysis of the water distribution for sprinkler layouts.

* The ability to graph the Scheduling Coefficient and the Coefficient of Uniformity as a function of water pressure, sprinkler nozzle, and spacing.

* The ability to analyze matched precipitation layouts.

* The ability to output results in Metric units.

Phase I software as I have just described will be available in March at a cost of $149. Users may subscribe to semi-annual releases and updates of profile data through Hunter Industries. Profile data will also be available through C.I.T.

The second phase of water distribution will have the ability to exchange AutoCAD files with the Hunter Irrigation Design Tools and analyze the water distribution of a resultant design. The effect of wind on water distribution will be analyzed as test data becomes available. Additional features will incorporate a mouse and plotter interface. At this point, I would like to introduce the program's developer, Larry Hopkins, who will be happy to answer any questions you might have after today's meeting, or you may contact him at Hunter.

Thank you for letting me take up some of your valuable time today. If you're ever in the San Diego area, stop and see us.

Thanks again.

MAINTAINING HEALTHY POA ANNUA [1]

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To understand Poa annua culture we need to focus first on how and why it invades turf. Next we need to consider how it differs from other planted grasses so we can figure out its cultural needs.

Annual bluegrass invades turf via seed that comes as a contaminant in purchased seed stock or via seed from plants in surrounding areas or in the seedbed. Initial invasion is generally slow and may take 5-10 years to make up 25% of the grass stand. Further increase is rapid and Poa annua will often dominate turf within 2-3 years after reaching the 25% mark. The actual encroachment rate depends on the characteristics of the turf it is invading and the type of cultural practices that are commonly used.

Turf subject to any regular disturbance which reduces turf cover will be invaded rapidly. For example, non-irrigated lawns may be dominated by annual bluegrass quickly because the turf goes dormant and thins out. Heavy wear areas with compacted soils generally lack turf which allows Poa annua to invade when conditions are optimum for germination. Regular aerification and periodic topdressing also open up turf and provide an excellent avenue for Poa annua invasion. Regular vertical mowing which thins turf is conducive to Poa annua encroachment. planting poorly adapted grasses which are unable to maintarn density throughout the year facilitates annual bluegrass invasion.

Disturbance is necessary for annual bluegrass to invade turf areas but there are other factors that play a role in the process. Poa annua is typical of colonizing species in that it develops quickly once it germinates. It is perhaps the only grass we grow that can make the change from juvenile to mature form under the extremely low mowing heights on putting greens. Further, Poa annua seed buried in soil may remain viable for up to 6 years or longer and is constantly being introduced to the surface by cultural practices such as coring and vertical mowing.

Poa annua is uniquely suited to invade turfgrass plantings. It thrives in disturbed environments and persists as a community due to its prolific seed production and the persistence of its seed in soil. It is a strong competitor in part because it matures rapidly when compared to other grasses.

Once Poa annua invades and dominates turf it is subject to different conditions. In well maintained turf the many diverse phenotypes of Poa compete with each other and a gradual shift occurs towards fine textured types with a high capacity for tillering. These are almost exclusively perennial types. In poorly maintained turf there is strong selection for rapid growing prolific flowering types. Genetic diversity stays high and the Poa is largely transient, often following the pattern of a true winter annual. Regardless of the maintenance conditions Poa annua generally remains phenotypically diverse and never achieves the uniformity we associate with domesticated grasses.

Because Poa annua invasion typically occurs at sites there planted grasses cannot compete, (shade) or will not persist (compacted soil) it is often growing under significant environmental stress. This gives the false impression it is a weak, shallow rooted grass with poor stress tolerance. In reality, annual bluegrass ranks intermediate in most categories of stress tolerance. What keeps Poa annua competitive in stressful sites is its ability to reinvade from seed after injury has occurred.

Now we come to the real purpose of this discussion, "How can we maintain healthy Poa annua "indefinitely?" As with most other grasses the answer appears to be proper fertility, proper soil conditions, and proper irrigation. Disease control is also an important part of the equation.

1. FERTILITY

Since soil acidity is closely linked with soil nutrient content we'll consider it in this section. Kamp (1981) used a survey technique to relate prevalence of common turfgrasses to existing soil pH. Poa annua was scarce at pH 5, increased significantly between pH 5.0 and 5.5, and again between pH 5.5 and 6.0. It reached a peak between pH 6.0 to 7.0 and declined dramatically above pH 7.0. What this tells me is that Poa annua is adapted to a wide range of soil pH's with an optimum probably in the range of 5.5 to 6.5. Below pH 5 availability of base cations decreases and soluble aluminum increases which may well be toxic to Poa annua roots. What we might expect from Poa annua turf under low pH conditions is a very weak root system and sensitivity to drought and possibly anthracnose or Drecschlera blights. Above pH 7.0 phosphorus availability may decline which could affect Poa performance. High pH soils often have high soluble salts and Poa annua has poor salt tolerance.

PHOSPHORUS

Phosphorus nutrition has often been linked with Poa annua invasion. In Kamp's (1981) study, annual bluegrass occurrence increased as soil phosphorus levels increased. Earlier studies (Juska and Hanson 1969, and Sprague and Burton 1937) also indicate that annual bluegrass grows better at higher phosphorus levels. Regular phosphorus fertilizer improved stand density and sumner survival (Dest and Allinson 1981). However, in a recent study (Dest 1987) phosphorus fertilization had no effect on species composition in a mixed stand of bentgrass and annual bluegrass.

It appears that annual bluegrass does respond better to high phosphorus than grasses such as colonial bentgrass and red fescue. The big question is what exactly is happening. While we commonly claim that high phosphorus stimulates root development there is little real evidence that this is true. Most studies show increased rooting when phosphorus is added to alleviate deficiency conditions. Higher levels don't appear to stimulate greater root growth, however. It may be that high soil phosphorus affects seed production resulting in more viable seed under high phosphorus nutrition than under low. It's hard to evaluate the role of phosphorus under field conditions. Many turf areas have been repeatedly fertilized with high levels of phosphorus for many years so that soil levels are extremely high. Under these conditions, changes in fertilizer balance may not affect the turf.

To insure adequate phosphorus levels it is important to maintain soil and thatch pH somewhere in that optimum range of 5.5 - 6.5. It is my opinion that phosphorus is best applied regularly in balance with other nutrients rather than in periodic large doses. Phosphorus applications should always accompany aerification to maximize depth of placement. This may be particularly important in soil greens where surface applied phosphorus will stay right where it is put due to low solubility and limited leaching. I doubt if most annual bluegrass turf areas benefit from phosphorus levels greater than two pounds P_2O_5 Per 1000 sq. ft. Per year but there really isn't much research to draw from on this question.

POTASSIUM

Numerous research studies have linked potassium to drought, desiccation, and cold tolerance of grasses. Recent research indicates we have generally underestimated the importance of potassium in turf culture (Shearman 1986). Recommended nitrogen/potassium ratios have changed from as high as 4:1 to as low as 1:1. (Shearman 1986). Kamp (1981) found annual bluegrass was more likely to be found at intermediate to high levels of soil potassium than at lower levels.

Sandy soils or sand based turf areas are likely to contain too little potassium to insure healthy annual bluegrass. Since potassium is prone to leaching in these soils it needs to be applied regularly in small amounts rather than occasionally at high levels.

Nutritional needs of heavy textured soils are harder to predict. Many soils with high clay or organic matter contents tend to fix or at least retain potassium in exchangeable form. Soil tests often read very high in K_2O for these soils. Can we assume that high soil test levels mean potassium fertilizer is not needed? The answer probably depends on how soil samples are made. A four inch deep soil sample from a turf with a 1″ root system may not reflect the status of potassium in the root zone. This is particularly so if a large percentage of the roots are growing in the thatch layer. Soil samples should include only the functional rootzone if test values are to mean anything.

To insure adequate potassium levels I feel potassium should be applied frequently and in balance with N and p. Remember that in sand soil tests will always be low and in soil the tests may not reflect the actual availability of K in the rootzone.

NITROGEN:

Nitrogen fertilization is an important key to healthy Poa annua. The amount of N applied and the source of the N are two critical considerations.

Amnonium based fertilizers, particularly ammonium sulfate appear to have deleterious effects on annual bluegrass. The acidifying effect of these fertilizers may explain why Poa annua stands become weak and prone to diseases such as anthracnose as well as other environmental stresses. In the case of amnonium sulfate, sulfur itself may play a role in decline of Poa annua. It isn't entirely clear what causes toxicity and it may be a combination of factors. But it is clear that to maintain healthy Poa annua avoid prolong use of acidifying nitrogen sources and particularly ammonium sulfate in developing a fertilizer plan. The same caution applies to sulfur coated urea on these areas.

There is a difference between occasional applications of SCU or ammonium sulfate and a steady diet of these materials. Discrete use will help you supply adequate sulfur for nutritional needs without jeopardizing Poa annua vigor. Long term use may lead to symptoms such as poor rooting, increased wilting, and increased summer diseases. These symptoms may take a long time to show up so you need to scrutinize your nitrogen sources carefully.

Nitrogen from urea and natural organic sources may be the preferred sources. Nitrate sources are also acceptable. This is an area where we need a lot more information than we now have.

The past twenty years have been like a roller coaster ride as far as nitrogen levels are concerned. For years 8 - 12 lbs of N per 1000 sq. ft. per year was the standard. Since the 1970's we have moved lower and lower in our application rates. By the early 1980's some people reported applying as little as 3 lbs N per 1000 sq. ft. per year on putting greens. What is the optimum (N) application rate for healthy Poa annua? I believe most people will find 6 lbs of N per 1000 sq. ft. per year plus or minus 1 lb. will probably be about right. Too little nitrogen will leave you with Poa annua that grows slowly and has a relatively high proportion of mature to senescing shoots prone to such vague diseases as anthracnose and possibly Drecshlera blights. Too much nitrogen stimulates excess growth and may increase susceptibility to Fusarium patch disease.

In general terms the key to nitrogen fertilization of Poa annua lies in maintaining growth and tillering without over stimulating growth. To achieve this you'll probably see better results from frequent fertilization at relatively low rates as opposed to high rates applied infrequently. The trick is to keep the Poa annua healthy enough to avoid stress related summer diseases,

FERTILIZER BALANCE:

Nutritional balance for healthy Poa annua probably means a ratio of $N:P_20_5:K_20$ of 3-1-2 to 3-1-3 with complete fertilizer applied at regular intervals. Total N on soil greens or athletic fields will probably be in the range of 5 - 7 lbs N per 1000 sq. ft. per year spread throughout the growing season. Total N on sand based turf may run higher on young turf but will probably be in the 5 - 7 lbs N range for mature turf that is several years old. Liming should be targeted for the thatch and effective rootzone to achieve pH's in the 5.5 - 6.5 range. It is not clear what the micro element needs of Poa annua are.

I feel Poa annua will always be healthier if it is not nutritionally stressed. Make sure you are using balanced fertilizers with proper ratios of $N:P_20_5:K_20$. Avoid zero phosphorus materials formulated for bentgrass greens.

2. SOIL CONDITIONS

Aside from soil pH the critical factor for healthy Poa annua is soil aeration. I feel the increase in stress induced problems with Poa annua can often be traced to inadequate coring practices. In recent years the trend has been towards aerifying earlier in the spring and later in the fall than was once common. A turf aerified in March and October may go up to 6 months between aerations. Heavy play coupled with intense mowing and irrigation leads to severe compaction. Compaction and wet soils leads to shallow rooting and turf that generally is under a great deal of stress.

We need to time coring of annual bluegrass according to its root growth patterns during the year. Significant root growth will generally occur in fall through winter in mild climates and in spring prior to flowering. Root growth declines dramatically during peak flowering (Karnsk et al 1982) and then resumes with new tiller growth in early summer. Growth declines again during mid to late summer when soil temperatures are high. Following this cycle, it appears the logical times for coring are early spring before flowering, early summer after flowering, and fall once soil temperatures have dropped but before they get too low for active root growth to occur.

The early summer coring combined with the others will maximize potential rooting or so it appears. This is another area where there is limited research to work from. My experience tells me that with Poa annua more aeration is better than less aeration.

An added benefit of coring is the continued disturbance which results in burial of fresh seed and planting of seed brought to the surface in plugs. Where soil permits, core shredding may further contribute to seed reserves in the surface profile. In this situation the early summer coring may be particularly beneficial.

3. IRRIGATION

Poa annua encroachment is definitely enhanced by over irrigation. However, that doesn't mean Poa annua turf thrives under continued over irrigation. The key is to maximize the effective rootzone via coring, proper PH, and balanced nutrition, then irrigate to provide enough water for healthy Poa annua. Too much water reduces soil oxygen and leaves you with a very shallow root system and turf that is very sensitive to environmental stress and stress related diseases. It probably isn't advisable to practice stress to stress irrigation with Poa annua. However, you should determine what the practical limits are for irrigation frequency before you blindly irrigate every night.

4. DISEASES

Much of the problems we associate with annual bluegrass involve diseases. In the Pacific Northwest annual bluegrass generally suffers from two types of diseases. Diseases such as Fusarium patch (pink snowmold) and Typhula snowmold are predictable and damage healthy as well as stressed turf whenever climatic conditions are conducive for fungal activity. Diseases such as anthracnose, Helminthosporium, Bipolaris, and Curvularia are most commonly found when annual bluegrass is under cultural and environmental stress.

In the first case (ex. Fusarium) careful fertilization will reduce disease severity but will not eliminate the need for fungicide applications. Indiscriminate fertilization with high levels of nitrogen in fall and winter will generally increase snowmold diseases. Poa annua under stress from high levels of sulfur will generally be injured worse than healthy grass.

Stress related diseases such as anthracnose are more difficult to deal with because they are nearly always associated with cultural and environmental stress. Under stress conditions, fungicides are often ineffective which leaves turf managers helpless at the worst possible time. To minimize these disease problems it is critical that you develop cultural programs to alleviate stress as discussed earlier.

Stress related diseases are hot topics of debate among pathologists. In the case of anthracnose some argue that it isn't even pathogenic (Couch 1979), while others feel it is a serious pathogen (Vargas 1985). Others feel anthracnose is part of a larger problem (Jackson, 1985, Smiley 1983). Smiley (1983) wisely points out that the sporadic and variable severity of anthracnose caused by Colletotrichum gramincola may be due to pathogenic races of the fungus. Jackson (1985) concluded that anthracnose itself may not be highly pathogenic but may injure turf predisposed to attack by parasitic nematodes and other fungi. I don't feel we know as much as we need to know to develop reliable and effective controls for stress related disease. Until research finds answers, turf managers will need to avoid stress related diseases through careful turf culture.

CONCLUSIONS

Long term culture of annual bluegrass requires careful and knowledgeable maintenance. Managers need to provide balanced fertility with careful choice of nitrogen sources. Soil pH should be in the optimum range of 5.5 - 6.5. Regular coring. To provide disturbance and maintain soil aeration is important. Careful irrigation providing adequate water but avoiding drought or saturation is critical. Used in concert these practices will minimize stress which predisposes annual bluegrass to vague and complex diseases such as anthracnose. Judicious use of fungicides on common diseases will further enhance turf quality.

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NITROGEN USE EFFICIENCY ON SAND [1]

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The choice of nitrogen fertilizers or nitrogen fertilizer combinations may be a an important decision in improving nitrogen use efficiency whether it is being made by turf managers or product formulators. The nitrogen from different nitrogen sources is available to plant roots at different rates, in different forms and under different environmental conditions. In addition, nitrogen used on sand grown turf may be subject to leaching during heavy rainfall or excess irrigation which may move soluble nitrogen beyond the effective bounds of the grass root system. All these factors can and do have an impact on the nitrogen efficiency which occurs in turfgrass systems.

No studies have been conducted on turfgrass in the northwest which provide insight in the fate of applied nitrogen. This is a preliminary report of some of the findings from 1986 associated with nitrogen application to 'Penncross' colonial bentgrass (Agrostis palustris Huds.) putting turf grown on peat amended sand lysimeters.

Following the period of establishment, during the summer of 1984, plots receiving different nitrogen sources were harvested with a Toro Greensmaster walking mower up to three times weekly through 1985, 1986 and early 1987. Each sample was dried, weighed and analyzed for total nitrogen. All leachate was collected from each of the lysimeters and analyzed for soluble nitrogen. Turf quality was monitored on a regular basis. Sand residual nitrogen at the end of the study was determined.

Total growth was significantly higher for ammonium sulfate than other sources tested and growth for UF was significantly lower than for all other nitrogen sources (Table 1). All other nitrogen sources (urea, urea plus $MgCl_2$, ammonium nitrate, oximide, IBDU and SCU) showed total annual growth similar to one another. The distribution of growth by month with each of the nitrogen sources tested was closely parallel to one another, except during winter periods when little significant growth occurred with any nitrogen source. Although nitrogen sources significantly produced different amounts of growth, it appeared no one nitrogen source produced greatly different growth on a monthly basis than was apparent on an annual basis.

The average annual turf quality was significantly higher for ammonium Sulfate fertilized bentgrass but the average annual turf quality of urea, ammonium nitrate, oximide, and SCU were grouped below but close to ammonium sulfate (Table 1). Urea plus $MgCl_2$ and IBDU turf quality were significantly lower than the above sources with the annual turf quality of UF fertilized bentgrass significantly lower than all other sources included in the test. Turf quality of bentgrass as influenced by nitrogen source, assessed on an average monthly basis, was not parallel as it was for growth. The average monthly turf quality of urea plus $MgCl_2$ was strongly depressed during the spring and early summer as opposed to urea alone while the fall turf quality of urea plus $MgCl_2$ was better. Also SCU turf quality from from July to October was low (and Urea in September-October) as compared to other nitrogen sources which did not reduce turf quality.

Average annual total nitrogen content of turf clippings were significantly higher for SCU and ammonium sulfate and significantly lower for UF as compared to the other nitrogen sources in the study. However, these rather small differences in tissue nitrogen content when multiplied by annual growth estimates produce more variation in nitrogen grow-out (recovery) (Table 1). By far the least nitrogen was grown-out in UF treated plots compared to all other sources and by far the greatest amount of nitrogen was grown-out by bentgrass in ammonium sulfate treated plots. SCU, oximide, ammonium nitrate, urea plus $MgCl_2$ and urea were similar in total nitrogen grow-out.

On the basis of nitrogen applied to the turf areas within one season, about 58 percent of the nitrogen was grown-out in ammonium sulfate plots. From 42 to 51 percent of the applied nitrogen was grown-out where all other nitrogen sources were applied except UF where less than 30 percent of nitrogen applied was recovered in the annual clippings.

The quantity of nitrogen retained in the sand and organic matter in the lysimeters changed greatly during the study. Only six percent total nitrogen was measured in the top six inches of sand of ammonium sulfate fertilized lysimeters. In UF fertilized lysimeters, 14 percent total nitrogen was measured. Likewise, oximide and Urea plus $MgCl_2$ showed total nitrogen levels of about 10 percent.

Without considering leaching losses which have not yet been summarized, 75 percent of the ammonium sulfate nitrogen applied to lysimeters could be accounted for in the sand substrate upper profile and clippings collected from the lysimeters during 1986. This equivalent value was approximately 68 percent for urea, 67 percent for urea plus $MgCl_2$ 65 percent for ammonium nitrate, 62 percent for UF, 58 percent for oximide, 55 percent for SCU, and 52 percent for IBDU.

The data and interpretations presented here represent an initial analysis of observation made in 1986. A great deal more data have been collected. When nitrogen movement data are completed a total balance sheet can be determined for nitrogen applied to sand in similar environments.

Table 1. Average total annual growth, average annual turf quality and percent nitrogen recovery in tissue of colonial bentgrass turf on sand lysimeters at Puyallup, Washington in 1986 (Brauen)*.

Nitrogen Source	Clipping growth (g/m^2)	Turf** quality (9 = best)	Nitrogen recovery (g/m^2)
Urea	489 b	6.41 b	24.19 b
Urea + $MgCl_2$	466 bc	5.49 c	22.85 bc
Ammonium nitrate	487 b	6.51 b	23.81 b
Ammonium sulfate	571 a	7.22 a	30.13 a
Oximide	452 bc	6.49 b	21.83 bc
IBDU	437 c	6.25 b	20.65 c
Sulfur coated urea	458 bc	6.11 b	23.45 b
Urea formaldehyde	327 d	4.48 d	13.92 d
LSD (.05)	38.7	0.47	2.55

* Represents a preliminary summary of 1986 data. Means within a column followed by the same letter are not different significantly at the .05 confidence level.

** Rating from 1 to 9, 9 - best quality.

DEEP TINE AERIFICATION REALLY WORKS [1]

Gene C. Howe, Jr. [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Owner, Sportsturf Northwest, Redmond, WA

An Understanding of Soils

Even if many of you have the state-of-the-art sand based fields, there are still many silt, loam, or clay soil fields in service.

Picture a bucket of golf balls (representing sand particles) and a bucket of silver dollars (representing most soil particles). This gives you an idea of the pore spaces of a sand soil versus the silt, loam, or clay soils.

Sand gives you the water, air, and nutrient movement which , in turn, will give you a great rooting medium if it falls within the specified seive ranges. The sand, however, must be kept free of any organic material that will impede vertical movement through the sand profile.

The proper sand cannot compact because of its structure. If the sand has finer particles in it, then it has the capability of compacting, thus causing the start of turf deterioration.

"Is It Soup, Yet??"

Any weakening of the turf plant will allow it to become the start of the downward spiral to turf disaster. The tearing of athletes cleats in the organic material in an unmaintained soil will soon become a part of the "soup" that will eventually destroy a field. Normally, the addition of the native annual bluegrass weed, poa annua, to this weaken site will help to compound the problem. Any amount of the flatter soil particles in your heavily-used athletic fields and parks that is allowed to become compacted through this heavy use will become the main ingredient of this disaster "soup" suddenly this bucket of silver dollars has lost most of its value.

Other ingredients of this "recipe" include improper usage, scheduling, lack of proper, scheduled maintenance practices, foul weather at time of the activities, reduction of turf plant vigor and density. Soon the field will shout "soup's on!!"

Over the past several years, espcially with the help of people such as Dr. Roy Goss who we roasted at last night's banquet, the idea of the sand-based athletic field has become common place to turf professionals in the northwest.

While attending national conferences on sports turf management I was very surprised that other regions were just being introduced to the sand-based concept.

It appears to me that the pacific northwest has taken the lead on this type of contruction. Now we just have to educate people that, after they are funded for construction, that without proper maintenance by a turf professional, their investment has lost all of its value. This is where the arguments concerning installing a plastic carpet are begun.

Though we, as turf professionals, may know better, the education of others does take time and it is up to us to help provide this passing of education on to others.

To be a successful sand-based field we must all add the phrase ''properly maintained'' or ''professionally managed'' sand-based fields.

Now it is also a given fact that not all fields can be built out of the proper sand. The education of those in charge of funding is one obstacle. Isn't it strange that ''there always seems to be enough money to do a bad job over again.''

What Can I Do With My Soil Field??

We sometimes come out of the seminars all pumped up with the information and education of the very best way to go and then go home to our ''real world'', sometimes soil-based fields, inadequate budgets, equipment, crew size and skills, and a forever advancing clock when everything must be done.

Though it is not a substitute for a properly engineered and constructed sand-based field there are was to keep a soil field from falling apart on you.

Increased maintenance procedures such as mowing, fertilization, overseeding, thatch control, weed control are a start, but the most important procedure, to me, is the **aerification of the soil.**

The need to keep these soil particles open and loose is paramount. In doing so, the air, water, and nutrients are able to get down into the rootzone where they can do their jobs. In the past aerification has been limited by the equipment available.

What I call a fairway aerifier with 3/4″ open tines can penetrate up to 3″ inches deep if the soil will allow. This depth normally is OK for helping keep the top of the soil open for good turf growth, but cannot do much for the problem of deeper compaction of the soil. Though this equipment has been around for many, many years, its use is still the backbone for aerification of large areas.

Golf course putting greens have aerifiers that operate on a cam system the drive the tine into the soil, still at a depth of approximately 3 inches.

The Verti-Drain to the Rescue

The introduction of the **Verti-Drain** has finally changed all of that.

This piece of equipment has the capability of driving 3/4″ or 1″ tines to a depth of 16″ deep, if conditions are ideal.

Besides driving the tine that deep, the erti-drain also gives a flexing action to the tine that helps to fracture the soil at the bottom of its stroke.

The spacing is controled by the forward movement of the tractor, which must have a creeper gear to enable the slower speeds requried. Spacingas closed as 1.5 inches is possible,

It uses solid tines, but open tines are available. I have not used any open tines. I have had tines for my machine made for me with a much stronger metal. The metal used cannot be too brittle because of breakage, but will bend if it is not strong enough. There a happy medium somewhere!!

One drawback to this piece of equipment is its price. $18,000 dollars plus another $14,000 for the proper tractor is a stiff price to pay. Problem is, there are no alternatives.

Sportsturf northwest has attempted to stay on top of all equipment improvements to provide the best assistance possible.

Results Have Proved Very Positive

Sand Point Country Club used the Verti-Drain for 3 weeks in November, 1986. A couple of weeks later two inches of rain fell on the area, but the next day the course "played like it was spring".

Overlake Country Club used the machine on its worst putting green (number 11) with really nothing to lose. The improvement made by the Verti-Drain "now make it one of the best greens here".

The exciting results on athletic fields were next. Out normal aerification and topdressing used to call to 40 cx of sand topdressing after 4 passes with the fairway aerifier. After the deep aerification of the verti-drain at 4″ center, up to 120 CY of sand topdressing have been applied and dragged into the holes. Players and coaches have felt the change in the softness of the field immediatedly.

While demonstrating on a golf course north of seattle, an irrigation head was hit after 50′ of the fairway was done. Water shot skyward and spread out over the fairway going downhill. You could really tell where their Verti-Drain had been!!

Problems With the Machine

This equipment is not without its problems. Our long, hot and dry summer bake-hardened the soils that limited the depth of the Verti-Drain. This is more costly as more tines are bent and the shock is transfered directly to the machine, breaking some parts that are costly to the customer. I have a machine shop and engineer working on several different ways to improve the machine in hopes to protect it from destroying itself.

In Conclusion

It is very important to me to be able to keep this particular piece of equipment operating. I have seen nothing like it to break up our compacted soils which will, hopefully, give the turf cover a new lease on life. The Verti-Drain is a definite winner and, besides its problems I want sportsturf northwest to keep it in our stable of specialized turf care equipment.

The machine is currenly scheduled through Novmeber. If enough interest is made to warrant another machine, a second machine and tractor will be made available as soon as possible.

When considering the use of this machine please remember that compaction and turf abuse that has taken years to develop cannot be removed in one pass of the Verti-Drain or any other piece of equipment. The verti-drain will reduce the time to improve the soil, but, you must remember, it will still take time.

About the author and Sportsturf Northwest (not necessarily to be included in proceedings)

Gene howe, owner, has worked on several golf courses, including Tam O'Shanter in Bellevue, Inglewood Country Club in Kenmore, Sudden Valley in Bellingham and was assistant superintendent during construction of Port Ludlow.

He was also the park director for the city of Bothell for six years. During this time, he started Sammamish Turf Farm in Woodinville in 1977.

While trying to make improvements to the parks in Bothell during extremely tough budget years, and while hearing the same story from others in the area, the idea of Sportsturf Northwest was developed with Jim Chapman. There was a need for a ''middle man'' that provided the turf equipment that was necessary to do the jobs correctly but whose purchase was difficult to justify during these economic hard times.

Demand has dictated our growth. We now have grown and have a building full of the best and latest turf maintenance equipment including three trucks and trailers, three utility tractors (with turf tires), three reel mowers, and an wide assortment of the latest of implements.

Presently, we have a full-time crew of three and add people on an as-needed basis during the busy season (April through October). We always seem to be in a ''growth stage''.

Sportsturf Northwest is a Turf Management Service Company. We assist school districts, park departments, private athletic groups, and others with the maintenance of their large turf areas, with a focus on athletic fields.

Our programs can take a muddy and unsafe field and, using basic turf maintenance practices in concentrated visits, can rebuild or renovate a poor turf back into a safe turf surface. Besides all inclusive programs, we also provide assistance to many grounds crews by filling in their maintenance gaps by doing single maintenance functions when they do not have the time, equipment, or personnel to do the job correctly when it needs to be done.

These programs and functions include different types of soil aerification, thatch removal and control, topdressing, overseeding, fertilizing, and spraying. Sportsturf Northwest also gets involved with contract mowing with our 11 to 15 foot wide reel mowers.

We do some construction work, but normally take on a project at the seedbed preparation stage and do the fertilizing, seeding, maintenance through a couple of mowings. We have our proven methods of seeding sand fields to get the best results possible. While we focus on athletic fields, we specialize in sand-based athletic fields. We have done some golf course work, including fairway, tee, and green seeding, and have just introduced the laying of penncross putting green sod on greens and some tees.

We are now growing another crop of the same bluegrass/ryegrass blend sand-based sod for athletic fields that we grew and installed for the Seattle Seahawks at their new training facility in Kirkland. Of course, this is grown on specific graded ''WSU specified'' sand.

Certain pieces of our equipment are now being rented out, including the new Verti-Drain to golf courses on a monthly basis.

This practice will continue as long as our equipment is treated with respect by others. There are other equipment needs that may be available for rental in the future.

In our ''spare time'' we operate Sammamish Turf Farm, which sells a soil-based ryegrass sod to retail and wholesale customers.

SAND-BASED ATHLETIC FIELD SOD: THE SEA-HAWK EXPERIENCE [1]

Gene C. Howe, Jr. [2]

[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.
[2] Owner, Sportsturf Northwest, Redmond, WA

The Seahawk Story

Every once in a while a special project comes along. This is the story of one of ours.

The Seattle Seahawks needed to move to new headquarters because their 10 year lease was up, the property was prime for development, and, most importantly, they needed more room for both the players and administrative facilities. for example, they did not have a separate weight room and, with the weight training taking place in the already small dressing room.

One problem they had right off the bat was the planning for the move *as it pertained to their new natural grass fields.* After many public hearings to decide which of 4 sites they would move to, the go-ahead was finally given to a 12 acre site at the Northwest College in Kirkland. This decision was made in mid-August, 1985. The site needed to be logged off, and approximately 10,000 cubic yards of material had to cut and filled. The earliest start was mid-September.

The plan was to hold the 1986 training camp at the new site instead of at Cheney. This alone would save some $500,000!

This timetable was very possible for the construction of the building and the artificial field, but the two natural grass fields could not be seeded in winter and a spring seeding would not allow for play on the fields during all of 1986.

In a meeting with the Seahawks Management, Dr Roy Goss, their project architects and Carl Kuhn, their field engineer and myself, the idea was introduced of growing a sand-based sod on our Woodinville farm using the proper specified sand. When the Seahawks realized that there was no other alternative, we began preparations on August 25th.

The Mad Dash to Get Seed In Sand

An excavation company was hired to re-dig a 1,800 foot drainage ditch, using the spoils for an acess road, and leveling off a 4 acre parcel of our farm to receive 4 inches of sand. this preliminary work took 10 days.

We had 2 barges holding 3,600 tons of specified sand hauled from Steilacoom to Kenmore where it was trucked to the farm in Woodinville. This parade of 21 trucks with pony trailers hauled all of this sand in one day. We had the sand graded to as close to our marked stakes as possible with the finishing grade made with a 24 foot land plane from our neighbors, *JB Instant Lawn*.

While all of this was going on, we were installing a simple irrigation system that pumps water from the Sammamish River to a 4″ mainline through valves to 2″ aluminum hand lines across the sand.

Everything worked so well that we went from rough ground on August 25th through the installation of sand, to fertilizing and seeding the 4 acres on September l2th.

Because our objective was to get the sod moved in May, and because we were not allowed to use our normal sod netting to hold the rolls together, we planted the farm with a bluegrass blend, followed with a planting of a ryegrass blend two weeks later after the bluegrass had germinated. This process gives us the very best chance of success.

Jim Chapman from Lilly/Miller assisted in supplying the proper starter fertiliers and an agressive maintenance fertilizer program. Let up on supplying nutrients. This was not a project to relax on for a minute. There was a big deadline to meet in the spring. By the time we had the big snowstorm in November we had mowed the 4 acres 6 times. I believe that the 2 or 3 weeks of warm weather in February really saved the project.

Waiting and Planning for Harvest

Working backward from July l6th, Dr Goss predicted a minimum of 6 to 8 weeks for the installed sod to knit strong enough for the activity of Seahawks summer camp.

We figured that it would take 2 weeks to transport and lay the sand-based sod. this meant that we would have to start the process around May 8th, which we did.

On April 20th we had a test cut of the sod. Two of the 3 rolls that we cut completely fell apart. We waited and wondered. We took one more test cut on May lst and decided we had better start the next week to meet our timetable.

Harvest Time

The original idea was to have JB Instant Lawn harvest the 4 acres and transport it to the new site. Because of the lack of sod strength, the sand itself, and because we could not fit our two schedules together, it was decided to harvest using our Ryan Heavy Duty Sod Harvesters.

Besides the regular crew, an additional 14 people were hired on the harvesting end and 14 people were hired for the installing.

This turned out to be so different than the harvesting of our regular sod. The sand-based sod had no ''body'' whatsoever. when you rolled it up, you would gain 10% in length. You could stretch and mold a roll of sod to meet your needs.

We were forced to hand roll each piece. It took 4 hands to load each roll onto pallets. we put 21 rolls to a palllet. Eight pallets were forklifted onto our 20′ 5th wheel trailers and hauled to the Seahawks site. This is only 1800 square feet per trailer load. There were to be some 100 round-trips to be made with our 3 trucks and trailers.

The process was reversed at the other end. Pallets were unloaded and transported to the field.

The field has 13″ of this sand over a drainage and irrigations system. The sand must to kept wet so that the tractors would not sink. Because there was not electricity at the site yet, all watering had to be done by manually setting the valves.

Because of access problems, we started in the center of the puzzle and worked out from both sides. We eventually had 2 ''laying'' crewsworking, one on a side.

The sod was knit to where you pull it out with some difficulty in a week. By the time we were done, some of it was ready to mow. By the time we could get on it to mow it we had another problem. The blades were a good 4 to 5 inches. if we mowed it with our equipment, that many clippings, coupled with the amount of watering we were doing, would cause problems. We also knew that we could not take our sweeper on the field.

Our first two mowings were with a Cushman 72″ rotary with vacuum pickup loaned to us by *Northwest Mowers*. Set at 2½ inches, we had to empty the container after 1½ trips across the field!! After another mowing at 2 inches, we were ready to start mowing with our HF-5 reel mower. At this time no one knew if the sod would hold up to the pressure of a practice, no less a summer training camp. On July 8th, (8 weeks after starting, 6 weeks after finishing) it was our idea to see if the sod was ready. A decision on whether or not to go to Cheney had to be made.
The quarterbacks and some receivers set out to see what would happen. Everything held together.

A week later, after 3,000 people waited up to 2⅕ hours to tour the new facility at the open house, the field was ready for the main test - summer camp!!

The Final Test

On July 16th summer camp opened. We figured that there would be a week of getting back into shape. That was a mistake. With their two-a-day drills, that afternoon was spent going full-bore.

The facts: there were 120 players battling for jobs. They were on the field working for 6 hours a day (two 3 hour practices) 7 days a week for 4 weeks before getting a Sunday off. This equals over 100 full football games per field for this period.

By the time they got that one Sunday off, the field they were working on was only 12 weeks old.

One saving grace was the fact that there were 2 full-size fields to work with. Each week the fields were re-painted perpendicular to the ones they used last week. At times, the old lines had to be painted with green paint to get rid of them faster.

The field held up very well. There were very few rips or tears of sod. There was some minor repairing to do, which we did by hand, sometimes with a putting green cup changer.

Later in the season, we got up the nerve to try a more major repair. We would basically make the same type of repair as you do in replacing a cup plug on a putting green. We would use the Ryan Sod Cutter as the cup cutter, cutting a 3 inch thick section out of the field and out of the nursery area, pack it into the damagmed area, and water it heavily. These areas were used for practice the next day with no problems.

The players were pleased with the field. There was some movement of turf at the beginning. We did roll the field before almost every practice, something that is usually not done. More water than normal was applied to keep the sand ''stable''. Many of the players told us that they could feel the field firming up weekly.

After the exhibition season, they then started cutting people down to the 45-man roster limit. After that, the field was home free. Their usage on it lowered to Wednesday and Thursday hard practices, with some lower use at other times.

They do have use of an artificial surface field. In October, a 55 foot high air-inflated bubble was installed. They used this field when the weather dictated. The players and management agree that the natural grass fields are much easier on bodies.

The fields ended the season in great shape.

The only problem we encountered during the year was the slipperiness of the turf when the colder weather came, which slowed down the growth. This coupled with those 2 weeks of heavy fog caused some problems with slipping on hard cuts. We sprayed on wetting agents, which did help.

Sportsturf Northwest is contracted to keep the turf in the best possible condition. We take care of all field mowing, fertilizing, spraying, rolling, repairing, irrigating, and, at times, assist with painting of lines and other tasks.

This spring we started a full program to keep all thatch and annual bluegrass under control. Before the year is over we will aerify with fairway and greens aerifiers, verticut, take the thatch control rake over the field, vacuum everything up, overseed, topdress and drag 120 CY of specified sand into the holes. Except for the overseeding, all of this is done 4 times per year. The last time it was done over a weekend so the field could be ready for Monday morning practice.

Remembering that I mentioned earlier that we had some problems in 1986 with clippings clogging up cleats, Dr. Goss made the suggestion that all clippings be caught with our HF5. We began this process the week before summer camp started. The field is mowed every Monday, Wednesday, and Friday at 5:00 pm after afternoon practice. We are taking off about 120 hand-packed cubic feet of clippings per mowing (3 times per week). I wish all of you could see the difference this has made. It has been easy with the dry weather, but I know the rain is coming. At least when it does, the true test will be made. I will question the coaches and players to get their opinions.

We are hoping that this field to be used up into mid-January of 1988 and for many, many years to come.

In Closing

This special project is the type we will all remember for some time to come. It was fun to have many different challenges. Being able to develop first-class turf on a first-class field for a first-class people made the job that much more fun.

ORGANICS OR B.S.? [1]

Robert H. Ringer [2]

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[1] Presented at the 41st Northwest Turfgrass Association, Salishan Lodge, Oregon, September 21-24, 1987.

[2] Director of Training and Sales Development, Ringer Corporation, Eden Prairie, MN

Organics or B.S., that's a good question, isn't it? In most peoples' minds there's never been much doubt about the answer. Organics or natural products have never been given much credibility, nor has much research been devoted to this area in the past. In fact most professionals, experts and the general public alike have considered natural products as snake-oil alternatives.

However, over the past couple of years, there's been a growing public awareness of the hazards that some chemicals can create. Presently there are soil and ground water pollution problems in at least 23 states. Generally, problems have occurred from overuse and abuse of chemical products. These situations could be improved upon just through more conscientious use. Chemicals should not be discredited as a whole, because we have learned a lot through their uses, and they will continue to be a part of our lives in the future. Nevertheless, we have to be realistic, we only have one environment and there are many natural alternatives today that can fertilize and deal with a variety of pests and fungus very effectively.

Contrary to popular belief there has been a great deal of research and development in the area of natural products. I represent the Ringer Corporation which has been involved in this area for about 20 years. We have developed a full line of 14 natural products that can safely fertilize a variety of plants as well or better than any product on the market. In the past 2 years, we have experienced a tremendous amount of growth due to increasing demand by consumers, dealers and distributors as well. So it's obvious that peope are looking for viable, safe alternatives.

In the past there have been many problems with natural products. Typically they have been bulky, hard to apply, and hard to get. It's also taken a long time to see results, and results have sometimes shown limited ability. Fortunately a lot of research and development has been done to overcome all of these former obstacles.

The Ringer Corporation has taken one of mother nature's oldest concepts and put it into a concentrated form that recreates the natural cycle of growth. The major food source for living plants comes in the form of protein, which has been provided mainly by the recycling of organic materials such as plants, leaves, grass clippings, etc. However, nature has only been able to provide an average of 5% protein. We have developed a product line that averages around 55-60% protein, consisting of all natural ingredients. Also added to the products are billions of micro-organisms and enzymes, that breakdown the ingredients into nutrients readily available to the roots.

Our most successful product is called Lawn Restore which is sold through retailers in a 25 lb. bag. The commercial counterpart is called Turf Restore and is packaged in 50 lb. bags. Both products come in a granular form and are easy to apply with either a broadcast or drop spreader. We now have national distribution for both products so they're readily available to the trade.

What has made these products successful is that they have a multitude of benefits. The products are slow releasing, non-burning, long-lasting fertilizers, because they consist of natural, insoluble ingredients. Our products actually feed the soil so that the soil can feed the plants, which in turn promotes a deep, healthy root system. This process in conjunction with a high degree of microbial activity has been proven to reduce thatch. Through the rebuilding and revitalizing of the soil it's also been proven that we can eliminate the conditions that promote fusarium and necrotic ring spot disease. When the program is continued on a maintenance basis these problems can be kept from recurring. Also, with a deeper root system, more moisture is retained and less watering will be needed over time. All these benefits are achieved while using a non-toxic product, safe for use around kids, pets and water.

These are not products that produce instant results, however because of their concentrated make-up they work much faster than natural products of the past. They are a proven success when used as a program and not as a one-shot deal. Generally within 2-4 weeks after the first application, gradual green-up occurs and disease becomes stabilized. After the second and third applications is when the program really starts to take hold, and lawns turn deep blue-green and diseased patches start to fill in.

These products may seem more expensive at first, but not when you compare all the benefits to a regular bag of fertilizer. It becomes especially economical when used as a problem-solver, because it eliminates a number of costly steps, with one sweep of a spreader.

For the past 4 years we have been testing Lawn Restore at Michigan State University, under the direction of Dr. Joe Vargas and Dr. Paul Rieke. The tests have shown that Lawn Restore is a slow-releasing, long lasting fertilizer. Also that it is capable of reducing thatch, and eliminating the conditions that promote necrotic ring spot disease (formerly known as fusarium). We are continuing to test our products at Michigan State and other major universities around the country, in hopes of finding the full capabilities of these natural products.

It's time that we all realized that we are in the midst of a growing trend. Also that there are an increasing number of well researched natural products that really do work. We need to start taking these alternatives seriously and open our eyes to the future.

EDITOR'S NOTE:

The following Proceeding papers that were presented at the conference were not submitted for publication:

Design Nightmares	Patricia Elder
Poa Annua and Rubigan	Jeff Gullikson
Sprinklers-Refit, Rebuild or Repair	Robert Koehler
Water Needs in Review (Panel Presentation)	Ernie Jones

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