# Proceedings

Of the

# 47th Northwest Turfgrass Conference

**October 11-13, 1993**

**Holiday Inn**
**Yakima, Washington**

## PREFACE

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

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Blair Patrick, Managing Editor

## 1992/93 PRESIDENT'S MESSAGE

*Becky Michels*

On behalf of the 1992/93 Board of Directors of the Northwest Turfgrass Association, it gives me great pleasure to thank the many members, employees, spouses and friends who attended and supported this year's Northwest Turfgrass Association **47th Northwest Turfgrass Conference and Exhibition**.

The program at this year's conference at the Yakima Holiday Inn in Yakima, Washington was excellent thanks to the hard work of the following conference committee chairmen: Don Clemans and Jim Dusin, Conference Education Program Committee; Tom Christy, Sponsor Committee Chairman; Bill Griffith and Jim Dusin, Golf Tournament Chairmen; Jim and Shirley Dusin and Bo and Gayle Hepler, Hospitality and Companion Program Chairmen; Jim Dusin and Don Clemans, Tours Committee Chairmen; and Blair Patrick and Jerry Crabill, who handled conference registration and site arrangement. Each of the chairmen chaired strong committees and to everyone who made the conference possible, my sincere thanks.

We had another year of outstanding presenters that covered a wide range of topics relating to turf management. Space here doesn't permit me to properly recognize or thank them individually but, were it not for them, our conference would not have been of the quality it was.

It gives me great pleasure to offer a special thank you to all supplier sponsors who sponsored a tee during the golf tournament. This is a major source of our research and scholarship funds for the year and that support is very, very sincerely appreciated.

My best to NTA President, Tom Christy, the board of directors and the membership for a successful 1993/94.

Becky Michels

1992/1993 President

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| **Sulfur-Calcium Phosphorus Effects on Winter Diseases** | Stanton E. Brauen, Coordinator<br>WSU, Research & Extension Center<br>Puyallup, Washington |
| **Computerized Tree Inventory Appraisal** | Brad White, Research Assistant<br>U. of W., College of Forestry<br>Seattle, Washington |
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# SURFACE CHARACTERISTICS OF PLAYING FIELDS[1]

Donald V. Waddington[2]

[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
[2] Professor Emeritus, Department of Agronomy, Pennsylvania State University, University Park, Pennsylvania.

The playing quality of sports turf relates to both player performance and player safety. Playing quality is a function of the turfgrass and soil conditions on the field, and influences traction, impact absorbing capabilities (hardness), and ball response. Traction and hardness are related to injury potential as well as player performance. Most games played on sports turf involve a ball, and important ball responses are bounce and speed and trueness of roll.

Assessments of surface playing quality have been both subjective and objective. Objective, quantitative methods are preferred. Factors such as ball bounce, hardness, and traction can be quantified using various methods; however, soil and plant conditions need to be quantified as well so that relationships among agronomic and performance characteristics can be established. Then turfgrass managers will be better able to alter playing surface conditions with their maintenance practices.

## CHARACTERIZATION OF SURFACES ON HIGH SCHOOL FIELDS

How field conditions relate to injuries was a topic addressed in one of our earlier studies at Penn State. Practice and game fields used for American football at twelve high schools were selected for the study. The fields were assessed for agronomic factors such as amount and type of cover (both turfgrasses and weeds), smoothness, and stoniness both before and near completion of the playing season. A survey of management practices such as fertilization, core cultivation, weed control, and mowing was also conducted. Athletic trainers at the participating schools kept records of injuries and rated each injury as to severity, body location, and relation to field conditions. Although no single management practice or surface characteristic was correlated with the number of injuries, the trainers did classify 21% of the injuries as being either definitely or possibly related to the playing surface. The results indicated that there was a need to provide safer playing surfaces, which would minimize the potential for injury. Results from this study also showed that the schools with better maintenance inputs had the better fields, that better built fields had also received better maintenance, and that practice fields received fewer maintenance inputs than game fields, had more use, and were in much poorer condition.

In a second study on high school football fields, practice and game fields of twelve schools were evaluated five times over a 13-month period to determine relationships between hardness and traction, vegetation and soil properties, and maintenance practices. Traction was measured with a shear vane and hardness was quantified using a Clegg impact tester, which measures the maximum deceleration during impact of a dropped missile. High values for peak deceleration, indicate low impact absorption by the surface or a 'hard' surface. Data were collected in areas representing both heavy and light use. Fields that had received good maintenance practices and that had better soil and turfgrass conditions had a lesser degree of hardness. Hard surfaces were associated with lower soil water contents, higher soil bulk densities, and thinner turf cover. Core cultivated fields had lower bulk densities and lower impact values. Practice fields were harder than game fields and heavy-use areas were harder than light-use areas. Greater shear resistance was associated with areas having a denser turfgrass cover. Turf cover tended to override expected differences in shear resistance due to bulk density or soil moisture variations. The results of this study showed that turfgrass managers can affect surface quality by utilizing management practices that affect soil moisture, bulk density, and turfgrass cover.

## IMPACT ABSORPTION (HARDNESS) RESEARCH

Our first work on surface hardness was conducted under laboratory conditions. Boxes that were packed with different textured soils to five depths, and with and without turf, were carried into the laboratory where impact absorption was measured using non-portable apparatus. Peak deceleration was lower with turf cover than with bare soil, and when soil was core cultivated. Peak deceleration was greater with a soil depth of 7.5 cm than with depths of 15 cm or greater. The rigid box bottom and metal surface on which boxes were placed for testing affected peak deceleration when soils were shallow. Deeper soils provided a greater cushioning effect. Thus insufficient soil depth over large stones or bedrock in a field could create an increased risk for impact type injuries.

We needed a method to measure impact absorption characteristics in the field on both actual playing surfaces and on research plots. A procedure utilizing portable apparatus was developed and evaluated. The Clegg impact tester was used in conjunction with a vibration analyzer to obtain deceleration-time curves. These curves show the deceleration values throughout the time of impact. The peak deceleration, time to peak deceleration, total impact time, deformation of the surface, a severity index, and rates of change in deceleration can be obtained directly or calculated from information on the curve. This method was then used for continued research on turf and soil surfaces. Field studies were conducted in which we assessed the effects of turfgrass species, cutting height, turf cover, verdure, thatch, compaction, core cultivation, soil water content, and impacting hammer weight on impact characteristics. We have used three hammer weights: 0.5, 2.25, and 4.5 kg. Research in Australia and Europe had shown that the 0.5 kg missile correlated well with ball bounce; however, most of our work has been done with a 2.25-kg hammer, which we feel has an impacting energy per unit area that is more in line with running or falling impacts of athletes. In our work, the 0.5-kg hammer was more sensitive than the heavier hammer to the presence of turf (vs soil surface), cutting height, and thatch thickness, indicating that these factors would probably affect ball bounce more than injury potential. Examples of differences in peak deceleration due to treatments are shown in Table 1. Harder surfaces were associated with lower cutting height, compaction, absence of turf, and drier soil. Peak deceleration values are higher with the 0.5 kg hammer because this lighter hammer stops quicker upon impact. Impact results are also affected by the surface area and shape of the impacting surface of the hammer and the drop height. Thus, knowledge of equipment and procedures used to measure impact absorption is important when interpreting impact results. When we first began measuring impact absorption, we made measurements on a number of nonturf surfaces so that we could relate the peak deceleration values to other surfaces. These results are shown in Table 2. Note the wide range of values that can exist on natural fields.

## TRACTION RESEARCH

Initial evaluations of traction were made using a shear vane. Thin metal blades (vanes) on the base of the apparatus are pressed into the turf, and then the maximum torque required to rotate the apparatus is obtained. Torque values are used to calculate shear resistance. There is no doubt that this method tells us something about the strength of the turf; however, relating this information to traction, or footing, experienced by an athlete is questionable. The shoe soles used by athletes hardly duplicate a shear vane. Thus, we set out to develop an apparatus and operating procedure to measure horizontal forces associated with traction on natural surfaces.

A traction measuring apparatus was constructed by modifying a frame and leg assembly that the Physical Education Department had used in a laboratory to measure traction characteristics of various artificial and natural surfaces. We named the apparatus PENNFOOT. It consists of two frames: an outer frame with wheels, which is used to transport the apparatus from one test location to another; and an internal frame containing the leg and foot assembly, loading weights, and a hydraulic pump, pistons, and pressure gauge used to raise and lower the internal frame and to rotate or pull the foot. This apparatus allows the flexibility for measuring both linear and rotational traction, for changing the amount of loading weight on the foot, and for changing footwear on the foot.

Initial testing of this apparatus showed that grass species, cutting height, and loading weight affected traction, but the effects were not always the same for rotational and linear measurements. For linear measurements, force was measured at 9 equal intervals over a travel distance of 5.1 cm, and torque was measured at 0, 10, 20, 30, and 40 degrees during rotational measurements. The greatest effect of treatments occurred after some initial movement of the shoe occurred. Under the conditions of our research, traction values on tall fescue and Kentucky bluegrass were not significantly different from each other but were significantly greater than perennial ryegrass and fine fescue when studded shoes were used. Linear traction was lowest with fine fescue. [Rotational tractional measured with a smooth, leather-soled shoe (not a typical athletic shoe) indicated greater "grip" with perennial ryegrass and least with fine fescue.

Kentucky bluegrass and tall fescue were intermediate and had similar values.] Cutting height affected traction only with linear measurements. Greater traction was obtained at heights of 3.8 and 5.1 cm than at 6.4 cm. Loading weights used were 60, 74, 88, and 102 kg. Each increase in weight resulted in an increase in traction values measured. Early work with the laboratory apparatus had shown that the degree of traction with different types of footwear is not necessarily consistent with all loading weights. This effect needs more study on natural turf and soil surfaces. Work is continuing with PENNFOOT to determine the effects of various turf and soil characteristics on traction.

## THE FUTURE

There is a great need for more traction and impact research. Ideally some standardization of methods will then occur among researchers and others. Player input should be sought to determine how the players' assessments of hardness and traction correlate with values obtained with the test methods. Finally, guidelines should be developed for construction and maintenance techniques that will provide the turfgrass manager the opportunity to maintain the soil and turf in such a manner to keep playing conditions within a desired optimal range. Optimal ranges should be developed using both player and researcher inputs.

## ACKNOWLEDGEMENTS

Major contributors in the planning through publication phases of the Penn State research include J. C. Harper, Professor Emeritus and former Turfgrass Extension Specialist; C. A. Morehouse, Professor Emeritus of Physical Education and former Director of the Sports Research Institute; and graduate students R. L. Henderson, A. S. McNitt, R. O. Middour, and J. N. Rogers.

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Table 1. Effect of cutting height, compaction, surface, and soil water content on peak deceleration as measured using 2.25 and 0.5 kg hammers on Kentucky bluegrass turf.

| Comparison | Peak Deceleration 2.25 kg | Peak Deceleration 0.5 kg |
|---|---|---|
| Cutting height: 19 vs 57 mm | 86 vs 77 | 145 vs 139 |
| Compaction: with vs without | 91 vs 71 | 161 vs 118 |
| Surface: soil vs turf | 87 vs 74 | 170 vs 107 |
| Soil Water: 16% vs 26% | 106 vs 60 | 196 vs 103 |

Table 2. Impact values for high school football fields and other surfaces.

| Surface | Peak Deceleration (2.25 kg hammer) |
|---|---|
| High school fields | 33 to 167 |
| Artificial turf | 60 to 91 |
| Frozen natural turf | 303 |
| Tiled, concrete floor | 1,280 |
| Carpet and pad on tiled, concrete floor | 190 |
| Carpet and pad on hardwood floor | 134 |

# EVALUATION OF NEW NITROGEN FERTILIZERS[1]

Donald V. Waddington[2]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.

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As new nitrogen (N) sources are introduced for use on turfgrass, it is important that they be evaluated under a range of turf, soil, and climatic conditions. It is apparent that all conditions will not exist at one research site; however, when N sources are evaluated at a number of locations, on different soils, and on various species and cultivars, one can better predict their performance for turfgrass fertilization.

## RESEARCH METHODS

Several approaches can be used in N evaluation research. We normally use two applications per growing season: spring and fall. This timing allows us to obtain data on the longevity of response. With more frequent applications, the long-term response from one application may be masked by the next application. We usually use an application rate of 2 lb N/1000 ft2. Differences between sources are not as evident at lower rates. Clippings are removed so that they will not contribute to the pool of available N. When clippings are returned, greater growth and color responses occur. We use clipping yields, color ratings, and N uptake to assess N availability. If other nutrients are not limiting, higher yields and darker color ratings indicate a higher availability of N. Yield and color data are collected on a weekly basis during the growing season. Several common N sources are usually included for comparison purposes. Another approach used in research with N sources is to evaluate rates and timings that might be appropriate for the N source. Thus a slow-release source might be applied twice per season and the response compared to a fast-release source applied four times per season. This type of research applies more closely to what the turf manager may do, but it does not provide the oneon-one comparison of quickness of initial response, time of peak response, and residual response that is obtained by fewer applications at the same rate. Even with two applications per season, we often find that when ureaform is finally giving a greater response than more soluble N sources in late summer, it is time for the next application, which will cause a much greater response with the more soluble sources than with ureaform. Thus, the residual response from the earlier application of ureaform will no longer be apparent.

## FERTILIZERS EVALUATED

Over the past several years we have evaluated a number of newly introduced N sources. Some are commercially available and others are experimental formulations. Older sources that were included for comparison purposes are as follows: Nitroform (38-0-0) and Nutralene (40-0-0) from NorAm [71% of the N in Nitroform is water-insoluble N (WIN), and 36% of the N in Nutralene is WIN]; Vigoro's IBDU (31-0-0), which had 90% of the N as WIN; Milorganite (6-2-0); sulfur-coated urea (32 to 39% N); and urea (46-0-0).

Brief descriptions and results with newer N sources follow: POLYON. These polymer coated fertilizers are manufactured by Pursell Industries by reacting two reagents directly on the surface of urea to form the polymer coating. The process has been named the Reactive Layer Coating Process and the product has been referred to as RLCU. The coating weight can be varied to obtain different release rates. This new technology provides slow-release N with a thinner coating than is required with sulfur-coated urea (SCU), and the N contents are 44, 43, and 42% depending on the coating weight. We have used materials with coating weights ranging from 4 to 12%. Response to the thinner-coated materials is similar to that obtained with common SCU products; however, the thicker-coated POLYON is more efficient than thicker-coated SCU. Initial response with thicker-coated POLYON is slow, but residual response is very good. Thus, such materials should be mixed with a fast release source (e.g., urea) that will provide the initial response after application. POLY-S. These products from O. M. Scott & Sons are manufactured by coating urea with sulfur and then a polymer. These products are an improvement over Scotts SREF (slow-release encapsulated fertilizer), a sulfur-coated urea that released more like a quick-release than slowrelease source in our tests. There are three coating weights that yield products with 38, 39, and 40% N. Our results have shown that the differences in release rates among these formulations will give the turf manager several options in selecting a release characteristic. Adding urea will help with initial response if the slower-releasing formulations are used. MICREA. This product supplied by Agriventures, Inc. is a urea-formaldehyde reaction production that contains 26% N. Many long-chain polymers are present and 94% of the total N is WIN. Used by itself, MICREA provided very little response under our conditions, even when applied at 12 lb N/1000 ft2 per season. When MICREA was used with soluble N to give similar amounts of WIN as found in Nitroform and Nutralene, responses were similar to or slightly less than those from Nitroform and Nutralene. ONCE. This product is a polymer coated 24-6-10 manufactured by Grace Sierra. We used it in both one and two application treatments to get 4 lb N/1000 ft2 per season. It was slower to respond than Pursell's SCU, but with one application response tailed off at the end of the season. Under our conditions, we would prefer twice over once. TERRENE. This material (5-3-0) is an activated sewage sludge and a product of Wheelabrator Clean Water Systems, Inc., Hampton, NH. In comparisons with

Milorganite, we found these products to give similar results. These two products, along with Nitroform, were less efflcient than urea, Nutralene, and IBDU. CORON and N-SURE. CORON (28% N) is a solution N source manufactured by CORON Corp. by reacting urea and formaldehyde. About 40% of the N is urea-N and the remainder is reacted N, primarily water soluble methylene ureas. N-SURE (28% N) is a solution that was supplied by Arcadian Corp., and about 25% of the N is urea-N and the rest is reacted N in the form of triazones. In a 2-year study, CORON, N-SURE, and liquid urea gave similar color and yield responses. Less fertilizer burn occurred with CORON and N-SURE than with urea. Thus, a major benefit to their use would be better color due to reduced injury following application. METHYLENE UREAS. We have evaluated experimental methylene urea products from O. M. Scott & Sons that have relatively low levels of WIN and higher amounts of soluble methylene ureas than usually found in products such as Nitroform and Nutralene. Response in summer and early spring from spring and fall applications, respectively, indicated a sustained response due to the soluble methylene ureas. Scotts' Triaform fertilizers are examples of this new technology. In these products, 60% of the polymer-N is soluble in cold water. Long-term residual (into the following growing season) was associated with the amount of WIN in the products. Nitroform and a Scotts' experimental having 75% of the N as WIN provided the greatest long-term residual.

Nitrogen release characteristics, physical form (liquid vs dry), chemical and physical properties, and cost are factors that must be considered when selecting a N source. Research such as that discussed in this paper will help in making sound choices for fertilizer programs.

# SOIL TESTING FOR TURF[1]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
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Soil testing for turf is the process of measuring the plant-available nutrient status of the soil and of forming recommendations on which to base the fertility program. The process can also be a valuable tool in evaluating salinity and for the identification of potential toxicities (7). It is widely practiced throughout the world and is recognized by golf course superintendents as an important procedure for the development of an effective management program. The soil test reporting form provide a variety of useful information, but generally contains terms and concepts that can be confusing for everyone but those who have studied the science of soil testing in detail. This article will define and explain some of the terminology that is common to most reporting forms and will discuss some of the underlying principles of soil testing science. It will also provide an update on current philosophies used in developing modern chemical tests and in interpreting their results.

## DEVELOPMENT OF A SOIL TEST

There are three basic steps involved in the development of a soil test. They are **correlation, calibration, and interpretation** (5). **Correlation** is the initial step. It involves the selection of chemical extractants that approximate the plant's ability to remove nutrient elements from the soil. The total amount of a given element found in the soil is generally not available to the plant. Soil scientists have determined that the component of this total pool that is available to the plant's roots can be estimated through the use of the proper extractant. This part of the soil testing procedure is the most well developed of the three components. The modern extractants used by soil testing labs, if properly chosen for the soil to be tested, are generally considered by soil scientists to be good estimators of the plant's ability to extract soil nutrients. Studies have also shown that testing labs are quite consistent in extracting similar amounts of essential elements when uniform soil samples are submitted simultaneously to several independent testing laboratories (10). The second step in developing a soil test is **calibration.** This is the process of determining the meaning of the values generated by the soil test extraction. A soil test extraction by itself is practically meaningless. For instance, if a test were to show that 20 ppm phosphorus (P) were available in a particular soil, the information would be of little value unless we knew something about potential plant response to this amount of P. Is it enough, or is it insufficient? Can we expect a plant response to the addition of more P, or is no response likely? It is the function of calibration to answer this question. **Calibration** can only be performed through careful and thorough field tests. Plant response can vary with each element, it will vary with each plant species, and can even vary within a plant species on different types of soil. As a result, the calibration phase of soil testing is weaker than is the correlation phase. For some crops and for some soils, extensive data exist. For others data are lacking. For turf, the lack of calibration data is clearly a problem. This problem is intensified by the variety of species that we deal with and by the diverse soils on which we establish turf. Data gaps for the minor elements are particularly a problem for turf as will be discussed later. The process of **interpretation** is the third part and is of most interest to the end user of soil testing. This involves using the information gathered in the other two phases and integrating it into a recommendation on how much of a particular fertilizer element is needed. Interpretation is the most variable of the three steps. Turner (10), in an extensive study of soil testing for turf, demonstrated that soil testing labs were quite consistent in extracting nutrient levels from uniform soil samples sent to testing facilities around the United States. However, the interpretations made based on the test results were highly variable. Recommendations by different labs for phosphorus (P) fertilization varied as much as 6-fold and recommendations for potassium (K) fertilization varied nearly ~fold on the same soils. Turner summarizes the work later (11) by stating that soil testing for turf can be "more guesswork than science." Plant scientists involved in the study of turf generally agree with this statement. Soil testing at its best, with extensive calibration data, is still an approximation of the plant's needs. For turf, where calibration data are very limited, the term "guesswork" is appropriate. But soil tests remain the best guide on which to base fertility programs for turf.

## SOIL TEST TERMINOLOGY

The standard soil test reporting form includes a series of descriptive terms followed by numbers. These terms and numbers are often presented with little, if any, explanation.

The first thing that appears on most soil test forms is the **Cation Exchange Capacity (CEC).** A plant science dictionary or textbook will define this term as "the ability of the soil to exchange cations," which is still of little use without further explanation. The cations are positively charged elements that occur in the soil. Several of the cations that are important as plant nutrients or play other important roles in soil chemistry are listed in Table 1. The fine particles of the soil, particularly the clays, and the organic component of the media are surrounded primarily with negative charges. These positive and negative charges function in similar ways to magnets. As like poles of magnets repel and opposite poles attract, like charges repel and opposite charges attract one another in the soil (Fig. 1). This allows the negatively charged soil and organic materials to hold the cations so that they can be exchanged with the root systems and used by the plant.

Table 1. A selection of cations that play and important role in soil chemistry.

| ELEMENT | CATION |
|---|---|
| HYDROGEN | $H^+$ |
| CALCIUM | $Ca^{++}$ |
| MAGNESIUM | $Mg^{++}$ |
| POTASSIUM | $K^+$ |
| SODIUM | $Na^+$ |
| AMMONIUM | $NH_4^+$ |

The units of the CEC test are milliequivalents (meq.)/100 g of soil. The numbers listed on the form are an estimate of the number of negative charges available to hold cations. The concept of the milliequivalent is complex and the reader is directed to an advanced soil chemistry text for more detailed information on the term. Some knowledge of relative CEC numbers, though, can provide sufficient information to understand and interpret the soil test (Table 2).

Table 2. The cation exchange capacity of soils and soil components.

| SOIL TYPE OR SOIL COMPONENT | meq/100 g |
|---|---|
| SAND | >1- 6 |
| CLAY | 80-120 |
| ORGANIC MATTER | 150 - 500 |
| CLAY LOAM SOIL | 25 - 30 |
| SAND GREEN | >1-14 |

Sands are very low in CEC and have a much lower ability to hold and exchange cations than do clays. Clays, however, readily compact and do not provide a suitable media for the growth of turf on areas that are to receive heavy traffic such as golf course greens. In turf management, we generally use sands to construct the most heavily trafficked areas. To help increase the CEC (as well as the water-holding capacity) of the sand, organic matter is usually added to the media during construction. While this is an improvement, sandy media such as a modern sand green will still likely have a CEC ranging from >1 up to approximately 14 meq/100 g. These are relatively low numbers that may result in a need for repeat application of moderate levels of the cationic nutrient elements such as Potassium K+ during the growing season. The CEC of a fertile clay loam soil, such as may be found on fairways in the agricultural regions of the midwest, will range from 25 to 30 meq/100 g. The CEC is not a measure of soil fertility, but of "potential" soil fertility. It measures the number of charges only. Determination of what is on the CEC sites is another part of soil testing. The second item listed on most soil test forms is the pH. This is a commonly used term in many scientific disciplines and can provide some very useful information about the soil when its meaning is understood. The term is written with a small "p" and a capital "H". The "H" stands for hydrogen and the test is basically a measurement of the hydrogen cations in the soil solution and on the cation exchange sites. The pH number listed on the form is filled with useful information about the soil's ability to supply plant nutrients. The pH scale varies from a low of O to a high of 14 (Fig. 2). Everything below 7 is called acidic and everything above 7 is called alkaline or basic. The midpoint 7 is the neutral point. The pH number can reveal much useful information about what is on the CEC sites.

Acidic soils will have high amounts of H+ on the CEC sites and will by default be low in the basic cations such as Ca++, Mg++, and K+. Soils high in the basic cations will have a high pH which can result in reduced availability of nutrients such as iron (Fe), manganese (Mn), and zinc (Zn) (Fig. 2). A balanced availability of plant-essential nutrients is found between pH 6 and 7. An excessively high or low soil pH may result in the need for pH modification. Detailed discussions of pH modification for turf areas can be found in sources 1 and 2 in the reference list at the end of this article. The **"buffer pH"** which occurs on some soil test forms is a measure of the soil's buffering capacity, or resistance to change in pH. This test plays an important role in low pH soils that require lime. The buffer pH provides the soil test labJwith an estimate of how much lime to recommend to bring the pH up to acceptable levels. Soils can vary in lime requirements by several thousand pounds per acre and the buffer pH measurement should always be used in making lime recommendations.

## NUTRIENT AVAILABILITY

The other parts of the soil test form are usually dedicated to evaluations of the availability of plant-essential elements in the soil. There are presently 17 elements considered by plant scientists as essential for plant growth (Table 3) (9). Depending on the testing lab, the test procedure may be limited to P and K only, or it may include a wide array of tests including Mg++, Ca++, S, Zn+, Mn++, Cu++, Fe++, and B.

Table 3. The 17 elements determined to be essential for the growth of plants.

| | | | |
|---|---|---|---|
| CARBON | C | IRON | Fe |
| HYDROGEN | H | MAGNESIUM | Mg |
| OXYGEN | 0 | BORON | B |
| PHOSPHORUS | P | MANGANESE | Mn |
| POTASSIUM | K | COPPER | Cu |
| NITROGEN | N | ZINC | Zn |
| SULFUR | S | MOLYBDENUM | Mo |
| CALCIUM | Ca | CHLORINE | Cl |
| | | NICKEL | Ni |

Nitrogen (N) is usually not tested. There are tests that accurately assess the N status of the soil, but N levels can vary so rapidly that the tests have little meaning in most plant systems. This is particularly true in irrigated turf grown on sandy soil medias where the N status can vary significantly over a 24-hour period. Proper N fertilization depends on the experience and skill of the turf manager and is based on visual evaluations of color and growth of the grass.

There are tests for most of the other essential elements. The usefulness of these tests varies with the amount of calibration information available on which to make interpretations of fertility needs for turf. Some are quite useful, others provide little information. The ways in which soil test results are expressed on the reporting forms will vary by lab. Some may simply list words like "low" or "adequate." The most useful reports list test numbers with the interpretation of whether the values are low, adequate, or high. The way of expressing numbers may also vary among labs. Some express the results in pounds per acre (lb/A) of available nutrients. Others use parts per million (ppm), where 1 ppm is equivalent to 1 lb of available nutrient per million pounds of soil. Soil tests in the U.S. are traditionally based on the "acre furrow slice," the soil in the upper 6 to 7 inches of the profile. This amount of soil is considered to weigh 2 million pounds. Two pounds per acre is equivalent to 2 parts per 2 million or 1 ppm, and ppm will always be one-half of the lbs/A. Soil test results for the cations may also be listed on a % of base saturation basis. There is an important distinction in soil testing philosophy between the tests that list % of base saturation and those that list weights or ppm of available nutrients. An understanding of the two basic methods of soil testing can be useful in deciding on modifications of the fertility program.

## SOIL TESTING PHILOSOPHIES

There are two basic philosophies behind modern soil test procedures. They are known as the **Sufficiency Level of Available Nutrient (SLAN)** and the **Basic Cation Saturation Ratio (BCSR)** procedures (6,7). Both are widely used in the U.S. and some labs report the results from both on their forms and use a combination of the two methods in arriving at fertility recommendations. The SLAN method of soil testing is the oldest of the two and is the method that has traditionally been used by most university soil testing labs. This method relies on extensive correlation and calibration data as earlier described. Response curves are generated for as many plant species and soil types as possible and, where data exists, interpretations are based on field response studies. Where insufficient data is available, estimates are based on closely related situations. The BCSR method is based on the concept that an ideal ratio of cations on the CEC sites will produce the best plant response. This concept has been the predominant one used by most private soil testing labs in the U.S. The exact ratios vary somewhat, but they generally approxirnate 65% for Ca++, 10% for Mg++, 5% for Kf, and 20% for H+. The interpretation of these tests often depends heavily on specific ratios such as the Ca++/Mg++ and the Mg++/K+ ratio. When a soil is tested and ratios are found to vary from prescribed values, applications of nutrients are recommended to restore the balance. The BCSR philosophy has often been criticized by some soil scientists for being based on insufficient plant response data and for its tendency to over estimate the need for expensive fertility level modifications. Work will continue on the two soil test concepts for years to come and much more research will be needed to resolve the controversies that arise over the two techniques. The best tests will likely be those that combine the two philosophies to make fertility recommendations. In the meantime, the most sound advice that can be made to the turf manager is to thoroughly evaluate the situation before beginning any expensive modification of the soil's nutrient status. If a soil test based on the BCSR philosophy calls for expensive applications of fertilizers to modify the ratio of cations on the CEC sites, get a second opinion from a university lab. The applications may be necessary, they may not. The small cost of the additional tests may be well worth the money.

## INTERPRETATION OF SOIL TESTS FOR P AND K

It has been the experience of the author, that soil testing labs that are more familiar with test interpretations for garden and field crops than for turf will generally overestimate the amount of P and underestimate the amount of K needed for turf. Phosphorus is known for its relative immobility in the soil. At the time of turf establishment, starter fertilizers (i.e. 13-25-10) that are high in P are used. The limited root system at establishment is not able to reach out to obtain sufficient P and the P in the soil does not move readily in the soil solution to the vicinity of the root. Mature grasses have fibrous, multibranched root systems that are very efficient at removing P from the soil. Mature grasses are often fertilized with materials low in P and high in N and K (i.e. 20-2-15). Most garden and field crops require the application of higher P levels than those needed for grasses. It is not that they necessarily need more P than grasses, but these species are usually less efficient at removing the P from the soil. There are several different chemical extractants available to testing labs for P. The test used by most labs is the Bray 1. There are other tests that are available for varying soil conditions, such as high pH's. The numbers generated by these tests will vary widely and the type of test used should be verified before trying to interpret the results. Those soil test firms that generally make recommendations for gardens and field crops will usually interpret Bray 1 test levels of less than 30 ppm as low. For turf, levels of 10 to 12 ppm are usually sufficient. The author has observed no measurable response of Kentucky bluegrass turf grown on soil with levels as low as 7 ppm available P. Again, this is due not to a low P requirement by grasses, but to the efficiency with which grasses remove P from the soil. Table 4 includes information on which to base P interpretations for turf. The ranges are for the Bray 1 test and are based on observations by the author and others involved in turf research. They should be used as a general guide and should provided a better guide to P test interpretation than the higher figures used for other types of crops.

Table 4. Phosphorus soil test levels for turf.

| PPM | | LB/A |
|---|---|---|
| 0-5 | VERY LOW | 0-10 |
| 6-10 | LOW | 12-20 |
| 10-20 | ADEQUATE | 20-40 |
| 20- | HIGH | 40- |

The recommendations for K use on turf have changed considerably in the last decade. Fertilizer analysis such as 20-3-3 were common only a few years ago. Modern analysis are more in the range of 20-3-15 or even 30-0-30. Supplemental applications of 0-0-50 are also quite common on many golf courses. What has changed during that time is our understanding of turf response to K. Soil test interpretations of a decade ago were generally borrowed from other crops where the primary goal of K fertilization is plant yield. Potassium plays an important role in plant growth, but it also plays very important roles in stress tolerance. The ability of creeping bentgrass to survive high temperature stress, the ability of perennial ryegrass to survive cold winters, the ability of a bermudagrass green to tolerate wear stress, and many other things related to the turf plant's ability to tolerate stress are affected by K. Maximum tissue production is reached at lower levels of available K than are some of these stress related responses. In turf management, the goal is not maximum tissue production, but the maintenance of a quality turf area that is capable of surviving the many stresses that turf is subject to. Soil test labs that interpret tests on yield response data borrowed from other crops will generally underestimate the amount of K needed by turf.

Table 5 includes ranges of extractable K for turf. These are considerably higher than those used for other crops. Exactly where these levels should be is somewhat controversial. Whereas yield is easy to measure, stress related responses are much more difficult to observe and to document. There are some that feel that the ranges should be higher, some feel that they should be lower. These ranges are the opinion of the author. They are much closer to the needs of turf than are those currently used by most testing labs, but they may change with time as more data on turf response to K are collected.

Table 5. Potassium test levels recommended for turf.

| PPM | | LB/A |
|---|---|---|
| 0-40 | VERY LOW | 0-80 |
| 41-175 | LOW | 81-350 |
| 175-250 | ADEQUATE | 350-500 |
| 250- | HIGH | 500- |

Both tables 4 and 5 can be useful guides for the interpretation of your own soil tests if actual test levels are printed on the form. Again, many labs will often overestimate the need for P and underestimate the need for K for turf areas.

How much P and K fertilizer should be applied when the test says that the levels of these two materials are low? There is no clear answer to this question. It varies with soil type, pH, species, and may change with environmental conditions. On a low CEC soil, such as a sand green, it may not be possible to build up K to an adequate test level. On these low CEC soils, 'spoon feeding' the grass with repeated applications of small amounts of K and other nutrients will be the best solution. Fertilizer applications to mature turf have to come into contact with the tissue and some materials such as potassium chloride (KCL) may burn the foliage. Generally, no more than 1 lb of P or K/1000 ft2 should be applied to the turf in any one application. This may even be excessive in the case of KCL in warm weather. The best way to build up levels of P and K, is to monitor the levels in the soil following application. The tests should not be taken immediately after application. Ideally, there should be more than 1 month between the application of these materials and a retest of the soil.

## TESTS FOR OTHER NUTRIENT ELEMENTS

There are also soil tests available for other nutrients. While the extraction procedure for many of these tests may be quite good, the information on which to base interpretation of the results for turf is generally quite poor. The BCSR method of testing will generally be used for Mg++ and Ca++. Calcium deficiencies may occur at low pH levels, particularly on low CEC soils. Calcium deficiencies are rare and are easily handled by the application of lime. Magnesium deficiencies can readily occur on turf established on low pH, low CEC soil, such as an acidic sand green. Magnesium is found at the center of the chlorophyll molecule and plants deficient in Mg++ will be chlorotic or yellow. The BCSR method of soil testing may overestimate the need for Mg++. This can particularly be a problem where Ca++/Mg++ ratios are used to make the interpretations of Mg++ requirements. By this method, if the ratio of the 2 elements is determined to be unsuitable, expensive applications of Mg++ may be recommended. This may or may not be necessary. An easy way to find out is to apply light applications of epsom salts (magnesium sulfate) to a test area of the turf. If you get a response, you need Mg++. If you do not see a response, you do not need it. If expensive modifications of the Mg++ base saturation is recommended, be sure to get a second opinion from an independent testing lab. Iron tests are also available. Iron chlorosis of turf grown on soils with pH levels above 7 are common. There appears to be problems with at least some of these tests. It has been observed in the last 2 years that soil test reports for turf areas with high pH's are often shown to have high levels of available Fe++. It is also reported by superintendents that they do see an Fe++ response on the turf grown on these soils. This would indicate a problem with the test. In a case like this, believe your eyes, not the soil test. **Manganese** has received a lot of attention lately because at least 1 major fertilizer company has begun marketing a fertilizer with Mn++. Soil tests often show that Mn++ levels are low. The reliability of these tests is uncertain, however. If a Mn++ deficiency is suspected, try a test area using a fertilizer with and without Mn++.

If there is a visible response, the Mn++ is obviously needed. Nutrient responses can be subtle and, as in the case of K, benefits may not always be readily visible. But if no visible response to Mn++ can be observed, it would be recommended to verify the deficiency with further tests before incorporating the Mn++ containing fertilizer into your program. A second opinion on micronutrient deficiencies will generally be worth the cost. **Zinc** tests are widely performed on turf. Rarely are deficiencies identified. The primary concern over zinc in golf course soils has been that of potential toxicities. Recent work has shown that creeping bentgrass can tolerate very high levels of soil Zn++ with no apparent damage (3). Zinc effects have been observed on bermudagrass and St. Augustinegrass, but only at very high levels (4). Much more work will be needed on a wide variety of turf species managed under a variety of conditions to obtain sufficient information on which to accurately interpret tests for this element. **Copper** is used in very small quantities by grass plants. The author is not aware of any reports on Cu++ deficiencies on turf grown under golf course conditions. Like Zn++, Cu++ has occasionally been associated with toxicity problems. Some data on bermudagrass and St. Augustinegrass have been collected that indicate the possibility of toxicity to those species at very high levels in the soil (4). But again, much more work will be needed before adequate interpretations of Cu++ tests can be made. **Boron** is rarely tested for in standard soil tests. The plant needs minute quantities of this element to survive. Toxicity may be a concern on golf turf that is being irrigated with sewage effluent water that is high in B. Although standards will vary with location and species, the figure that is generally used is that sewage effluent water should not exceed 1 ppm in solution. The author is not aware of any published critical soil levels of B toxicity for turf.

## TAKING A REPRESENTATIVE SOIL SAMPLE

The best chemical soil test with the most experienced and knowledgeable interpreter can provide no useful information if the soil sample to be tested is not representative of the area. Soil testing labs vary in the recommended depth of testing, some recommend a 3 inch depth below the thatch for turf samples, others recommend 6 or 7 inches. Follow the recommendations of the lab to which the samples are to be submitted. Take special care to make sure that each core of soil collected is taken to the same depth. Several samples should be collected at random from the area. On a green 15 to 20 cores should be collected at random from the entire green with a sampling tool and be combined together. Never collect the entire sample from a single area. On the course, sample from representative areas. If there are known variations in soil type over the course, separate the tests by soil type. High areas of the course should be tested separately from low areas, etc. Be sure to keep good records of where numbered samples were collected. Numbered codes are easily forgotten by the time the test results are returned.

## HOW OFTEN SHOULD SOIL TESTS BE TAKEN?

The number of soil tests to take on a golf course may be budgetary question if funds are limited. Where limited testing is to be done, group samples in a logical way for the course. Combine sampies from greens with similar soil type. Sarnples from similar tees can also be combined as can samples from fairways with similar soil types. On a new course, or when starting a new job on a course without an adequate soil test record, individual tests on all greens, tees, and fairways would be useful to establish a base of information on which to compare future tests. Complete testing of all areas is not necessary every year unless some type of pH modification program or fertility build up program is underway. Under normal conditions, soil test levels are unlikely to undergo major changes from year to year and a few tests from representative combined areas on a yearly basis will generally be sufficient to monitor conditions on the course. Complete tests on the course can usually be separated by 5 years or more, depending on local conditions.

## SUMMARY

Soil tests remain the best way of assessing the fertility needs of turf and they can be an important tool in developing sound management practices. However, they have limitations and the results of the tests should only be used as a guide in determining fertility needs. There is a need for much more research to calibrate tests to turf response. This is true even for widely studies materials like $K^+$. For the micronutrients, very little data are available for turf and caution should be exercised when modifying fertility practices based on these tests. Careful observation and the skill of an experienced superintendent are still the most important part of the golf course management program.

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# THE USE OF A NATURAL PRODUCT FOR CONTROL OF ANNUAL WEEDS IN TURF[1]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.

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The last few years have brought increased public interest in environmental issues concerning the use of pesticides. This has been particularly true in the turf industry where the general public may be involved in the applications of pesticides to their own lawns or where they may see the application of these materials on golf courses or by lawn care companies. With this concern, has come an increased interest in natural products that are perceived as being safer than traditional synthetic pesticides.

In 1986, a research project involving food-grade corn meal as a growth media for a microorganism produced some observations that led to the patenting of a natural organic product for the preemergence control of annual weeds. The objective of this work was to establish a *Pythium* fungi in the soil of a new golf course green that had been constructed at the Iowa State University turfgrass research area. The effects of this pathogen were then to be observed on creeping bentgrass *(Agrostis palustris)* that was to be seeded on the infested soil. The *Pythium* was cultured in the laboratory for several weeks on the corn meal and then taken the field area where it was placed on the surface and tilled into a 3 to 4 inch depth of the soil.

Along with the inoculated corn meal plots, plots of the same size were treated with fresh corn meal that had not been treated with *Pythium.* The same total amount of corn meal was used in the two separate treatments. A third 'control' plot to which no corn meal applied was also established. Three cultivars of Creeping bentgrass were then seeded in strips over the top of the plots.

The attempt to establish *Pythium* in the treated plots was a failure and normal germination occurred in those areas. Normal germination also was observed in the control plots. But in the plots that had received the fresh corn meal, establishment was greatly reduced.

The reason for this inhibition was uncertain. One possible explanation was that there was some type of organic compound contained in the fresh corn meal that was destroyed by the activity of the fungal organism. To test this idea, several samples of processed corn grain were obtained for further testing. These included the starch, corn germ, corn fiber, and corn gluten meal (the protein fraction of the grain). These materials and the fresh corn meal used in the field trial were applied to pots of soil in the green house at increasing rates. Creeping bentgrass was then seeded over the top of the treated plots and germination was observed. The results of the greenhouse trials showed that the inhibitory substance was clearly in the protein fraction, the corn gluten meal.

Close observations of the grass plants in the greenhouse showed that the shoot (the above ground portion of the plant) formed normally in all pots. The effect of the corn gluten meal was to stop root formation. In pots treated with an effective rate of corn gluten meal, no rooting occurred and all plants died when water was withheld and the surface of the pots was allowed to dry.

The corn gluten meal is a 60% corn protein material that is approximately 10% nitrogen (N) by weight. It is a byproduct of the wet-milling process and is sold as a feed material for cattle, poultry, and several other species of livestock. It has been used in fish food for commercial fish production. It is also a primary constituent of some dog food products. Corn gluten meal is produced as a fine, yellow powder, but can be easily pelletized for easier application to the soil.

The next step in the research was to screen the effects of corn gluten meal on a series of other species. It was found that there were some differences in sensitivity, but that the material is effective in stopping or inhibiting root formation at the time of germination in a wide variety of both monocotyledonous (grasses) and dicotyledonous (braodleaf) species, including crabgrass *(Digitaria spp.).*

Corn gluten meal was then screened on mature Kentucky bluegrass *(Poa pratensis)* to determine if it had any detrimental effects on grasses once they were fully established. It was found that not only did the material not damage the mature grass, but that it made an excellent natural-organic fertilizer. Later work conducted over a series of years in the field has repeatedly shown that corn gluten meal compares to the best commerciallyavailable natural fertilizers. (Data comparing corn gluten meal to other fertilizer materials has appeared in the annual Iowa Turfgrass Research Reports since 1989. It appears in these reports under the coded name 'ISU EXPERIMENTAL'.)

The observations that corn gluten meal can inhibit the establishment of germinating weeds and at the same time serve as a fertilizer for mature grasses led to the idea that the material could be used as a natural 'weed and feed' product for lawns and other turf areas, as well as for garden and other crop production systems where weeds are a problem. Field trials demonstrated that this was possible and a patent was applied for on the concept in 1989. Patent 5,030,268, titled Preemergence Weed Control Using Corn Gluten Meal, was issued in 1991.

Continuing field work has shown that rates of corn gluten meal in the range of 20 lbs/1000 sq. ft. will reduce crabgrass infestation in Kentucky bluegrass turf by from 50 to 60% in the first year. As rates are increased, almost total control can be achieved. Timing is important because microbial activity is known to destroy the activity of the active component and it is recommended that the application be made close to the time of weed germination. Moisture is necessary to activate the material, but extended wet periods can reduce its effectiveness, as is the case with synthetic preemergence herbicides.

Current recommendations are that corn gluten meal be applied at 20 lbs product/ 1000 sq. ft. At 10% N by weight, this is an N application rate of 2 lbs. N/1000 sq. ft. This will significantly reduce germinating weeds in the first year and should with time bring this type of weed problem under control. Figures 1 and 2 show the first and second year's data respectively from a field trial on the control of crabgrass in Kentucky bluegrass turf. The repeat applications in 1992 were made to the same plots. The high rates of application in this study was far beyond what would be used in the turf industry. They were included to look for any possible detrimental effects to the Kentucky bluegrass turf from over applications. No damage was observed in either year. Of greatest interest is the 2 lb. N/1000 sq. ft. rate (20 lbs product/1000 sq. ft.). Crabrass was reduced by 60% in 1991 and by 85% in the 1992 at that rate of application.

It should be pointed out that there is no postemergence control of weeds. Any weed that has germinated and formed a root will not be controlled by corn gluten meal. As is the case with any weed and feed material, the weeds that do germinate will benefit from the nitrogen in the corn gluten meal.

The mechanism of weed control centers on the growth regulating, inhibition of root formation at the time of germination. It has been observed in both the greenhouse and in the field that if the soil surface remains wet during the germination period, affected plants may recover and resume rooting. A short drying period is needed for the death of weed seelings during the critical time when no root system has formed. As is the case with other natural subtitutes for synthetic pesticides that have reached the market, corn gluten meal will not provide as complete control as synthetics and is likely to cost more. But, it does provide a natural substitute for those who choose not to use synthetic herbicides for preemergence weed control.

In 1989, another major project was initiated to find the chemical structure of the active component responsible for the inhibition of root systems. Ph.D. candidate Dianna Liu has been working for 3 years on the project and in early 1992 identified 5 chemical structures associated with the root inhibiting response. Synthetic samples of these materials were obtained and the same root inhibiting response as observed with the naturally occurring materials has been demonstrated with the synthetic materials. These active components will open the door to many other areas of research. Possibly the corn gluten meal could be fortified to increase its effectiveness at lower rates of application. Less material would be required to achieve complete weed control.

A second Ph.D. student, Bryan Unruh, is presently conducting studies to determine the mode of action of these materials at the cellular level. This work could potentially lead to the discovery or development of similar compounds of use for weed control.

The active component may be useful in its pure form for weed control in cropping systems for which the corn gluten meal is not practical because of its cost. Research at Iowa State University by Dr. Jack Dekker of the Agronomy Department has shown that the corn gluten meal is active against many important agronomic weeds of significance in corn production. He has also shown that some corn hybrids are susceptible to its effects whereas others are tolerant. When the active component is available in larger amounts, there should be corn hybrids identified on which it can be safely tested.

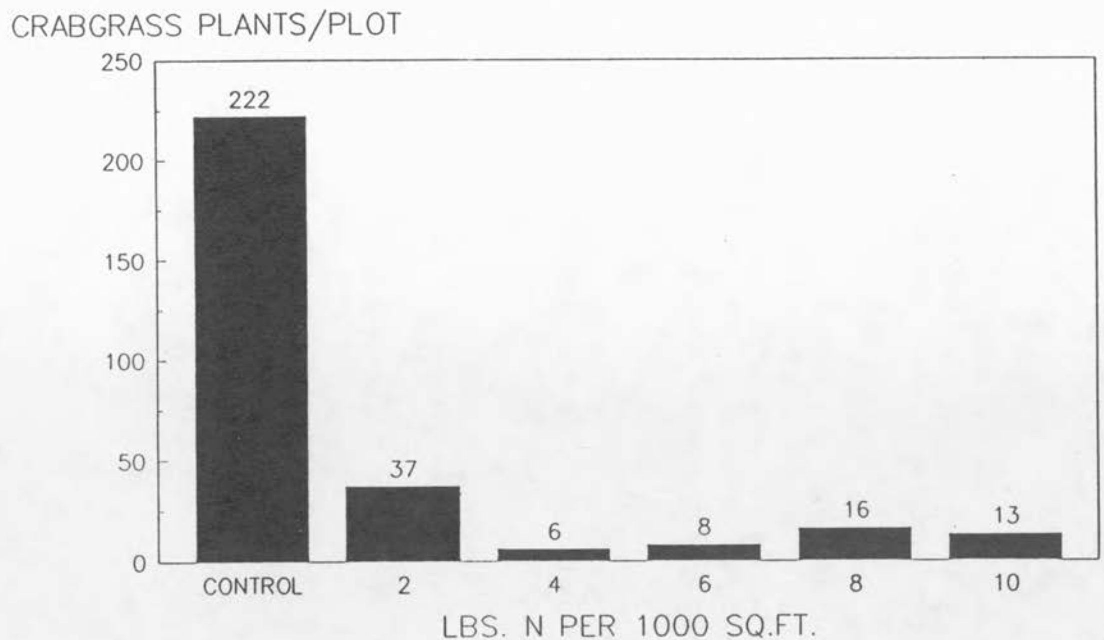
Strawberry's, along with other fruit and vegetable crops, present a more immediate opportunity for the use of corn gluten meal in its natural form. These crops have a much higher value and could provide a practical market for meal when proper timing and application methods have been established for the many cropping systems involved. Two years of work on strawberries have been conducted in the greenhouse and field work of this and other crops are planned for the 1993 season.

The interest in the idea of using corn gluten meal as a natural weed control has met with a great deal of interest in the United States and in other countries. There is presently much interest among environmental groups in the restriction pesticide use, particularly in the urban environment where large quantities of these materials are used on lawns and gardens. A,ready market should be there when the material is becomes available for sale. The present goal is to have corn gluten meal ready for the turf market in the early months of 1994.

# 1992 CRABGRASS CONTROL TRIAL

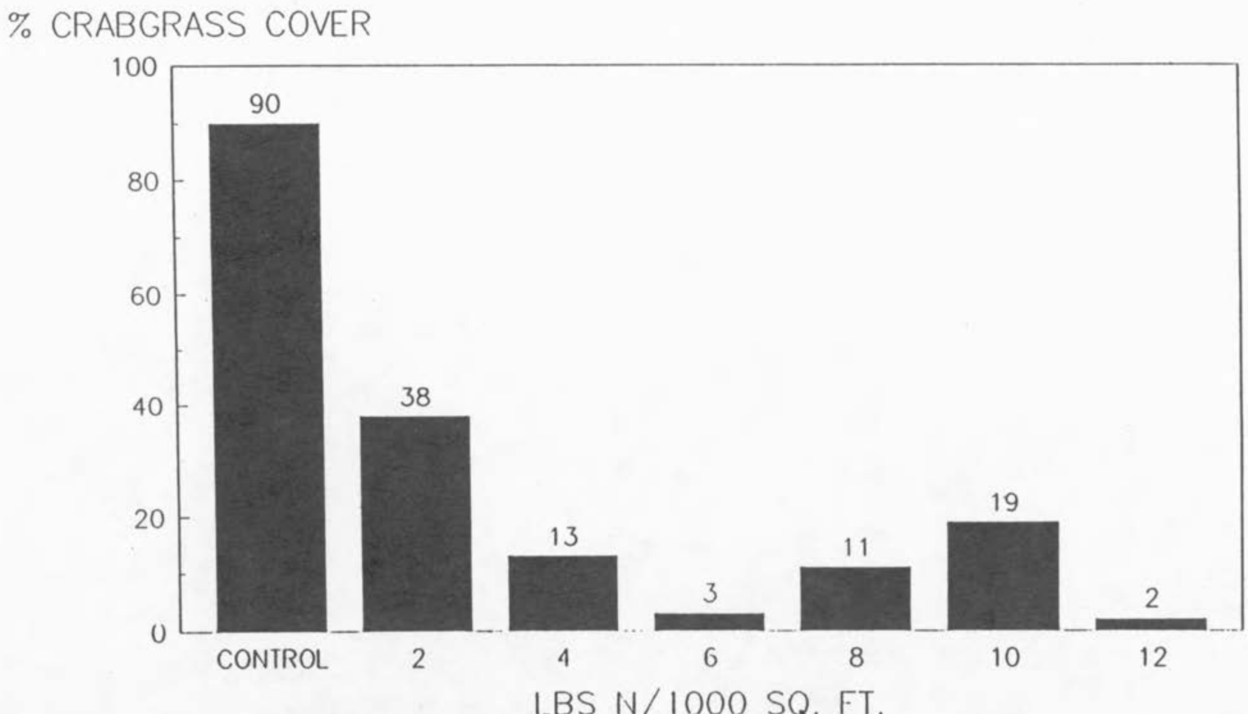
## CORN GLUTEN MEAL

### AUGUST 6, 1992




LSD 0.05 = 97

# CORN GLUTEN MEAL CRABGRASS CONTROL TRIAL
1991



# CONTROLS FOR EUROPEAN CRANEFLY-1993 RESEARCH UPDATE[1]

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European cranefly, *Tipula paludosa* Meigen, has been the main insect problem of turfgrass west of the Cascades for almost thirty years. The larval stage causes the damage by feeding on turfgrass roots and crowns in the thatch layer and near the soil surface. Insecticides have been successful in controlling larval populations, but other alternative methods for control are under investigation. These methods include: Turplex, a neem extract, and two nematode species, Steinernema *carpocapse* (Exhibit) and *Steinernema feltiae*. These methods were compared to a standard insecticide treatment of chlorpyrifos, (Dursban DTI), and no treatment. Turplex was applied as one application with no water after application, one application with 1/4" water after application, 2 applications 14 days apart with no water after application and 2 applications 14 days apart with 1/4" water after both applications. Nematodes were applied at 500/in2 and watered into the lower turf canopy.

Larval weight and length were significantly less with the chlorpyrifos (Dursban DTI) treatment as shown in Tables 1 and 2. Exhibit and Dursban DTI were the only treatments which significantly reduced cranefly numbers over the six weeks of the experiment (Table 3) due to variability. Turplex did give a 43% reduction in cranefly numbers which could be enough to drop below the threshold limit of 25 larvae/ft2 and reduce damage. More evaluations need to be done.

Methods of monitoring european cranefly numbers were compared in the spring of 1992 and 1993. Five soil drenches, consisting of a 2% Safer's soap, 2% Lemon Joy, 2% ammonia, 2% bleach and Dursban DTI were compared to soil core destruction for estimating cranefly populations. None of the drench methods showed the true number of larvae present in the area. Only the core destruction method was able to detect the true number of larvae present in the sample (Table 4). Drenches showed only 1/2 to 2/3 of the actual cranefly present, with the Dursban DTI driving the highest number of larvae to the turfgrass surface in both years of the study.

Table 1. Change in Cranefly Larval Weight from 3/19 - 5/11/93

| | (g.) |
|---|---|
| Turplex (1 app. + water) | 2.15 a |
| No treatment | 1.71 a |
| *S. feltiae* | 1.52 a |
| Exhibit + Turplex | 1.17 a |
| Turplex (2 app. + water) | 1.09 a |
| Exhibit | .99 a |
| Turplex | .96 a |
| Turplex (2 app. no water) | .83 ab |
| Dursban DTI | -.32 b |

Table 2. Change in European Cranefly Larval Lengths Over Six Weeks

| | Average Increase in Length (mm) |
|---|---|
| Turplex | 9.720 a |
| Control | 9.540 a |
| Exhibit | 9.040 a |
| Turplex (2 app. + water) | 9.020 a |
| Exhibit + Turplex | 8.820 a |
| Turplex (1 app. + water) | 8.000 a |
| *S. feltiae* | 7.220 ab |
| Turplex (2 app. no water) | 6.160 ab |
| Dursban DTI | 4.040 b |

Table 3. Change in European Cranefly Numbers Over Six Weeks

| | Average Change in Larval Numbers/ft$^2$ |
|---|---|
| Control | .2000 a |
| Turplex (1 app. + water) | .0000 a |
| *S. feltiae* | -1.000 ab |
| Turplex (2 app. + water) | -4.400 abc |
| Turplex | -4.600 abc |
| Turplex (2 app. no water) | -4.800 abc |
| Exhibit + Turplex | -5.400 abc |
| Exhibit | -6.600 bc |
| Dursban DTI | -8.800 c |

Table 4. Soil Drenches vs. Core Destruction to Estimate Cranefly Larvae Populations

| | Cranefly larvae/ft$^2$ | |
|---|---|---|
| | 1992 | 1993 |
| Core destruction | 26 | 23 |
| DTI solution (1lb. a.i/A) | 10 | 16 |
| 1% Safer's soap | 5 | 6 |
| 2% Lemon Joy | 5 | 6 |
| 2% ammonia | 4 | 6 |
| 2% bleach | 3 | 15 |

# BUFFALOGRASS EVALUATIONS FOR THE PACIFIC NORTHWEST-1993 RESEARCH UPDATE[1]

Gwen K. Stahnke[2]

[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
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Buffalograss, *Buchloe dactyloides* (Nutt.) Engelm., is a warm season, dioecious, stoloniferous species. In Yakima, three replications of the 22 NTEP cultivars of buffalograss were established in July of 1991. This is the official National Turfgrass Evaluation Program (NTEP) Buffalograss trial in Washington. Over the past two years, ratings have been taken on stolon length, color, quality, percent green grass, spring greenup and percent dormancy. In this report we will only talk about stolon length, percent green and mean quality ratings for the Yakima plots.

In August of 1992, eleven of the 22 cultivars of buffalograss were transplanted at the WSU-Pullman turfgrass research farm. Seven cultivars were also transplanted at the WSU-Puyallup turngrass research farm. None of the seven buffalograss cultivars have done well at Puyallup. The weeds, especially annual bluegrass and pineapple weed are outcompeting the buffalograss. Shown below are a list of the 22 buffalograss cultivars in the National Turfgrass Evaluation Program at the Yakima Arboretum (Table 1) and those transplanted in Pullman (Table 2).

Table 1. NTEP Buffalograss Cultivars

| | |
|---|---|
| *NE 84-609 | Rutgers |
| NE 84-315 | *Sharps |
| NE 84-378 | NTG-2 |
| NE 84-45-3 | NTG-3 |
| NE 84-436 | NTG-4 |
| *Buffalawn | NTG-5 |
| AZ-143 | *Bison |
| Highlight 4 | *BAM 101 |
| Highlight 15 | *BAM 202 |
| Highlight 25 | *Texoka |
| *Prairie | |

*Commercially available in 1993

Table 2. Eleven Buffalograss Cultivars Planted in Pullman
August, 1992

| | |
|---|---|
| NE 84-315 | Prairie |
| NE 84-609 | *Highlight 4 |
| NE 84-436 | Bison |
| Sharps | *Rutgers |
| *Buffalawn | NTG-2 |

*Cultivars which did not make it through the winter

Of the eleven cultivars planted inPullman,NTG-2, Bison, and Prairie were the fastest to cover approximately 90% of a 10' x 10' plot in one year. Three cultivars, Buffalawn, Highlight 4, and Rutgers did not survive the winter of 1992 in Pullman, The remaining eight cultivars showed only 10% winter kill in Pullman. Further evaluations will be necessary to fully determine if buffalograss cultivars are adaptable for use in Eastern Washington.

In Yakima, stolon lengths were measured and compared on May 13 and June 10, 1993 (Table 3). On May 13, NE 84-609 had significantly longer stolons than 14 of the buffalograss cultivars, while on June 10, NE 84-609 had significantly longer stolons that all other cultivars. NTG-5 had the next longest stolons on June 10, with the cultivars Highlight 4, NTG-4, BAM 202, :NE 84-315, and AZ 143 being in the top ten cultivars for greater stolon length on both evaluation dates.

Percent green buffalograss was evaluated throughout the season (Tables 4a and 4b). Early in the spring (4/28, Table 4a), NE 84-315 had the greatest percentage of green grass, with all four Nebraska selections greening up the earliest. Two weeks later (5/13, Table 4a), NE 84-609 had the greatest percent green grass, but was not significantly different from the other cultivars. By the end of June (6/28, Table 4b), the percent green of the buffalograsses had again changed with Rutgers and Highlight 15 having the greatest percent green (100%), but they were not significantly different from the top twelve cultivars. The last evaluation on 8/4/93 (Table 4b) did not show any significant differences between 18 out of 22 cultivars as far as percent green grass.

The overall quality of the buffalograss cultivars was evaluated for the entire 1992 growning season in Yakima (Table 5). Rutgers was the top ranked cultivar, but it was not significantly different from the top 18 cultivars. Variability was great between replications of the cultivars. Only Rutgers, NTG-5, Highlight 15, NE 84-609 andNTG-4 had significantly greater quality than BAM 101 (Top Gun), Buffalawn, Highlight 25, and NE 84-45-3.

Table 3. Average Stolon Length for the Top Ten Buffalograss Cultivars

| Cultivar | 5/13 (INCHES) | Cultivar | 6/10 (INCHES) |
|---|---|---|---|
| NE 84-609 | 6 a | NE 84-609 | 18 a |
| NE 84-315 | 4 ab | NTG-5 | 12 b |
| Bison | 4 ab | Highlight 4 | 8 c |
| Sharps | 4 ab | BAM 101 | 8 c |
| BAM 202 | 4 ab | BAM 202 | 8 c |
| Rutgers | 4 ab | NTG-4 | 8 c |
| AZ 143 | 4 ab | NE 84-315 | 6 cd |
| NTG-5 | 4 ab | AZ 143 | 6 cd |
| Highlight 4 | 3 b | NTG-2 | 6 cd |
| NTG-4 | 3 b | NE 84-436 | 6 cd |

Table 4a. Percent Green Buffalograss

| Cultivar | 4/28/93 (%) | Cultivar | 5/13/93 (%) |
|---|---|---|---|
| NE 84-315 | 80 a | NE 84-609 | 70 a |
| NE 85-378 | 70 ab | Bison | 70 a |
| NE 84-436 | 70 ab | Sharps | 60 ab |
| NE 84-45-3 | 70 ab | NTG-1, BAM 202 | 50 abc |
| Prairie | 60 bc | Rutgers, AZ 143 | |
| NTG-3 | 60 bc | NTg-5, NE 84-315 | |
| NTG-2 | 60 bc | Highlight 15 | 40 abc |
| AZ 143, NTG-1 | 50 bcd | NTG-4, BAM 101 | |
| Sharps, NTG-4 | | | |
| NTG-5, BAM 202 | | | |

Table 4b. Percent green Buffalograss (cont'd.)

| Cultivar | 6/28/93 (%) | Cultivar | 8/4/93 (%) |
|---|---|---|---|
| Rutgers | 100 a | NTG-5 | 98.33 a |
| Highlight 15 | 100 a | Rutgers | 95 ab |
| NTG-3 | 95 a | Highlight 15 | 93.33 ab |
| NE 84-609 | 90 ab | Bison | 90 abc |
| BAM 101 | 90 ab | NE 84-609 | 90 abc |
| NTG-1, Sharps, Bison, NE 84-45-3, Highlight 25 | 80 abc | Prairie | 86.67 abc |
| | | BAM 202 | 86.67 abc |
| | | Buffalawn | 85 abc |
| Buffalawn, NTG-2 | 70 abc | NTG-3 | 83.33 abcd |
| | | NE 84-315 | 83.30 abcd |
| | | Highlight 4 | 81.67 abcd |
| | | NE 85-378 | 80 abcd |

Table 5. Mean Turfgrass Quality Ratings of Buffalograss Cultivars at Yakima, WA (1992)

| Cultivar | Quality | Cultivar | Quality |
|---|---|---|---|
| Rutgers | 5.9 a | AZ 143 | 4.8 abcde |
| NTG-5 | 5.6 ab | Highlight 4 | 4.8 abcde |
| Highlight 15 | 5.5 ab | NE 84-378 | 4.8 abcde |
| NE 84-609 | 5.5 ab | Sharps Improved | 4.8 abcde |
| NTG-4 | 5.5 ab | NE 84-436 | 4.7 abcde |
| NTG-3 | 5.4 abc | NTG-1 | 4.6 abcde |
| Texoka | 5.3 abcd | NTG-2 | 4.5 abcde |
| Bison | 5.0 abcd | BAM 101 (Top Gun) | 4.1 cde |
| Prairie | 4.9 abcd | Highlight 25 | 4.0 cde |
| NE 84-315 | 4.9 abcde | Buffalawn | 4.0 de |
| BAM 202 (Plains) | 5.0 abcde | NE 84-45-3 | 3.5 e |

At least one more winter is needed for a true evaluation of the buffalograss cultivars in Yakima and Pullman. Currently only eight of the 22 cultivars are commercially available with Texoka, Bison, Plains, and Sharps Improved being the only seeded cultivars which are feasible to plant here. NE 84-609 and Prairie are currently available only in vegetative forms commercially. Seed sources may beavailable within the next year.

# INTEGRATED PEST MANAGEMENT OF ORNAMENTALS[1]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
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A central purpose of an IPM program in urban horticulture is to lower populations of key pests below an injury level that is acceptable to homeowners or the public in general. I will discuss the effectiveness of such a program based on experiences gained as IPM coordinator for the University of Washington.

Urban landscapes are a mosaic of vegetated patches within a matrix of buildings, courtyards, fountains, parking areas and so forth. The structure of the matrix can have a major influence on pest populations by placing ornamental plants under unusual stresses. Buildings in particular, drastically modify the environment of associated plants. For example, interception of solar radiation reduces light and temperature exposures on the north side of buildings. Vegetation along the south side of buildings experience higher temperature regimes from direct insolation and reflected heat. Clusters of buildings often serve as canyon walls that funnel air and produce winds that can cool the surfaces of vegetation — a wind-chill effect.

The composition of ornamental plantings themselves, between and within vegetation patches, further complexes the variety of plant stresses that may occur in the urban landscape. The location of vegetation within the urban landscape and endogenous characteristics of the vegetation affect management options. Decisions on what species to plant, should consider whether the plants are annuals or perennials, native or exotic, and the specific cultural practices required by each species. Consideration of these elements, in the long run, regulate the kinds of pest problems that develop. For example, plant material at the entrance of a building, because of its unique aesthetic value, will require special attention to any pest problem. More remote patches of the same vegetation, on the other hand, may be managed as natural areas and not require any care. In general, maintaining plant diversity may concomitantly encourage diversity of pests but decrease the impact of any one pest.

In establishing an IPM program it is important to identify key plants which contribute significantly to the aesthetics of their location and are vulnerable to damage from pests. Identification of key plants, and pests that significantly impact their health and appearance (key pests), as well as the parasites and predators of key pests is a crucial developmental component of an IPM program. Information on the biology and phenology of key plants, and the biology and host selection behavior of key pests, as well as their parasites and predators must also be known.

In an IPM practice, accurate identification of the cause of plant damage is imperative. Misidentification of the damaging agent can render control efforts useless. For example, the presence of brown needles on a pine tree was initially thought to result from a two year drought. However, drought effects occur uniformly over an entire tree, while the pine in question had brown needles only on the lower portion of the crown. In addition, only last year's needles were affected. We found that the dead needle easily slipped off their fascicles and revealed an insect exit hole. This damage is symptomatic of the pine needle sheathminer, *Zelleria haimachi.* Further examination of foliage exposed pupae of the moth. As with foliar miners in general, Z. *haimachi* have difficulty regulating their body temperature in the presence of direct solar radiation. Consequently, foliar-miner problems are most likely to occur in shaded foliage.

The ability to distinguish between various kinds of insect damage to an ornamental plant is often necessary. Over 70 insects are known to attack elm trees. Fortunately, it is unlikely that all of these insects occur at once. At the University of Washington, few insects cause noticeable damage to elm trees. Leaf curl and chlorosis often indicate feeding damage caused by the woolly elm aphid, *Eriosoma americanum.* Stippling of foliage often indicates the presence of leafhoppers. Of the leafhoppers that feed on elms, the kind that feed on foliar mesophyll cells are most common and have not been a problem. However, leafhoppers that insert their mouthparts into veins of elm leaves can vector vascular tissue diseases. Leaf mining symptoms early in the year indicate damage caused by the elm leafminer, *Fenusa ulmi.* Damage that appears as irregularly shaped circular holes on leaves is often the result of feeding by the adult elm leaf beetle, *Pyrrhalta luteola.* This insect is the most important pest of elms at the University of Washington as larvae almost completely skeletonize the undersides of leaves in an outbreak. However, in other parts of Seattle, different pests pose problems on elm trees.

Pest monitoring is another important component of IPM. One use ofmonitoring is to determine when insect pests attain their different developmental stages. For example, daily high and low temperatures can be monitored and the data used to calculate degree days for predicting when elm leaf beetles eggs hatch and when the early instars occur. This is important because *Bacillus thuringensis* formulated specifically for elm leaf beetle is applied when larvae are in the first and second instars. When applied correctly, the effectiveness of control efforts are further enhanced because treatment occurs before larvae cause extensive damage. Another insect pest, lecanium scale, *Lecanium sp., is* most susceptible to pesticides in the crawler stage. After crawlers emerge they disperse to the underside of leaves on the host tree. A hand lens can be used to examine the foliage of trees infested with lecanium scale and establish when crawlers have emerged.

Monitoring is also conducted to determine if populations of a pest have reached a size likely to cause damage above a tolerable level. Monitoring populations of spruce aphid, *Elatobium abietinum, is* sometimes conducted by beating branches over a sheet of white paper. Aphids that drop to the paper are counted to assess the size of the population. Again, accurate pest identification is essential. The green spruce aphid, *Cinara fornacula,* for example, which is orange in color, feeds on twigs, not foliage as the spruce aphid does. Care must be exercised to only count the spruce aphids to get an accurate assessment of the pest causing damage to the foliage.

Monitoring parasites and predators can be as important as monitoring pests. Aphids, a chronic problem of barberry at the University of Washington, are frequently monitored in late spring to decided if treatment is necessary. During a particular year, populations of aphids may begin to increase, and lady beetles and lacewing larvae may be present in numbers insufficient to prevent aphid damage. Often, however, in the lower portion of the barberry patch, the aphids may be parasitized by wasps, evidenced as aphids turn from green to grey brown. The aphid population may continue to rise, but so will the number of parasitized aphids. Later an applied control decision may have to be made, but monitoring parasitic wasps may indicate that control of the aphids will occur without chemical control. In fact, during 1993, continued monitoring confirmed that aphid damage was maintained below a tolerable level by parasitic wasp activity.

Identification of injury thresholds and action thresholds are other important IPM components. The injury threshold identifies the greatest level of damage that a plant can tolerate. Action thresholds signal when pest populations are of a magnitude controls must be applied to prevent damage from exceeding the injury threshold. Both thresholds will vary with the location of plants across the landscape. Greater levels of damage can often be tolerated in remote portions of the landscape than can be tolerated at the entrance to a courtyard or building. For example, honeydew from woolly beech leaf aphids, *Phyllaphis fagi,* is tolerated where beech trees are located in wooded areas of campus. Honeydew is not tolerated when it sticks to bicycles locked in a rack beneath the crown of a beech tree, or when honeydew sticks to the pavement and the soles of peoples' shoes. Similarly, damage by the elm leafminer to the upper crown of an isolated elm will be tolerated simply because the damage is not seen. However, tolerance of damage caused by fungal pathogens to roses is low because the University of Washington's rose garden is located in a heavily used area and is one of the prominent features of the landscape.

Applied treatments in an IPM program may be cultural, biological, chemical, or a combination of methods. For example, proper plant selection is one strategy of cultural control. Spruce trees are highly susceptible to aesthetic damage by spruce aphid. Removal or exclusion of spruce from heavily used parts of the ornamental landscape will eliminate the problem. Planting disease resistant species is another strategy. For example, there are many cultivars of roses available from nurseries with varying degrees of resistance to black spot, rust, and powdery mildew. Proper placement of plants within the landscape is yet another strategy in cultural control. Frost sensitive and shade intolerant plants would be at risk on the north sides of buildings. Tall trees with shallow roots and full crowns would be at risk to windthrow where air movement is funneled through narrow passages between buildings. Disease problems increase where foliage remains wet for extended periods, such as when diseasesusceptible plants are placed near fountains. Plants such as boxwood and certain juniper species, which are susceptible to attack by leaf and needleminers, would have less foliar problems when planted in full sunlight.

There are other remedial controls, besides proper plant selection and cultural controls, that can be used as a means to prevent or mitigate insect problems. For example, leaf and needleminers problems can be minimized by pruning infested portions of the plant or that portion of the plant that is shaded. In our case, pruning the branches of the pine infested with pine needle sheathminer proved to be an effective remedial control. Pruning rose canes in late winter-early spring and removal of that material is another effective use of a cultural control to prevent damage from pathogens. Raking up and disposing of dead leaves under rose plants also removes spores of fungal pathogens. The rusty tussock moth, *Orgyia antigua, is* a serious pest of Oregon grape and laurel. Because O. *antigua* moths lay eggs on their cocoons, hand picking and removal of cocoons from host plants and surrounding structures is an effective way to reduce populations below the injury level. Maintaining vigorous plants through improved drainage, proper fertilization, and watering can enhance their ability to defend themselves from attack by key pests. In general, cultural controls increase the resistance of ornamental plants to pest damage during periods of stress.

The effect of biological control is evident in many instances across the University of Washington campus. The silver spotted tiger moth (SSTM), *Lophocampa argentata is* maintained at low endemic levels by at least three population regulating agents. Moths reared in the laboratory were found to be parasitized by a tachinid fly, an ichneumonid wasp, and an entomophagus fungus. Seventy five percent of the reared moths were killed by biological agents. Accordingly, the SSTM is present on campus but at a low endemic level.

In addition to encouraging resident parasites and predators, biological control can be enhanced by introduction of parasites and predators. In one successful case on campus, entomophagus nematodes applied to the soil beneath rhododendrons controlled weevil grubs feeding on rhododendron roots.

In those instances when cultural and biological controls are ineffective in maintaining damage by pests below a tolerable level, chemical control may be considered. To attain maximum control with minimal environmental consequences, chemical control should stress timing and proper selection of recommended chemicals. For example, application of fungicides should be timed to the phenology of the host plant by monitoring bud swell, bud burst, and weather conditions. Alternating fungicide applications will discourage the build up of resistance by pathogens to the chemicals used. Tortricid moths, the leafrollers and leaftiers, have been effectively controlled using a variety of *Bacillus thuringensis* (B. T.) applied when caterpillars are at an early instar. Another variety of B. T. has been formulated for uses against the elm leaf beetle. Treatment of aphid and scale problems can be accomplished with properly timed applications of summer oils and insecticidal soaps. Soil injection of a systematic insecticide was effective in control of oak-tree phylloxerans at the University of Washington. Exact timing and judicious use of small amounts of systemic pesticides for control of hemipterans can be done with one application per season as opposed to repeated applications of soaps or oils. Finally, all treatments should be evaluated to assess the effectiveness of the control measure. Comparison of pretreatment pest populations with post treatment populations must be done in order to assess treatment effectiveness. Alternatively, pest populations on treated plants can be compared to pest populations on untreated plants.

IPM programs change as more is known about pest-host interactions. In the broader picture, the dynamic and adaptive nature of IPM makes it a powerful and constructive tool to manage insect and disease problems across the urban landscape without producing more problems than it solves.

# TURFGRASS IRRIGATION: IT'S TIME TO KNOW HOW MUCH YOU USE[1]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
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Any doubts that water shortages in the Pacific Northwest are a growing concern were surely dispelled by the widespread restrictions imposed on turf and landscape irrigation during the 1992 irrigation season.

This situation is likely to occur with increasing frequency as the population of the region continues to expand, environmental pressures to maintain stream flows increase, and the capacity of delivery systems remains static.

Irrigation of turfgrass is viewed by many as a luxury during times of water shortage. Such views are often without consideration for the numerous practical and societal advantages of healthy, efficiently-maintained turf. As professionals associated with the care and maintenance of turfgrass, the onus is upon us, therefore, to use and promote efficient irrigation practices, and to demonstrate that turfgrass can be maintained without waste. If we don't, then disruptive ad hoc water restrictions will become the rule, and we will be doing our industry and society a disservice.

## EFFICIENCY REQUIRES KNOWLEDGE

Efficient use of water by turfgrass requires knowledgeable design and management of the irrigation system. A well-designed system permits uniform and timely application of water. Good design involves the appropriate spacing of sprinklers, sizing of pipes, and selection of controls.

Efficient management of irrigation involves application of only sufficient water to maintain acceptable turf quality and growth. This requires an informed assessment of the extent to which evaporation from the turf has exceeded that effectively replenished by rainfall since previous irrigation. This can be now be measured, as I shall discuss later. The rate of application should be such that run-off is avoided. In arid environments additional water may also be required at times to provide a degree of leaching. Regular inspection and maintenance of the application system are also important factors in achieving efficient use of water.

## THE CALIFORNIA MODEL

The state of California implemented legislation in 1992 to address the problem of increasing demand upon diminishing water supplies. Called the Model Water Efficient Landscape Ordinance, this addition to the state Code of Regulations (Division 2, Title 23, Chapter 2.7, Sections 490 through 495) provides guidelines by which local water agencies shall promote and regulate efficient water use for turf and landscape.

The regulations have present and future significance for the Pacific Northwest. This can be appreciated from California's assessment that:

1) the limited supply of state waters are subject to ever increasing demands;

2) the state's economic prosperity depends on adequate supplies of water;

3) state policy promotes conservation and efficient water use;

4) landscapes provide recreation areas, clean the air and water, prevent erosion, offer fire protection, and replace ecosystems displaced by development; and

5) landscape design, installation, and maintenance can and should be water efficient.

Using the collective expertise of a task force, California's model ordinance was developed with the purpose of:

1) promoting the values and benefits of landscapes while recognizing the need to invest water and other resources as efficiently as possible:

2) establishing a structure for designing, installing, and maintaining water efficient landscapes in new projects;and

3) establishing provisions for water management practices and water waste prevention for established landscapes.

The regulations are applicable to all new and rehabilitated landscaping for public agency projects, private development projects that require a permit, and developer installed landscaping. They set forth a wide range of provisions for achieving efficient water use including: calculation and allocation of maximum water allowances; water efficient landscape design plans; efficient irrigation design plans; irrigation schedules; maintenance schedules; auditing schedules; soil tests and grading plans; all of which must be documented. Other states looking for means to conserve water in the urban environment will find this an important reference legislation.

## EVAPOTRANSPIRATION AS THE BASIS FOR REGULATING IRRIGATION

My first inclination upon uttering the word "evapotranspiration", is to apologize, as a scientist, for the intrusion of scientific terminology into your daily lives. But then "total evaporation of water from plant and soil surfaces" is even more of a mouthful. The important fact, however, is that we can now predict evapotranspiration, or ET, from turf and landscapes with acceptable accuracy. This information, combined with rainfall measurement, can be used to regulate and monitor irrigation activity. I shall provide examples in a few moments.

The basis for estimating evapotranspiration from plants over a given period of time is that which would occur from healthy, well-watered grass in the same location. This rate, called "reference evapotranspiration" (inches/day, week or month), is affected by sunshine, humidity, wind, and temperature. As such, reference evapotranspiration provides an integrated measure of the weather for the purpose irrigation.

Calculation of the "maximum applied water allowance" for landscaping under California's new regulations is based upon reference evapotranspiration. Tabulated historical monthly rates for over two hundred regions throughout the state are an integral and important part of the legislation.

Historically, the U.S. Weather Bureau Class "A" pan evaporimeter has been the most widely-used device for providing regional estimates of evapotranspiration throughout the world. These large, water-filled pans are 48 inches in diameter, and are typically located at agricultural research facilities. Predictable relationships between evaporation from U.S. Class "A" pans and reference evapotranspiration have been established.

More recently, there has been a trend toward the use of automated meteorological stations, or "weatherstations", to provide daily estimates of reference evapotranspiration. These computerized installations generate and rely upon hourly measurements of solar radiation, temperature, humidity, wind and rainfall. Far simpler devices that provide the same information at a fraction of the cost are on the horizon.

## PREDICTION AND CONTROL OF TURFGRASS IRRIGATION USING ET

As stated earlier, the objective of efficient turfgrass irrigation is to replace only that water required to maintain acceptable plant quality and growth. Turf irrigation, therefore, is only required to the extent that this need is not satisfied by rainfall.

Summers in the populated areas of the Pacific Northwest are typically dry, and turf requires irrigation to maintain vigor, prevent dormacy, and reduce weeds. Spring and fall, however, can be variably wet, or dry. To be efficient, a watering program should thus be designed to provide the maximum expected need during peak season, but should be adjusted regularly to account for changes in evapotranspiration and rainfall throughout the season.

There are a number of formulas in use for calculating irrigation requirements. All use reference evapotranspiration as their basis, but differ in their accounting of the effectiveness of rainfall, and the efficiency with which water is applied. For my own purposes, and from practical experience, I prefer the following arrangement:

$$RT = \frac{PF \times SC}{AR} \times (ETo - ER) \qquad \text{(Eq. 1)}$$

where

RT = maximum expected runtime for an irrigated zone during peak irrigation season (hours/week)

PF = plant factor selected in accordance with the type and quality of turf or plants being irrigated. An average value for turfgrass is 0.6, but can range from 0.4 (low quality) to 0.8 for high quality turf.

SC = scheduling coefficient to adjust for the uniformity of water application by the irrigation system, and the acceptable percentage of dry areas. Determined by calculation or field tests, a scheduling coefficient of 1.1 to 1.3 is typical of well-designed and maintained systems, 1.6 is an average value, and 2.0 is indicative of a poor system.

AR = sprinkler application rate as determined by field tests or calculation (inches/hour).

ETo = reference evapotranspiration (inches/week). For calculating maximum runtimes, the local peak-season value for ETo is used.

ER = effectiveness of rainfall in satisfying evapotranspiration from well-watered grass (inches/week). An effectiveness of 75% is assumed, or ER = 0.75 x rainfall. The value of this term is usually close to zero during peak season.

Note: (ETo - ER) = "net evapotranspiration" (inches/week).

I know that many eyes tend to glaze over when presented with formulas. I shall therefore briefly describe the concepts behind Equation 1, and how it can be used in most simple fashion to determine when and how long to irrigate.

The objective is to come up with the maximum number of hours of irrigation required per week (RT) during the most demanding part of the season. The emphasis here is on time rather than quantity. This reflects the fact that the most efficient manner to control sprinkler irrigation of turfgrass is through the use of automatic controls (or "clocks") with repeat cycle features.

The number of days per week on which irrigation is actually applied is governed by a number of factors. For example, more frequent applications of lesser duration would be required for sandy soils (limited water holding capacity), heavy or compacted soils (slow infiltration rate), shallow-rooted turf (impervious layers), and sites with retricted time windows for water application (parks and golfcourses). The total maximum weekly requirement, however, would remain essentially the same.

The starting point for calculating maximum runtime is historic reference evapotranspiration (ETo) and rainfall records for your locality. Sources for this information include your irrigation equipment supplier, the local extension service, or your own records. Maximum net ET from well-watered grass is thus calculated (ETo - ER) in inches per week. This amount is then adjusted downward by the plant factor (PF) to estimate actual plant requirements, but increased by the scheduling coefficient (SC) to compensate for uneveness in water application by the sprinkler system. The better the system, the less the compensation. Dividing the result (inches/week) by the sprinkler application rate (AR, inches/hour) provides the maximum expected irrigation requirement (RT) in hours/week.

Once the calculation of maximum runtimes has been completed for each irrigated zone, and recorded in an irrigation program, then things become a lot simpler. This is so, since the term (PF x SC)/AR of Equation 1 remains effectively constant. As such, changes in the weekly runtimes (RT) throughout a season are a direct function of the current weekly "net evapotranspiration" (ETo -ER). For example, if a current net ET of 1 inch/week was 50% of the expected maximum during peak season, then current weekly runtimes would also be reduced to 50% of maximum.

Those of you who have centralized computerized irrigation controls and weatherstations have the luxury of implementing these adjustments automatically. One does not need this level of sophistication, however, to implement cost-effective, "weatherresponsive" scheduling of irrigation. Many automatic irrigation controllers today have a "water budget" feature that permits percentage or "global" adjustment of programmed runtimes with the push of a key. Alternatively, days or cycles can be added or deleted from a program with ease. The key to implementing this simple approach is ready access to local current net evapotranspiration information. A practical refinement is to add a rain-sensitive override switch to each of your controllers.

## MONITORING AND EVALUATION

Evapotranspiration and rainfall records provide the basis by which the efficiency of water application to turf and landscape sites can be readily evaluated. For example, consider the following re-arrangement of Equation 1:

$$IR = PF \times SC \times (ETo - ER) \qquad \text{(Eq. 2)}$$

where

IR = irrigation requirement of a site (inches of water)

Now, consider a municipal turfgrass sportsfield with a well-designed irrigation system for which the scheduling coefficient (SC) is 1.33. That is, applied water exceeds average requirements by 33% so as to keep the drier spots green. An appropriate plant factor (PF) for high quality turfgrass is 0.75. Thus, during any given month, it would be expected that the site would require 0.75 x 1.33 x (ETo - ER) inches of water, where (ETo - ER) is the total net evapotranspiration for that month. Calculation of the actual number of inches applied then only requires knowledge of the irrigated square footage for the site, and the volume of water applied using water meter records or billings. Water use in excess of that expected would indicate wastage or breakage, and the need for corrective action.

Using this approach, Moisture Dynamics has performed audits of turf and landscape water use by a number of major institutional users of municipal water. On average, it has been found that total water applied thoughout a season generally exceeds actual requirements by 20%. Excess at some sites, however, can approach 100% of actual requirements. Thus, while many employee-irrigators are doing a fine job, there is significant room for improvement.

With respect to the future, I predict the day will come when users of municipal water, including homeowners, will receive credit for efficient use of water applied to turf and landscaping. Such credit, in the form of a reduced billing, could be based upon the difference between winter and expected summer use rates. This, in turn, would require a simple inventory of turf and landscaped areas for those customers who desire to be considered eligible for credit. This approach would help efficient landscape water users to off-set somewhat the general rise in water consumption charges that must come if we are to conserve.

# CHEMICAL EDGING WITH GLUFOSINATE ('FINALE')[1]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.

[2] Assistant Professor and Research Technician III, respectively, Department of Crop & Soil Sciences, Washington State University, Pullman, Washington.

## INTRODUCTION

'Finale' will be the trade name (common name - glufosinate) for a new herbicide product discussed as 'Ignite' at the 1993 NTA conference. Finale [glufosinate-ammonium:ammonium-DLhomoalanin-4-yl-(methyl)phosphinate] manufactured by HoechstRoussel Agri-Vet Company is a non-selective herbicide for the control of emerged weeds in noncrop areas. The herbicide is an organic product that decomposes into naturally occurring compounds. Finale should be an environmentally safe product to use.

Finale is a non-selective water-soluble herbicide for application as a foliar spray for the control of a broad spectrum of emerged annual and perennial grass and broadleaf weeds. Finale will control certain woody species. Plants that have not emerged at the time of application will not be controlled. A thorough spray coverage is important for excellent control. Under good growing conditions the visual effects of application will occur within 2 to 4 days. Finale has no soil residual activity, which makes it ideal for landscape situations.

In our research at Washington State University, we used Finale for chemical edging along fences and cart paths at the WSU Golf Course during 1992 and 1993. According to the specimen label, on the golf course, Finale may be used along cart paths, around sign and light posts, and around sand traps. Finale may also be used for trimming and edging landscape areas, e.g., around trees and shrubs, beds, fences, paths, and parking areas.

## OBJECTIVE

Our research objective was to evaluate the efficacy of Finale for chemical edging in turfgrass areas that had a broad spectrum of grass and broadleaf species under irrigated and non-irrigated conditions .

## MATERIALS AND METHODS

Treatments were applied as a directed spray application on a spray-to-wet basis to ensure uniform and complete coverage of all vegetation .

1992 Irrigated site.
Location: WSU Golf Course at Pullman, WA.
Date of application: June 17, 1992.
Split application: July 15, 1992.
Application technique: 'Hudson' 1.5 gal hand-pump sprayer with a single, hollow-cone spray tip. Each herbicide treatment was mixed in water and applied at 270 gpa.
Species in application area: dandelion, Kentucky bluegrass, creeping bentgrass, white clover, black medic, meadow salsify, shasta daisy, Canada thistle, sow thistle, redstem filaree, broadleaf plantain, annual bluegrass, and fineleaf fescue.

1992 Non-irrigated site.
Location: WSU Golf Course at Pullman, WA.
Date of application: July 9, 1992.
Split application: August 6, 1992.
Application technique: Hudson 1.5 gal hand-pump sprayer with a single, hollow-cone spray tip. Each herbicide treatment was mixed in water and applied at 270 gpa.
Species in application area: quackgrass, Russian thistle, Kentucky bluegrass, prostrate knotweed, pineappleweed, prostrate pigweed, redstem filaree, dandelion, meadow salsify, prickly lettuce, sow thistle, Canada thistle, kochia, fineleaf fescue, sheperdspurse, smooth bromegrass, and tall fescue.

**1993 Irrigated site.**
Location: WSU Golf Course at Pullman, WA.
Date of application: May 25, 1993.
Application technique: Hudson 1.5 gal hand-pump sprayer with a single, hollow-cone spray tip. Each herbicide treatment was mixed in water and applied at 200 gpa.
Species in application area: dandelion, Kentucky bluegrass, creeping bentgrass, meadow salsify, Canada thistle, broadleaf plantain, annual bluegrass, common groundsel, mouseear chickweed, field pennycress, prickly lettuce, and fineleaf fescue.

**1993. Non-irrigated site.**

Location: WSU Golf Course at Pullman, WA.

Date of application: May 25, 1993.

Application technique: Hudson 1.5 gal hand-pump sprayer with a single, hollow-cone spray tip. Each herbicide treatment was mixed in water and applied at 175 gpa.

Species in application area: quackgrass, Kentucky bluegrass, pineappleweed, prostrate pigweed, redstem filaree, meadow salsify, sow thistle, Canada thistle, fineleaf fescue, smooth bromegrass, tall fescue, common mallow, and field bindweed.

Table 1. 1992 treatments at the WSU Golf Course on irrigated and non-irrigated sites.

| | | Formulation | Rate |
|---|---|---|---|
| 1. | Untreated control | | |
| 2. | Finale* | 120 9/l | 2 fl oz/gal |
| 3. | Finale | 120 9/l | 4 fl oz/gal |
| 4. | Roundup | 3 Ib a.e./gal | 2.5 fl oz/gal |
| 5. | Finale + Roundup | 1.32 Ib a.e./gal | 2 + 1.25 fl oz/gal |

* NOTE: Finale treatments are labeled Ignite on figures in this paper.
Initial treatments were applied June 17, 1992; split applications were made July 15, 1992.

Table 2. 1993 treatments at the WSU Golf Course on irrigated and non-irrigated sites.

| | | Formulation | Rate |
|---|---|---|---|
| 1. | Untreated control | | |
| 2. | Finale* | 120 9/l | 2 fl oz/gal |
| 3. | Finale | 120 9/l | 3 fl oz/gal |
| 4. | Finale | 120 9/l | 4 fl oz/gal |
| 5. | HOE39866 | 60 9/l | 4 fl oz/gal |
| 6. | HOE39866 | 60 9/l | 6 fl oz/gal |
| 7. | HOE39866 | 60 9/l | 8 fl oz/gal |
| 8. | RoundupL&G | 1.32 Ib a.e./gal | 6 fl oz/gal |
| 9. | Roundup | 3 Ib a.e./gal | 2.67 fl oz/gal |

* NOTE: Finale treatments are labeled Ignite on figures in this paper. Treatments were applied May 25, 1993.

## RESULTS AND DISCUSSION

Finale is a new herbicide that should soon be released for turfgrass use as the 120 9/l formulation; therefore, this paper will report primarily on our research on the 120 9/l formulation. Table 3 gives a comparison of grass and broadleaf weed control obtained by the two (60 9/l or 120 9/l) formulations. There was essentially no difference between the formulations in vegetation control.

Table 3. Comparison of vegetation control by herbicide formulations (Finale or HOE39866) at a non-irrigated site at the WSU Golf Course in 1993.

| | g / I | fl oz/gal | Grass | Broadleaf |
|---|---|---|---|---|
| | | | % control | % control |
| Finale | 120 | 2 | 52 | 69 |
| HOE39866 | 60 | 4 | 69 | 75 |
| Finale | 120 | 3 | 78 | 84 |
| HOE39866 | 60 | 6 | 73 | 86 |
| Finale | 120 | 4 | 84 | 87 |
| HOE39866 | 60 | 8 | 85 | 88 |

### 1992 IRRIGATED SITE.

A single application of Finale (NOTE: labeled 'Ign' or Ignite in Fig. 1 to 8) at 2 or 4 fl oz/gal when observed for broadleaf/grass control (average control of grass + broadleaf) gave good, quick knock-down (Fig. 1). Vegetation control lasted approximately 28 DAT (days after treatment) and then began to decrease. Roundup 2.5 fl oz/gal gave slower initial vegetation control; however, control continued to increase until approximately 42 DAT. The Finale 2 fl oz/gal + Roundup 1.25 fl oz/gal treatment gave a level of control similar to Finale 2 fl oz/gal. With a split application 28 days after the initial application, all treatments showed very good control 28 to 56 DAT (Fig. 2).

### 1992 NON-IRRIGATED SITE.

A single application of Finale gave excellent early vegetation control (Fig. 3). As at the 1992 irrigated site, control decreased 28 DAT. Roundup alone at 2.5 fl oz/gal or in combination with Finale 2 fl oz/gal gave the best long-term control (28 to 56 DAT). Split applications of Finale or Roundup gave excellent initial and late control; however, the Finale treatments provided quicker initial vegetation control (Fig. 4).

## 1993 IRRIGATED SITE.

Finale 4 fl oz/gal gave the best initial control of grasses and the level of control persisted at above 80% for 42 DAT (Fig. 5). Finale 2 fl oz/gal did not control grass vegetation at the irrigated site nearly as well as the 4 fl oz/gal rate. Roundup 2.67 fl oz/gal gave poor initial grass control; however its level of control increased between 7 and 28 DAT, and 56 DAT it was giving the highest level of grass control. Broadleaf control (Fig. 6) was similar to that observed on grasses (Fig. 5), but the difference in level of control between the 2 and 4 fl oz/gal rates of Finale was not as great in the broadleaf species.

## 1993 NON-IRRIGATED SITE.

Finale 4 fl oz/gal gave good initial grass control and the level of control persisted above 85% for 56 DAT (Fig. 7). Roundup initially was slow to control grasses, but 14 DAT it was giving 80% control and over 90% control from 28 to 56 DAT. The 2 fl oz/gal rate of Finale did not give acceptable control of grasses at the nonirrigated site (less than 60% at all rating dates). Broadleaf control by Finale 4 fl oz/gal was initially good and continued at approximately 90% to 56 DAT (Fig. 8). Roundup 2.67 fl oz/gal gave poor initial control (less than 30% at 7 DAT); however, broadleaf control by the 4 fl oz/gal rate of Finale and the 2.67 fl oz/gal rate of Roundup was very good 28 to 56 DAT (approximately 90% broadleaf control).

## CONCLUSIONS

Finale gave very good initial (quick vegetation knock-down) grass and broadleaf control on irrigated and non-irrigated sites for chemical edging. Control persisted approximately 28 DAT and then began to decrease. Repeat application, as seen in 1992, 28 DAT extended the control period to 56 DAT. The 4 fl oz/gal rate of Finale overall gave a superior level of control compared to the 2 fl oz/gal rate. The difference between the 2 and 4 fl oz/gal was especially noticeable in 1993 when treatment were applied in May compared to the later application dates in June and July during 1992.

## ACKNOWLEDGEMENT

This research was supported in part in 1992 and 1993 by funding from the Northwest Turfgrass Association. The senior author gratefully acknowledges the timely conducting of this research by Charles Golob while the senior author was attending the International Turfgrass Society meeting in 1993.

Fig. 1. Broadleaf/grass control following a single application of Ignite and Roundup under irrigated conditions in 1992

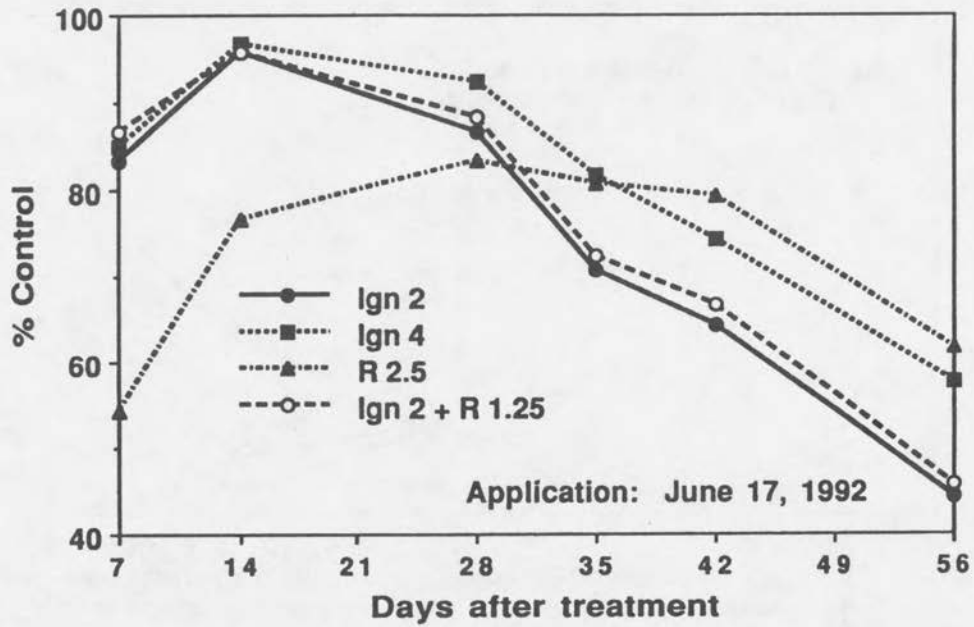


Fig. 2. Broadleaf/grass control with split applications of Ignite or Roundup under irrigated conditions in 1992 (Split app. at 28 days)

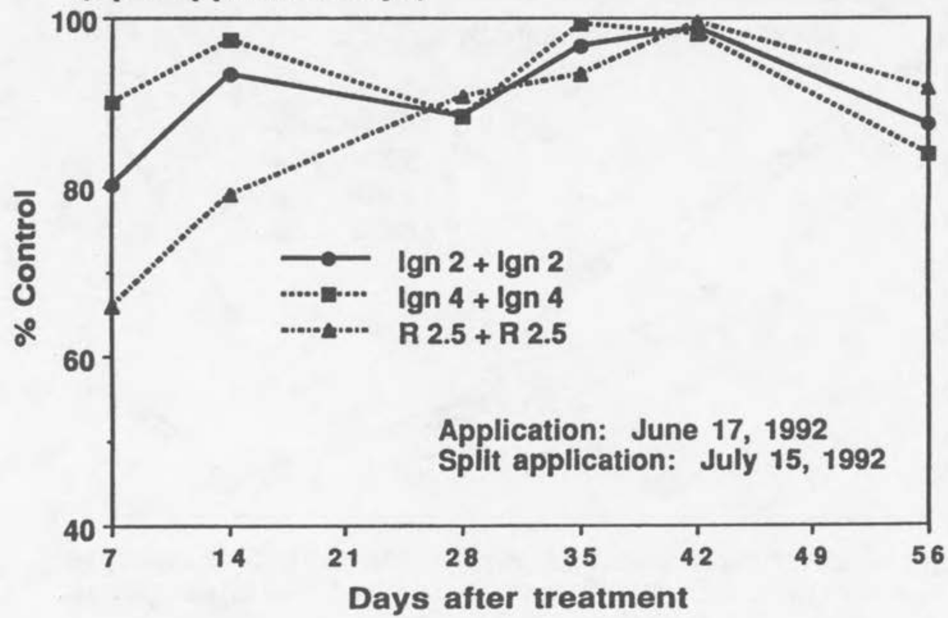


**Fig. 3.** Broadleaf/grass control following a single application of Ignite and Roundup under non-irrigated conditions in 1992

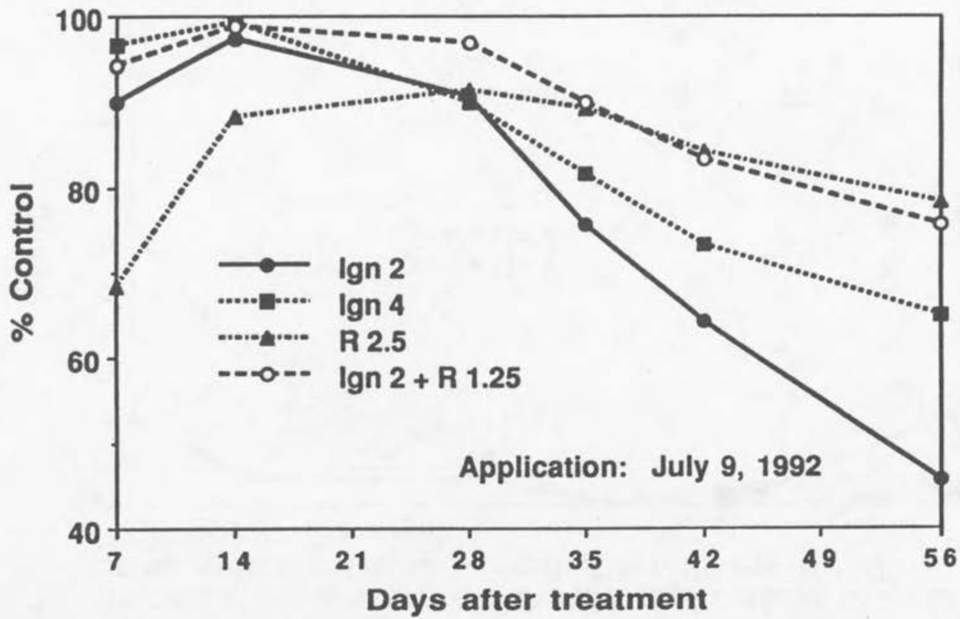


Fig. 4. Broadleaf/grass control with split applications of Ignite or Roundup under non-irrigated conditions in 1992 (Split app. at 28 days)

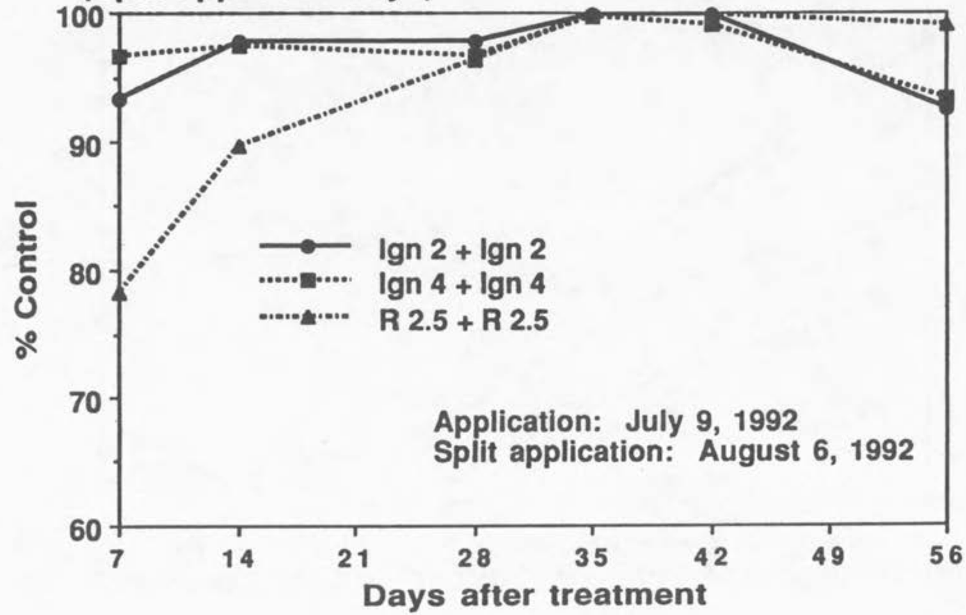


Fig. 5. Grass control following a single application of Ignite or Roundup under irrigated conditions in 1993

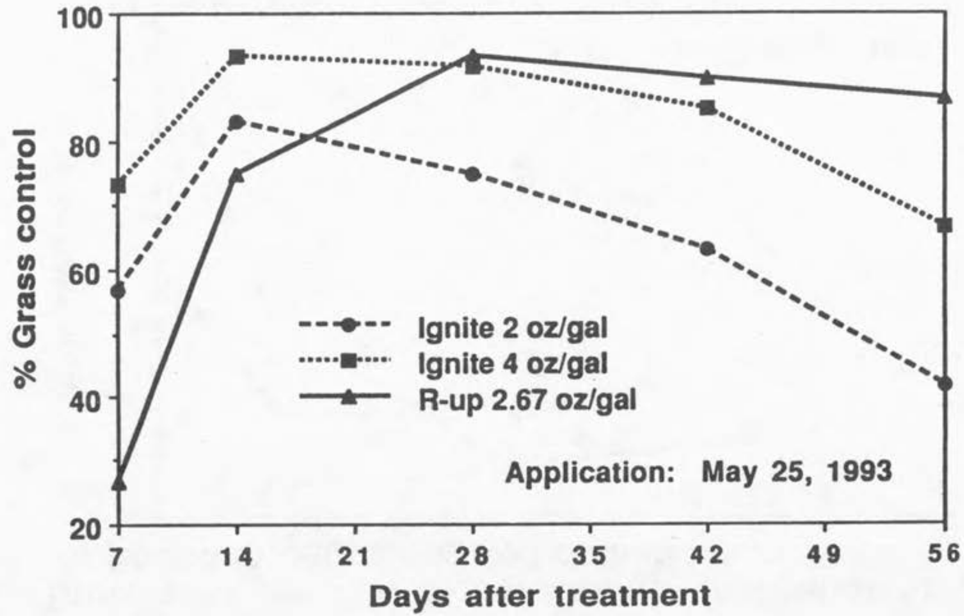


Fig. 6. Broadleaf control following a single application of Ignite or Roundup under irrigated conditions in 1993

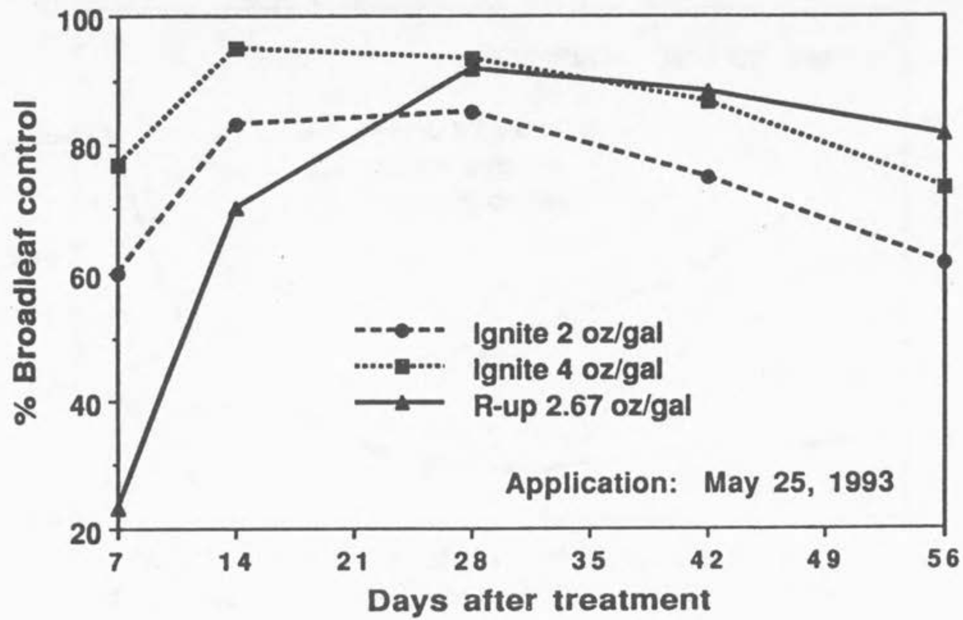


Fig. 7. Grass control following a single application of Ignite or Roundup under nonirrigated conditions in 1993

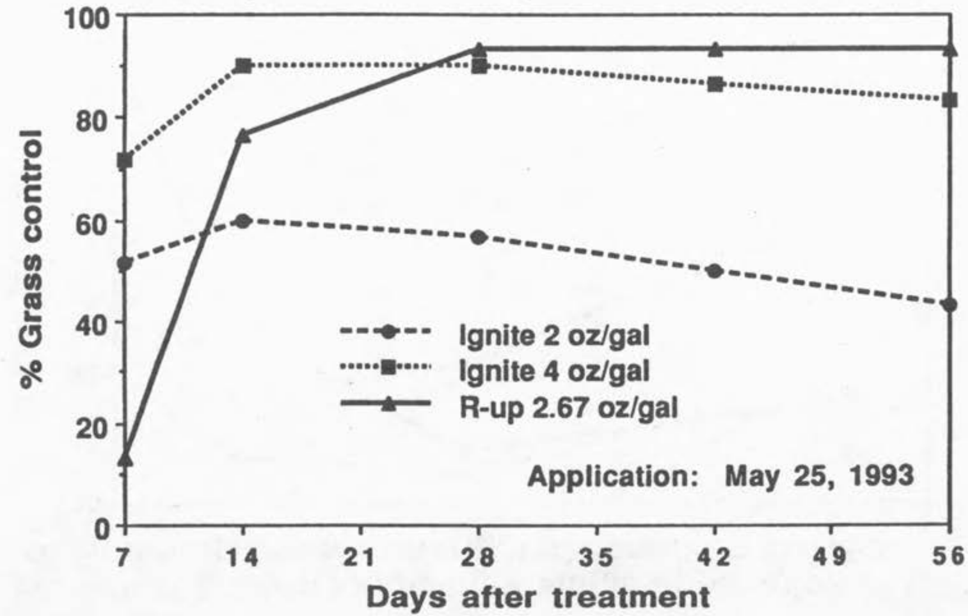
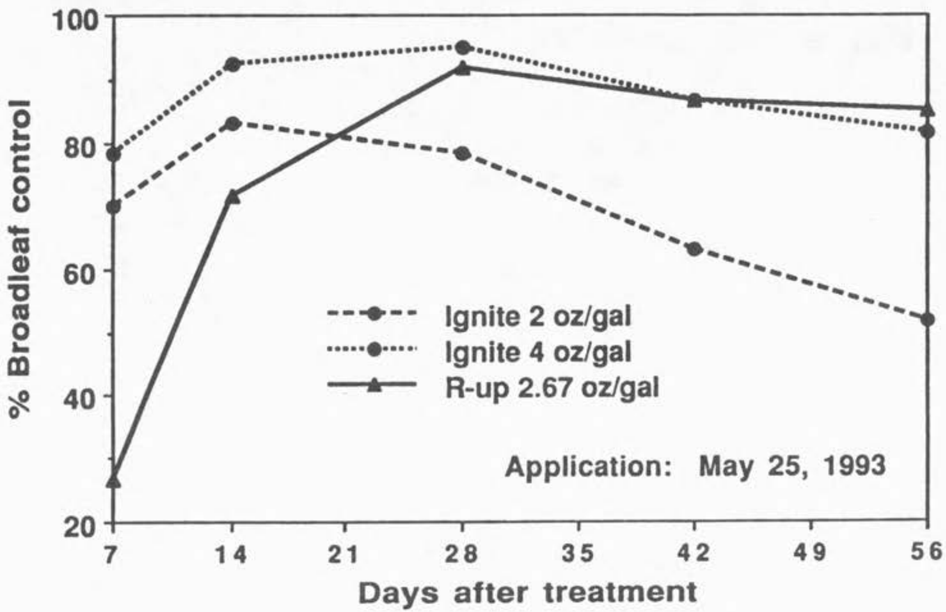


Fig. 8. Broadleaf control following a single application of Ignite or Roundup under nonirrigated condition in 1993



# THE EFFECTS OF FERTILIZER RATE, APPLICATION TIMING, AND ROOTING MEDIUM ON NITRATE LEACHING IN PUTTING GREEN SOIL[1]

J. Eric Chapman and William J. Johnston[2]
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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.

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[3] Extension Turfgrass Specialist and Coordinator, respectively, Washington State University Research and Extension Center, Puyallup, Washington.

## INTRODUCTION

In recent years, the turf industry has been seen as a potential threat to environmental quality due to perceptions of excessive nitrogen (N) use in order to maintain high turfgrass quality and appearance. In response to this, a study is being conducted at Farm 5, Washington State University Research and Extension Center, Puyallup, WA to provide greater information concerning the quantification and movement of nitrate N in sand-based and amended sand profiles.

The Pacific Northwest has a climate that includes long, mild, wet winters. Because of this, there is a history of constructing golf course putting greens, tees, and other athletic turf areas from unamended sand, some with coarse particle sizes, in order to reduce construction costs and improve drainage during the seasonal rains. This practice has led to public concern that leachate of nitrate-N may reach levels that could influence the quality of local ground water. Although nitrate leaching studies have been reported from mid-western, eastern, and southern locations in the United States, results from these studies may not apply to the climatic effects and construction techniques found in the Pacific Northwest. The current study was designed to address the issue of nitrate-N leaching risk from putting greens in the Pacific Northwest, and has been under way for two years. The objectives of the study are:

- To quantify the leaching of nitrate-nitrogen in pure and amended sand putting greens under a variety of N rates and application timings.
- To identify critical seasonal N loss.
- To provide best management practices for N fertilizer on pure and amended sand putting greens which promote environmental safety without sacrificing playability.

## MATERIALS AND METHODS

The study is being conducted on thirty six research lysimeters built similar to United States Golf Association putting green specifications. Each lysimeter measures 1.2 by 2.44 m, and is 36 cm deep. The lysimeters are lined with a chlorosulfonated polyethylene reinforced liner and fitted with a 37.5 mm perforated drain tube. The rooting medium consists of either pure sand, or an amended sand containing 88% sand, 10% spaghum peat, and 2% sandy loam.

The lysimeter area was seeded with 'Putter' bentgrass on 10 October 1991.

Fertilizer applications were made every 14 or 28 days. 22 or 11 applications were made per year, with no applications being made during the month of January. Fertilizer rates for the study were 4, 8, and 12 lb N 1000 $ft^{-2}$. The nitrogen fertilizer used was a granular blend of soluble and slow release types. Ammonium sulfate and ammonium phosphate represented soluble N sources, and equal parts IBDU, sulfur coated urea, and methylene urea represented the slow release N sources. Phosphorus, potassium, sulfur, and micronutrients were applied at regular intervals to all lysimeters.

Irrigation for the study was controlled to maintain field capacity and eliminate leaching except during natural rainfall. Samples were drawn from each lysimeter only when natural precipitation exceeded the moisture holding capacity of the lysimeter. Leachate volume data was recorded for each sample period. Each sample was preserved in 2 N KCl for storage. Nitrate concentrations were determined using segmented flow analysis for nitrate in ground water as established by U. S. Environmental Protection Agency (EPA) methods (EPA, 1984). Clippings were sampled weekly for use in plant grow-out and nitrogen level evaluations.

## RESULTS

Results from the second year of the study indicated several interesting trends. Statistical analysis of the this data is not yet complete, so the information discussed here is of a preliminary nature. Final statistical analysis is scheduled for December, 1993, and the results will be made available at the 1994 NTA meeting. For information on first year (1991), please see the Proceedings for the 46th annual NTA meeting (Chapman et al., 1992).

The first trend that can be observed from the 1992 data is that nitrate leachate values are, on the whole, much lower than those observed during the same time periods in 1991. The peak value for nitrate from October to December 1992 was 8.7 mg $L^{-1}$, compared to peak values of over 30 mg $L^{-1}$ for this time in 1991. EPA standards for safe drinking water limits nitrate concentrations to 10 mg $L^{-1}$. Lower values in 1992 may have resulted from maturation of the turf root system, and the accumulation of organic matter in the rooting profile. Organic matter has tended to increase in both soil types over time (Fig.7), and is being considered as a separate study.

A second trend noted was that for the observed portion of 1992, the only appreciable leaching of nitrate was at the 12 Ib N 1000 $ft^{-2}$ application rate. Figures 1 to 4 show that the 4 and 8 Ib N 1000 $ft^{-2}$ rates showed less than 0.5 mg $L^{-1}$ nitrate leached in any treatment. A rate of 12 Ib N 1000 $ft^{-2}$ is considered high for putting greens in the Pacific Northwest.

A third observation was that in 1991, the amended soil greatly reduced the amount of nitrate leached during peak leachate events (Fig. 5). In 1992, from October to December, higher values are observed in the amended soil than in pure sand (Fig. 6), although the amount of nitrate leached is below the EPA standards for either medium. This observation is consistent with other research done on nitrate leaching, which showed an increase in nitrate concentrations with an increase in soil content of the putting green. The reason given for this increase is higher mineralization capacity, perhaps due to to elevated microbial populations, in soils with higher soil contents. Higher mineralization could result in more rapid breakdown of soil organic material, with some of the released material being nitrate. The amended soil has shown higher amounts of organic matter than the pure sand (Fig. 7). If the plants were unable to take up additional nitrate due to slower fall growth patterns, then higher leachate values could be observed. The amended root medium does seem to show a buffering capacity during the 1992 period, with nitrate values initially lower and occurring later (Fig. 2 and. 4) than those observed in pure sand (Fig. 1 and 3).

Application timing did not seem to have an effect on total nitrate values during this period of 1992. Data from 1991 has shown that nitrate values tended to differ according to application timing, with less nitrate leaching occurring with the more frequent applications. This lack of effect from application timing seen in 1992 may again be due to the maturation of the root systems in both soil types over the course of the experiment.

## SUMMARY AND CONCLUSIONS

Data taken from 16 October to 16 December 1992 on nitrate leachate concentrations showed that of the three fertilizer rates, only the 12 Ib N 1000 $ft^{-2}$ showed values above 0.5 mg $L^{-2}$. The presence of soil amendments showed slightly higher peak nitrate values than those observed in pure sand. Over time, amended soils tended to show lower initial nitrate concentrations which occurred later and decreased more rapidly than values in pure sand. Fertilizer application timing seemed to show little effect. The amount of organic matter in the soil increased in both soil types over time.

Until a final statistical analysis can be completed, conclusions drawn from this study are tentative. However, it appears that reducing the total rate of nitrogen applied, and including amendments to pure sand during construction will provide benefits in controlling nitrate leaching from sand-based putting greens. Increasing fertilizer application frequency showed an observable reduction in nitrate leachate concentration in 1991, and may show more of an effect in 1992 when all data has been analyzed. As the turf root system matures, more nitrate can be taken up for plant use, thus lowering the amount of nitrate leached.

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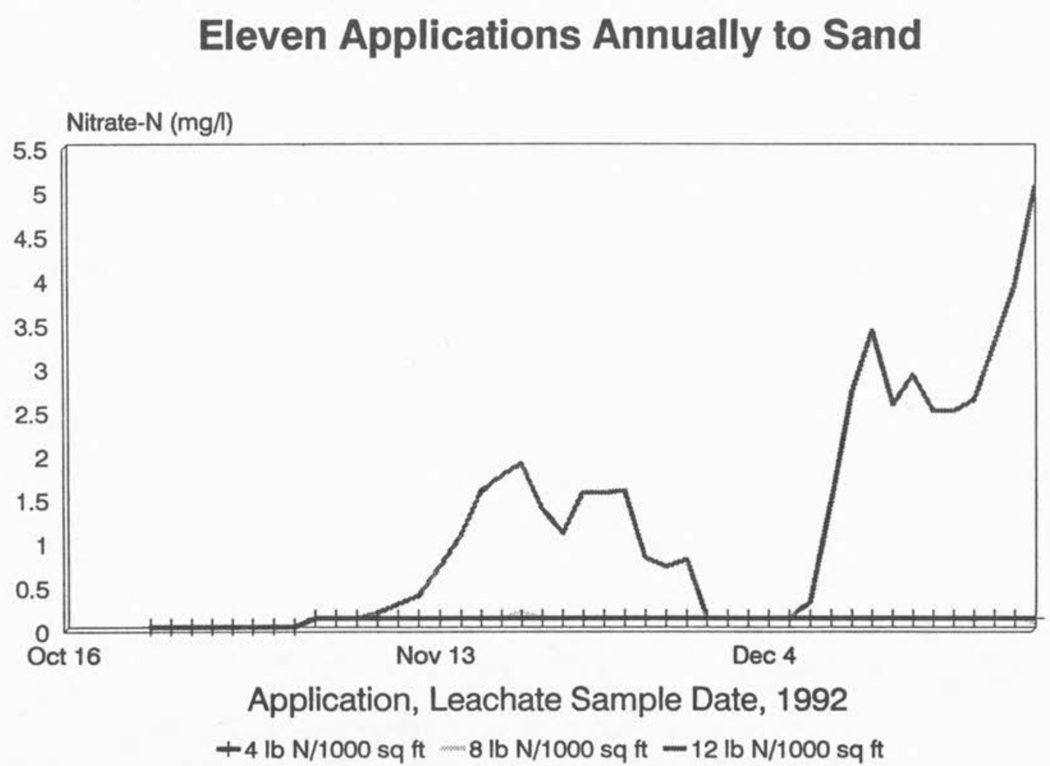
Environmental Protection Agency. 1984. Methods for chemical analysis of water and wastes. 600/4-79-020. Method 353.2.



Eleven Applications Annually to Sand
Nitrate-N (mg/l)
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Oct 16
Nov 13
Dec 4
Application, Leachate Sample Date, 1992
4 lb N/1000 sq ft
8 lb N/1000 sq ft
12 lb N/1000 sq ft


**Fig. 1**

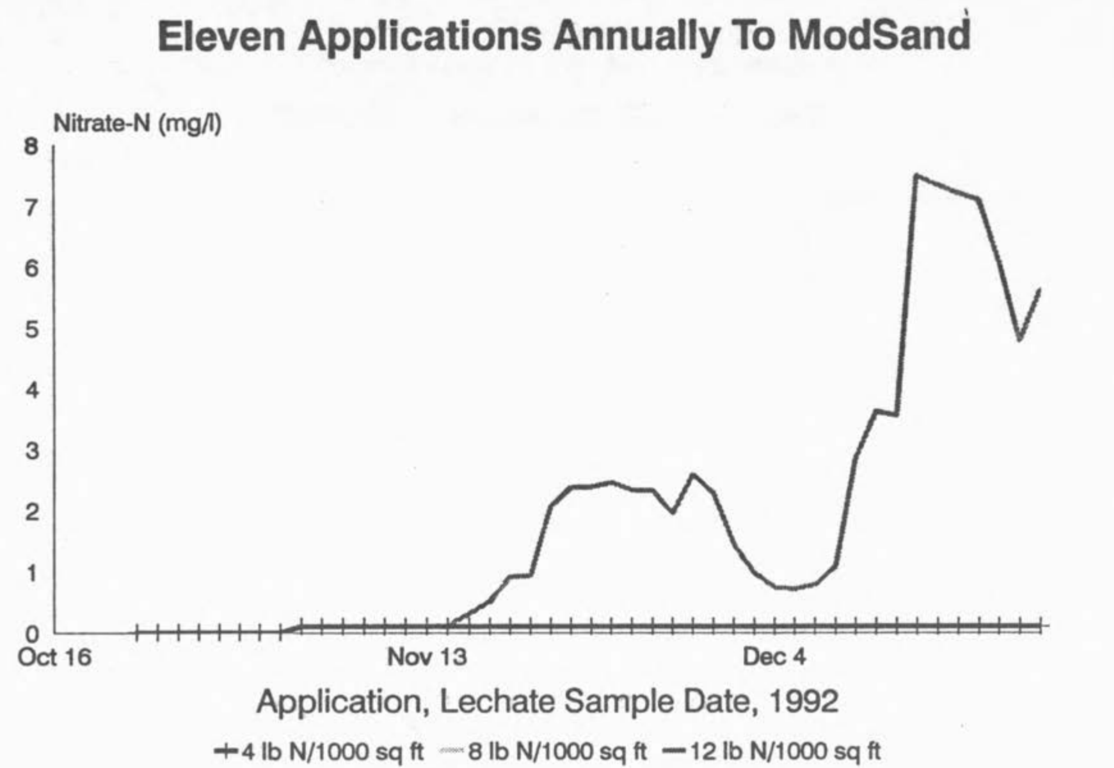

Eleven Applications Annually To ModSand
Nitrate-N (mg/l)
8
7
6
5
4
3
2
1
0
Oct 16
Nov 13
Dec 4
Application, Lechate Sample Date, 1992
4 lb N/1000 sq ft
8 lb N/1000 sq ft
12 lb N/1000 sq ft

Fig. 2

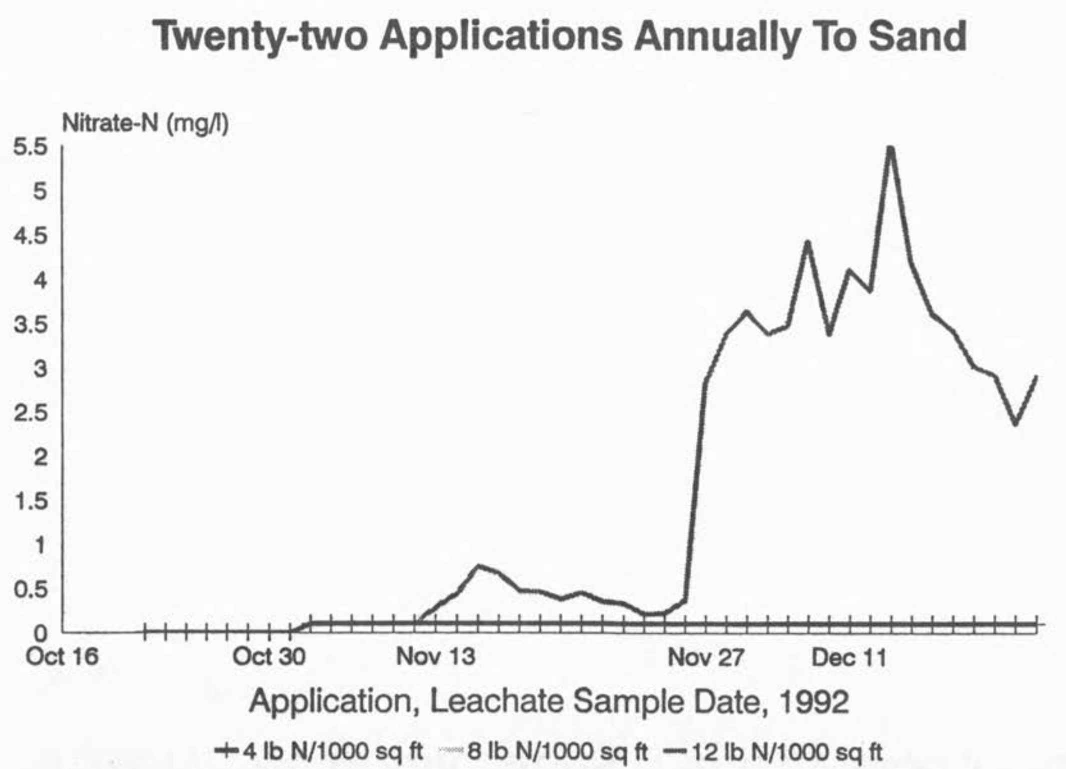

Twenty-two Applications Annually To Sand
Nitrate-N (mg/l)
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Oct 16
Oct 30
Nov 13
Nov 27
Dec 11
Application, Leachate Sample Date, 1992
4 lb N/1000 sq ft
8 lb N/1000 sq ft
12 lb N/1000 sq ft

Fig. 3

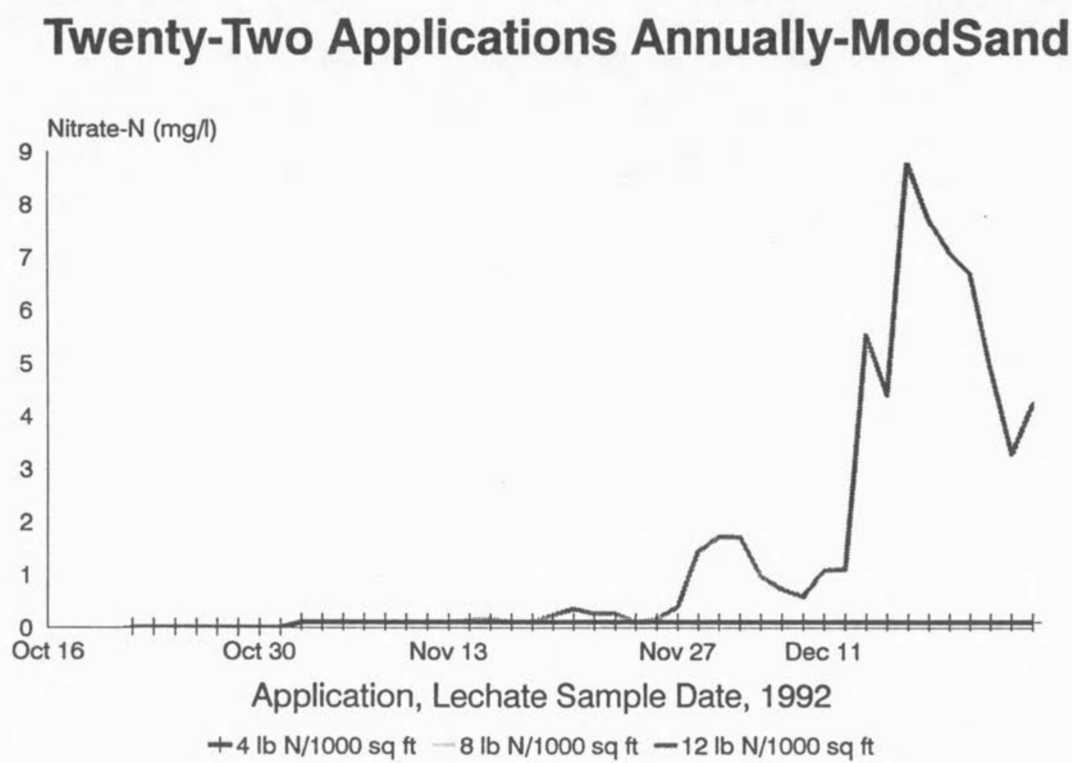

Twenty-Two Applications Annually-ModSand
Nitrate-N (mg/l)
9
8
7
6
5
4
3
2
1
0
Oct 16
Oct 30
Nov 13
Nov 27
Dec 11
Application, Lechate Sample Date, 1992
4 lb N/1000 sq ft
8 lb N/1000 sq ft
12 lb N/1000 sq ft

Fig. 4

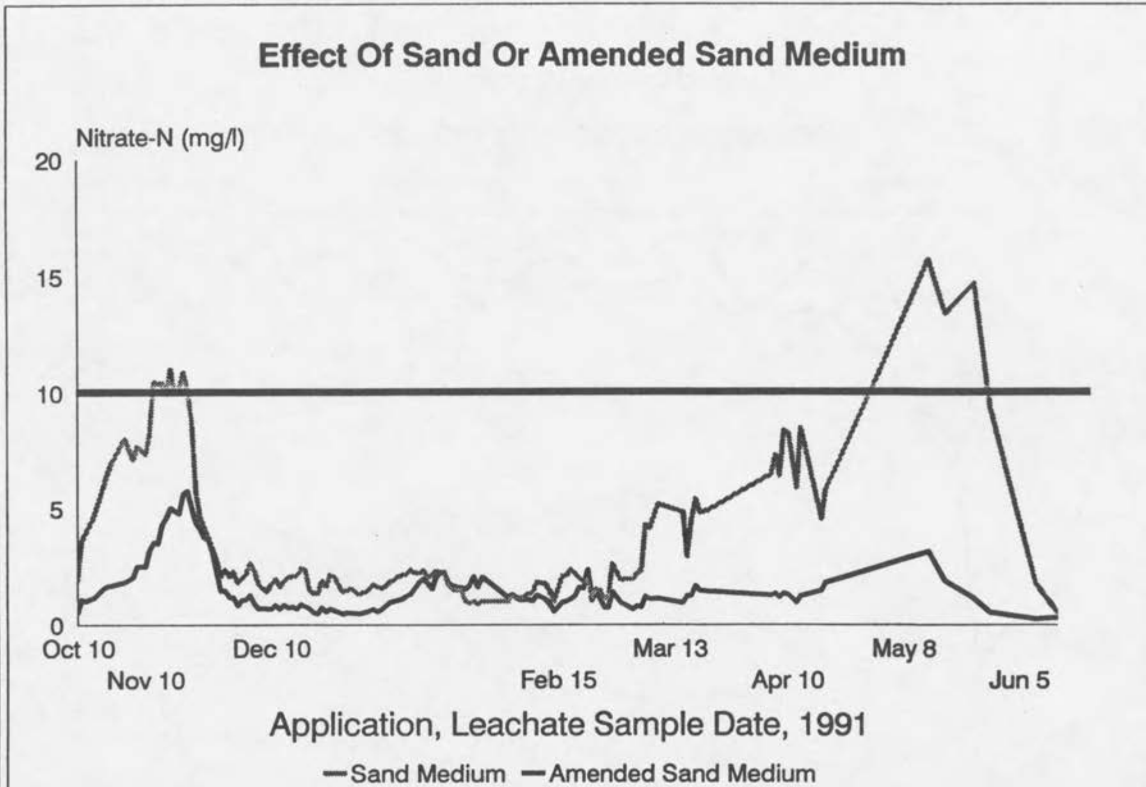

Effect Of Sand Or Amended Sand Medium
Nitrate-N (mg/l)
20
15
10
5
0
Oct 10
Nov 10
Dec 10
Feb 15
Mar 13
Apr 10
May 8
Jun 5
Application, Leachate Sample Date, 1991
—Sand Medium —Amended Sand Medium

Fig. 5

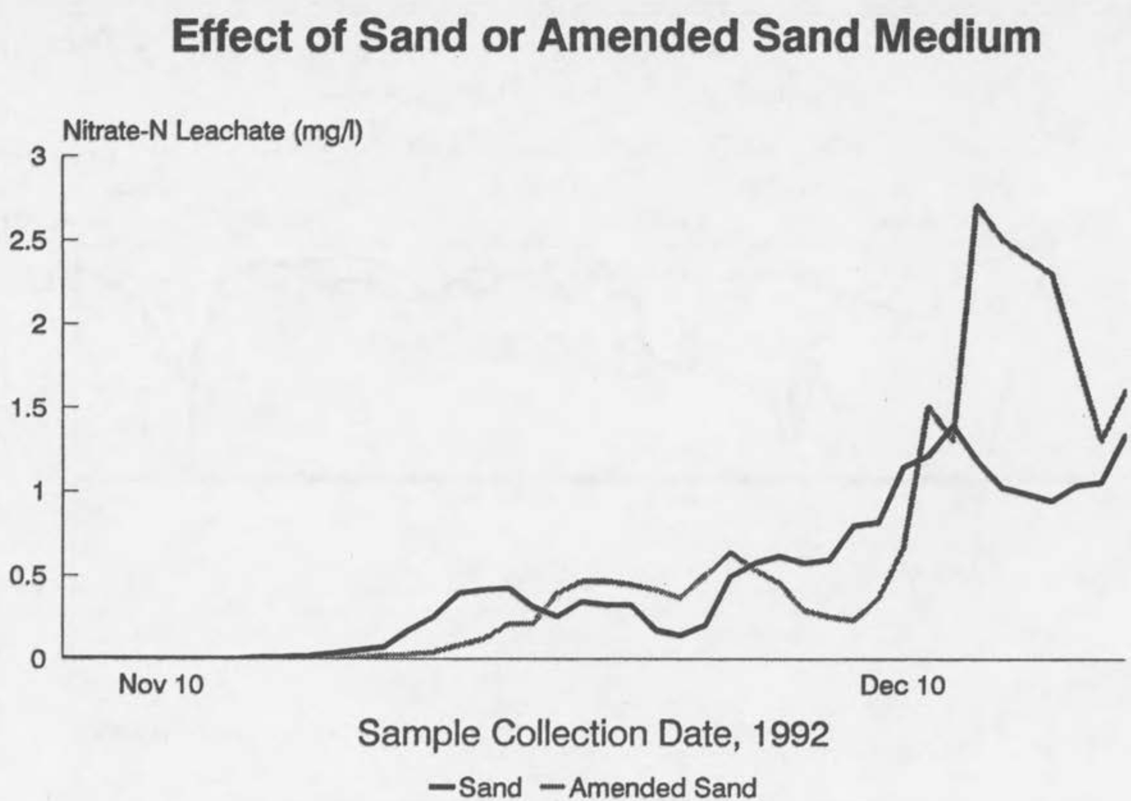

Effect of Sand or Amended Sand Medium
Nitrate-N Leachate (mg/l)
3
2.5
2
1.5
1
0.5
0
Nov 10
Dec 10
Sample Collection Date, 1992
—Sand —Amended Sand

Fig. 6

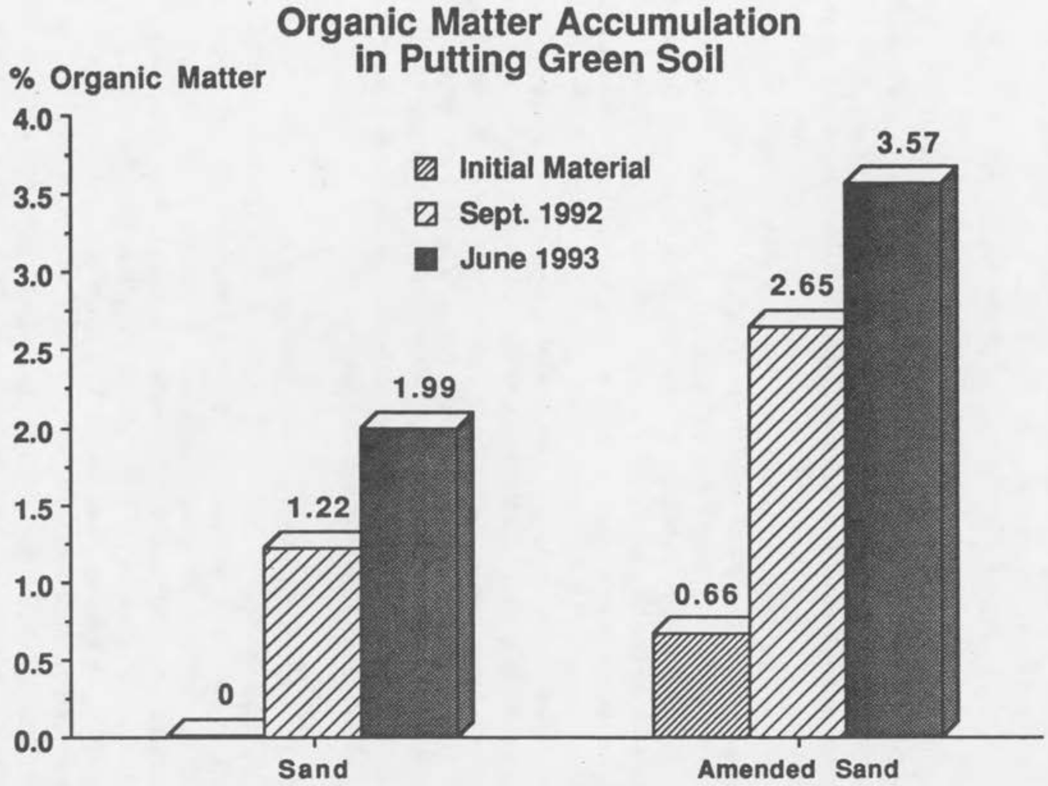

Organic Matter Accumulation
in Putting Green Soil
% Organic Matter
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Initial Material
Sept. 1992
June 1993
0
1.22
1.99
0.66
2.65
3.57
Sand
Amended Sand
Root Medium

Fig. 7

# PLANT DIVERSITY IN THE LANDSCAPE[1]

Jon C. Hooper[2]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
[2] Grounds Manager, University of Washington, Seattle, Washington.

Out of the thousands of plant species available and sustainable in the Pacific Northwest we almost always tend to actually plant and maintain a very small collection of plants. Why do you think that happens? Availability, survivability, cultural practices, aesthetics, maintenance practices and habit are all reasons why we are not more diverse with our plantings. We are missing out on a great deal of excitement, challenge, and beauty by not taking advantage of a very significant plant pallet. The University of Washington was also guilty of this problem up until a few years ago. (If you have ever been on campus you will view seas of Hypericum, Ivy and Otto Luyken) A group of concerned citizens, professors and staff expressed a strong concern that the new landscape planting improvements did not provide sufficient new plant varieties and diversity. Out of this protest evolved the University of Washington Plant Association Master Plan. The campus is divided into ten (10) different zones each having specific plant geographic character (Map 1). All new plantings now must include a high percentage (75%) of plant species that originate from those specific geographic areas. This system will guarantee the plant collection will improve our plant collection and diversity. The Universities need for plant diversity is specifically related to its educational value for various colleges and departments (Botany, Porest Resources, Landscape Architecture, Urban Horticulture and Entomology). The true value in plant diversity is in its beauty. education alld cultural practicality.

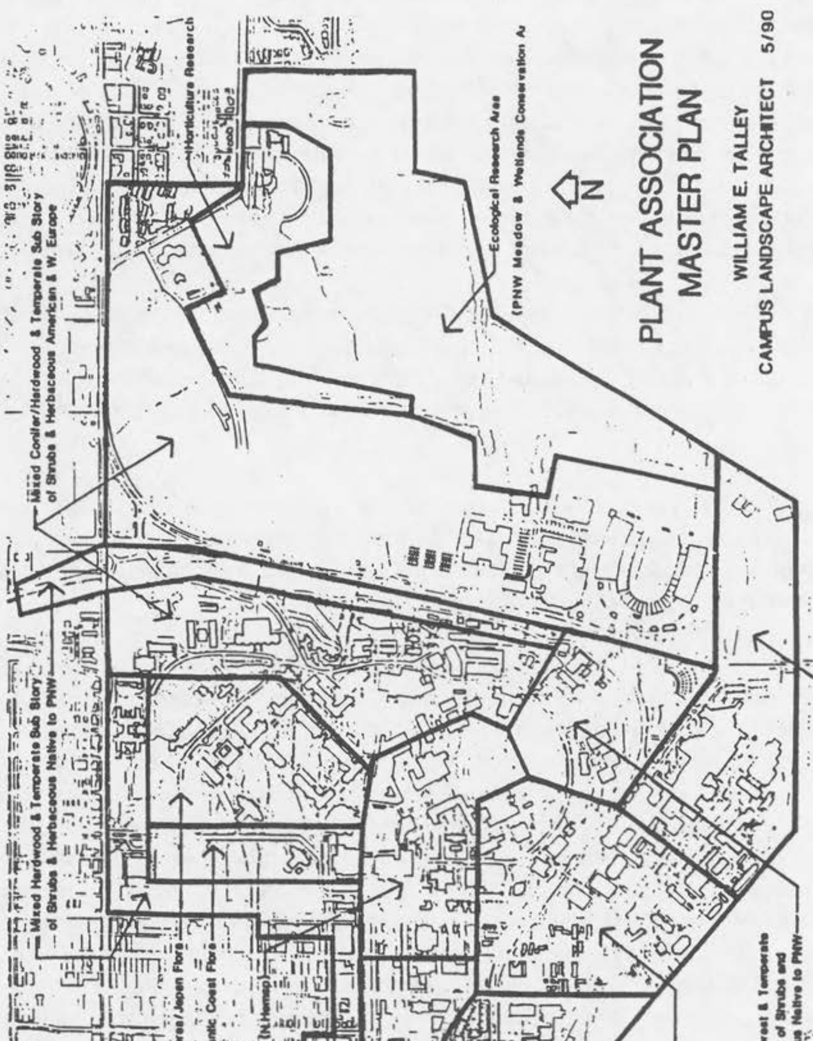
Today, the interest in gardening, by the general public, is at an all time high especially in regards to new and unusual species. This is shown by the popularity.of perennials, annuals and the success of Plower and Garden shows around the nation and the world. Your club members, customers and the general public are looking for and appreciates creativity, and ingenuity when it comes to new plantings, seasonal display beds and landscape restoration. The drought tolerant plantings that developed out of water shortages are excellent examples of what exciting diverse plantings can be developed when the need is created. In many cases, by looking differently at the available plant pallet additional landscape goals can be met. Reducing long term costs, improving plant performance in varying soil types, improving safety and security, developing new fragrances and improving the aesthetics of an area are a few possible benefits of this program.

How do you develop such a program and where would I start? First and foremost you need to make a commitment to the program otherwise the tendency is to stick with the old tried and true plants. You must accept up front that you will have some difficulties and failures as you will be pushing the range some plants. Once committed, the key to the program is developing a list of plants that will grow and develop in your climatic zone. Knowing the characteristics of the plants on your list will enable you to select the correct plant for the environmental and aesthetic parameters of each site (soil type, drainage, sunlight, plant texture, color, growing habit etc). In essence you need to be able to select the right plant or combination of plants for the right place.

Availability of plants may be difficult but growers are aware of the interest in plant diversity and are specializing to accommodate the demand. Our program at the University of Washington is causing even our consulting landscape architects to work harder at developing diverse planting plans that fit within our Plant Association Master Plan.

Problems? Yes as I mentioned before, not everything will go well. Plant hardiness, difficulty in establishment, poor plant performance. increased maintenance due to growing habit, and outright plant loss may result but with proper planning and preparation these problems can be minimized.

Enclosed is an abbreviated guide to potential available plant species for western Washington which I am sure would be suitable for western Oregon. For east of the Cascades you will need to develop a list of plants based on climate and hardiness. A quality publication I recommend is "Right Plant, Right Place", Nicola Ferguson, Summit Books 1984. This book lists and shows plants in color photo according to many factors (normal and fall color, soil types, drought tolerance, drainage, groundcover, hedges etc.). It is in paperback for around $20.00 at most book stores. For additional information contact your favorite nursery or an extension agent. Plant Diversity is an exciting and challenging venture and one that will - 1. Improve your landscape, 2. Improve your knowledge and appreciation of plants, 3. Satisfy and excite the viewing public and 4. Get many more exciting plants into the landscape. Please accept my invitation, at any time. to visit the University of Washington campus to get a feel for what Plant Diversity can do for your landscape.


Mixed Conifer/Hardwood & Temperate Sub Story of Shrubs & Herbaceous American & W. Europe
Horticulture Research
Ecological Research Area
(PNW Meadow & Wetlands Conservation A)
N
PLANT ASSOCIATION MASTER PLAN
WILLIAM E. TALLEY
CAMPUS LANDSCAPE ARCHITECT 5/90
Mixed Hardwood & Temperate Sub Story of Shrubs & Herbaceous Native to PNW
China/Korea/Japan Flora
United States–Atlantic Coast Flora
Mixed Pacific Rim (N.Hemisp)
United States / Pacific Coast Flora
Southern Hemisphere Flora
Mediterranean Sub Tropical Flora
Conifer Forest & Temperate Sub Story of Shrubs and Herbaceous Native to PNW
Eurasian Flora

## PACIFIC NORTHWEST NATIVE PLANTS

### Trees and Shrubs

Abies amabilis - Pacific silver fir
A. concolor - white fir
A. grandis - grand fir
A. lasiocarpa - subalpine fir
A. magnifica - red fir
A. magnifica v. shastensis - red fir
A. procera - noble fir
Acer circinatum - vine maple
A. glabrum - mountain maple
A. glabrum v. douglasii - Douglas maple
A. macrophyllum - big leaf maple
Alnus incana (tenuifolia) - mountain alder
A. rhombifolia - white alder
A. rubra - red alder
A. sinuata - Sitka alder
Amelanchier alnifolia - serviceberry
Andromeda polifolia - bog rosemary
Arbutus menziesii - Pacific madrone
Arctostaphylos canescens - hoary manzanita
A. columbiana - hairy manzanita
A. glandulos - hairy manzanita
A. parvifolia - small-leaved manzanita
A. patula - green manzanita
A. viscida - white-leaved manzanita
P. sitchensis - Sitka spruce
Pinus albicaulis - whitebark pine
P. flexilis - limber pine
P. jefferyi - Jeffrey pine
P. lambertiana - sugar pine
P. monticola - western white pine
P. ponderosa - ponderosa pine
P. sabiniana - digger pine
Populus tremuloides - quaking aspen
P. trichocarpa - black cottonwood
Potentilla fruticosa - shrubby cinquefoil
Prunus emarginata - bitter cherry
P. virginiana - common chokecherry
P. virginiana v. demissa - western chokecherry

Pseudotsuga menziesii - Douglas fir
Purshia tridentata - bitterbrush
Quercus chrysolepis - canyon live oak
Q. garryana - Oregon white oak
Q. kelloggii - California black oak
Q. sadleriana - Sadler's oak
Q. vaccinifolia - huckleberry oak
Rhamnu californica - California coffeeberry
R. purshiana - cascara
Rhododendron albiflorum - Cascade azalea
R. macrophyllum - Pacific rhododendron
R. occidentale - western azalea
Rhus glabra - western sumac
R. trilobata - skunkbush
Umbellularia californica - California bay laurel
Vaccinium deliciosum - Cascade huckleberry
V. globulare - globe huckleberry
V. membranaceum - thin-leaved huckleberry
V. ovatum - evergreen huckleberry
V. oxycoccus - wild cranberry
V. parvifolium - red huckleberry
Viburnum edule - moosewood viburnum
V. ellipticum - oval-leaved viburnum
V. opulus - high-bush viburnum

**Groundcovers**
Arctostaphylos media - X media manzanita
A. nevadensis - pinemat manzanita
A. uva-ursi - kinnikinnik
Berberis (Mahonia) repens - creeping Oregon grape
Ceanothus prostratus - squaw carpet
C. pumilus - swarf canothus
Cornum canadensis - bunchberry
Empetrum nigrum - crowberry
Fragaria spp. - strawberry
F. vesca - woods strawberry
F. virginiana - Virginia strawberry
Gaultheria ovatifolia - Oregon wintergreen
Linnaea borealis - twinflower
Maianthemum dilatatum - false lily-of-the-valley
Penstemon barrettiae - Barrett's beardtongue
Rubus pedatus - strawberry bramble

Satureja doooouglasii - yerba buena
Vancouveria hexandra - inside-out flower
V. planipetala - small inside-out flower
Whipplea modesta - whipplevine
Herbaceous Perrennials
Achillea borealis - northern yarrow
A. millefolium - white yarrow
Achlys triphylla - vanilla leaf
Acontitum columbianum - monkshood
Actaea rubra (arguta) - western red baneberry
Adiantum capillus-veneris - Venus-hair fern
A. pedatum - maidenhair fern
Agastache urticifolia - nettle-leaf giant hyssop
Anaphalis margaritacea - pearly-everlasting
Anemone deltoidea - western white anemone
A. oregana - oregon anemone
A. (Pulsatilla) occidentalis - mountain pasque flower
Angelica arguta - Lyall's angelica
Antennaria microphylla(rosa) - pink pusay-toes
Aquilegia flavescens - yellow columbine
A. formosa - red columbine
Armeria maritima - thrift
Arnica cordifolia - heartleaf arnica
Aruncus sylvester - sylvan goatsbeard
Asarum caudatum - wild ginger
A. hartwegii - marbled wild ginger
Asclepias fascicularis - maidenhair spleenwort
ASter alpinus - boreal aster
A. chilensis - Pacific aster
Chlorogalum pomeridianum - soap plant
Clarkia amoena - farewell-to-spring
C. pulchella - pink fairies
Claytonia megarhiza v. bellidifolia - alpine springbeauty
C. megarhiza v. nivalis - Wenatchee springbeauty
Clematis hirsutissima - sugar bowls
Clintonia uniflora - queen's cup
Coreothrogyne californica - prostrate beach aster
Corydalis spp. - corydalis
Cryptogramma acrostichoides (crispa) - parsley fern
Cymopterus terebinthinus v. ter. - turpentine cymopterus
Cynoglossum grande - Pacific hound's tongue
Cystopteris fragilis - fragile fern

Delphinium multiplex - tall larkspur
D. spp. - larkspur
Dicentra cucullaria - Dutchman's breeches
D. formosa - Pacific bleedingheart
D. formosa alba - white wild bleedingheart
D. oregana - Oregon dicentra
Disporum hookeri - Hooker fairy-bell
D. smithii - fairy lantern
D. trachycarpum - Sierra fairybell
Dodecatheon hendersonii - broad-leafed shooting star
D. jefferyi - tall mountain shooting star
D. pulchellum - few-flowered shooting star
D. spp. - shooting stars
Draba incerta - Yellowstone draba
D. paysoni - Payson's draba
E. montanum - avalanche lily
E. oregonum - giant fawn lily
E. revolutum (smithiij - giant fawn lily
Eschscholzia caespitosa - dwarf California poppy
E. californica - California poppy
Eupatorium occidentale - western eupatorium
Fragaria californica - California strawberry
F. chiloensis - coast strawberry
Frasera fastigiata - clustered fraser
Fritillaria camschatcensis - black lily
F. lanceolata - checker lily
F. pudica - yellow bell
Gaillardia aristata - blanket flower
Gentiana affinis (oregana) - prairie gentian
G. bisetae - elegant gentian
G. newberryi - Newberry's gentian
Geranium oreganum - western geranium
G. richardsonii - white geranium
G. viscosissimum - sticky purple geranium
Geum macrophyllum - Oregon avens
G. triflorum v. ciliatum - prairie smoke avens
Gilia aggregata - scarlet gilia
G. capitata - globe gilia
Goodyera oblongifolia - western rattlesnake plantain
Grindelia integrifolia v. macrophylla (stricta) - resinweed
Gymnocarpium dryopteris - oak fern
Hedysarum boreale - northern sweetvetch

Helianthella uniflora - little sunflower
Lillum columbianum - tiger lily
L. paralinum - leopard lily
L. washingtonianum - Washington lily
Linum lewisii - blue flax
Lithophragma parviflora - small-flowered fringecup
Lomatium nudicaule - barestem lomatium
L. spp. - desert parsley
L. utriculatum - common lomatium
Lonicera hispidula - hairy honeysuckle
Lupinus albicaulis - sickle-keeled lupine
L. albifrons - white-leaved lupine
L. argenteus - silvery lupine
L. argentus v. argentus (alpestris) - mountain lupine
L. bicolor - two color lupine
L. caudatus - tailcup lupine
L. ledidus v. lepidus - prairie lupine
L. littoralis - beach lupine
L. nanus - freshy lupine
L. polyphyllus - bigleaf lupine
L. sericeus - silky lupine
L. spp. - lupine
Machaeranthera (Aster) tanacetifolius - prairie aster
Matteuccia struthiopteris - ostrich fern
Mertensia paniculata v. borealis - tall bluebells
Mimulus cardinalis - cardinal monkey-flower
M. guttatus - yellow monkey-flower
M. lewisii - Lewis' monkey-flower
M. moschatus - musk monkey-flowe~
P. frigidus v. palmatus - sweet coltsfoot
Phacelia bolanderi - Boander's phacelia
Phlox adsurgens - periwinkle phlox
Pityrogramma traingularis - gold-fern
Plantago maritima - sea plantain
Polemonium carneum - great polemonium
P. occidentale - western Jacob's-ladder
Polygonum paronychia - black knotweed
Polypodium glycyrrhiza - licoriced fern
P. scouleri - leather-leaf fern
Polystichum andersonii (braunii) - Anderson's sword-fern
P. munitum - common sword-fern
P. munitum var. imbricans - Cascade sword-fern

Potentilla pacifica - common silverweed
P. spp. - cinauefoil
Pteridum aquilinum - bracken-fern
Pyrola asarifolia - pink pyrola
P. minor - lesser wintergreen
P. picta - white-veined pyrola
P. secunda - sidebells
P. spp. - pyrola
Ribes bracteosum - stinking currant
Romanzoffia sitchensis - Sitka mistmaiden
Saxifraga spp. - saxifrage
Scrophularia californica - California figwort
Sedum divergens - spreading stonecrop
S. lanceolatum - lance-leafed stonecrop
S. laxum - lax stonecrop
Wyethia augustifolia - narrow-leaf mule's- ears
W. helianthoides - white mulle's-ears
W. spp. - mule's ears
Xerophyllum tenax - beargrass
Zigadenus venenosus - death camas

**Grasses, Rushes and Sedges**
Agropyron caninum ss. majus (A. trachy.) - slender wheatgrass
A. dasystachyum - thickspike wheatgrass
A. inerme (A. spicatum var.) - beardless b. wheatgrass
A. riparium - streambank wheatgrass
A. smithii - western wheatgrass
A. spicatum - bluebunch wheatgrass
Aristida purpurea - purple three-awn
Bromus carinatus - California brome-grass
B. carinatus v. linearis - B. beviaristatus
B. marginatus (B. carinatus) - mountain brome
B. spp. - brome-grass
Calamogrostis nutkaensis - Pacific reed-grass
Carex brevicaulis - short-stemmed sedge
C. geyeri - Geyer's sedge
C. spp. - sedge
Cyperus spp. - cyperus
Danthonia californica - California oatgrass
Deschampsia cespitosa - tufted hairgrass
D. cespitosa v. longiflora - d. holciformis
Distichlis stricta - inland saltgrass

Eleocharis spp. - spike-rush
Elymus canadensis - Canada wildrye
E. cinereus - giant wildrye
E. glaucus - blue wildrye
E. glaucus v. jepsoni - western rye-grass
E. mollis (vancouverensis) - dune wildrye
E. triticoides - creeping wildrye
Festuca californica - California fescue
F. idahoensis - Idaho fescue
F. ovina - sheep fescue
F. rubra - red fescue
Hordeumn brachyantherum - meadow barley
Juncus effusus - common rush
J. ensifolia - daggerleaf rush
J. patens - spreading rush
J. spp. - rush
Koeleria cristata - Koeler's grass
Oryzopsis hymenoides - Indian rice grass
Panicum occidentale (pacificum) - witchgrass
Phalaris arundinacea - reed canarygrass
Poa alpina - alpine bluegrass
P. canbyi - Canby bluegrass
P. cusickii - Cusick's bluegrass
P. juncifolia (ampla) - big bluegrass
P. sandbergii - Sandberg's bluegrass
Scirpus spp. (bulrush)
Sitanion hystrix - bottlebrush squirreltail
S. jubatum - big squirreltail
Sporobulus airoides - alkali sacaton
S. cryptandrus - sand dropseed
S. microcarpus - small-fruited bulrush
S. validus - softstem bulrush
Sparganium emersum - simple-stem bur-reed
triglochin maritimum - seaside arrow-grass
Typha latifolia - common cat-tail
Zostera marina - grass-wrack
C. ercocarpus ledifolius - mountain-mahogany
C. montanus (betuloides) - birchleaf maintain-mahogany
C. hamaebatiaria millefolium - desert sweet
C. hamaecyparis lawsoniana - Port Orford cedar
C. nootkatensis - Alaska cedar
Chrysothamnus nauseosus - rabbitbrush

Clematis ligusticifolia - western clematis
Cornus nuffallii - Pacific flowering dogwood
C. stolonifera (sericea) - red-osier dogwood
C. stolonifera (sericea) v. occidentalis - red-osier dogwood
Corylus cornuta - western hazelnut
Crataegus columbiana - Columbia hawthorn
C. douglasii - Oregon hawthorn
Ephedra nevadensis - Nevada ephedra
E. viridis - mormon tea
Euonymus occidentalis - western spindlebush
Eurotia lanata - winter fat
Eraxinus latifolia - Oregon ash
Garrya buxifolia - box-leaved garrya
G. elliptica - silk tassel bush
G. fremontii - bear brush
Gaultheria shallon - salal
Golodiscus discolor - oceanspray
Juniperus communis - common juniper
J. occidentalis - western juniper
J. scopulorum - Rocky Mountain juniper
Kalmia microphylla - bog laurel
K. occidentalis - western swamp laurel

# LANDSCAPING WITH WILDFLOWERS[1]

Crystal Fricker[2]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
[2] Plant Breeder, Pure Seed Testing, Inc., Hubbard, Oregon.

We have been evaluating wildfowers at Pure-Seed Testing Inc. for twelve years. Our trials contain new species each year which are evaluated for seed production, flowering period, plant height, flower color, and aggressiveness. At our Oregon location we have studied over 800 species of wildflowers and ornamental grasses. Ninety percent of those species survived in our climate, which suggests the northwest is an excellent place to grow most wildflower species. We are continually looking for new species to produce as a rotation crop for our grass seed growers and as new additions to our wildflower mixtures.

Turf Seed Inc. is the marketing-production company that produces the wildflower seeds and markets wildflower mixtures. Wildflower seed sales have been increasing across the U.S. and in Europe and Japan. Wildflowers are being used on golf courses around the club houses in deep roughs, along cart paths, on slopes, difficult to mow areas and around tee boxes. Parks, industrial sites, roadsides and vacant lots are other places wildflowers are being planted.

The landscaper must decide between individual wildflower species or a mixture in his landscape. The advantage of a mixture is an extended blooming period with different colors, shapes and textures. When purchasing a wildflower seed mixture look for seed with 98% purity, 72% germination and no noxious weed seeds. The germination standard is lower due to dormancy inhibitors common in some wildflower species. Avoid mixtures with high percentages of cheap fillers such as Chicory, Baby's breath, Bachelor buttons and grasses. Some mixtures on the market have high proportions of less expensive items and low proportion of more expensive items resulting in an overall low quality mix. A good mixture should have not more than 5 to 10% of one item in the mix, depending on the number of species in the mix. Aggressive species can be helpful in a mixture especially in poor soil conditions. However, aggressive species need to be at lower proportions so they don't take over the mix in one year. Black-eyed-Susan, Yarrow, Toadflax and Chicory are aggressive species.

Some people say we should only use native species in our landscapes. Native species are great if you can get them. But most are hand collected, very expensive and hard to find. In 1988 and 1989 we were involved in a National Wildflower trial at 25 locations across the U.S. Twenty-five annual species and 25 perennial species were studied for 2 to 3 years. The results showed several species were broadly adapted in several different regions. Many of these species are in our wildflower mix called Bloomers, enabling it to perform well in most regions of the U.S. If a wildflower species is not invasive, adapted to your area and economically feasible, why not use it in the landscape? Another question commonly asked is should I buy seed grown outside my state? A consumer should not worry about where the seed was produced as long as it meets good seed standards. A genetic shift is not possible in a production field because there is no significant selection pressure in one growing cycle. As long a good stock seed is used there should be no concern if the seed was not produced in the use area.

A mixture with several components will perform well under several environments, open sun, shade, dry and wet conditions. Bloomers has 25 components half are perennial species and half are annuals. The following components are adapted to the northern United States: Perennial Gaillardia, Plains Coreopsis, Painted Daisy, Black-Eyed-Susan, Catchfly, Blue Flax, Godetia, Clarkia, Rocket Larkspur, California Poppy, Corn Poppy, Cornflower, English Wallflower, Siberian Wallflower, Lance-leaved Coreopsis, Sweet Williams, Purple Coneflower, Baby's Breath, Scarlet Flax, Spurred Snapdragon, Lemon Mint and Foxglove. This mix looks different with each variation of environmental conditions resulting in different species contributing to the overall performance.

Turf Seed Inc. is introducing a new wildflower mixture with a short plant height called Baby Bloomers. Baby Bloomers is 2' high containing several creeping perennials making it excellent for banks and terraced landscapes. Snow-in-Summer, Wild Thyme, Pink Evening Primrose and Missouri Primrose are a few of the components creating a unique low growing mix. Baby Bloomers can be used with Bloomers as a short contrasting border extending the overall blooming period and colors.

Once the wildflower mix is selected, proper establishment is a key step in the success of a wildflower planting. Begin soil preparation by removing existing vegetation with herbicides and or cultivation no deeper than 3 inches. Use a non-selective, non-persistent herbicide such as "Round-Up". Apply after rain or irrigation has sprouted weeds, usually mid spring for a spring planting or early fall for a fall planting. After the existing vegetation is removed, the seed bed should be prepared by tilling or diskirlg and dragging or raking smooth. For a uniform seeding mix seed with an equal amount of sand and broad-cast the seed in two directions. Rake seed in no deeper than 1/4". A seeding rate of 10 to 15 lbs. per acre or 6 oz. per 1000 sq. ft. is recommended. If there are no weed problems a no-till planting can be done, with a mulch to protect the seedlings until they are established. Hydro-seeding is another successful method of seeding wildflowers, especially on banks or areas that are diffucult to work up.

Irrigate the seeded area if rain showers don't keep the soil moist. Once the flowers are well established they shouldn't require irrigation unless wilting occurs. In fact, to much water will encourage foliar growth and less flowers. A 10-20-20 fertilizer can be applied at seeding time to get a good establishment. Usually, fertilizer is not needed unless the soil is depleted. A fall planting may be necessary if planting into dormant grass or if there is no irrigation available. Some wildflower seeds will germinate while others will lay dormant till spring. If there are bare spots come spring they can easilv be overseeded.

The cost of wildflower seed for an area is actually the same as grass seed because of the different seeding rates. Less wildflower seed is required because they develop into larger plants requiring more growing space. Grass weeds can be controlled with the labeled rate of poast. Some weeds may not be objectionable and blend in with the mixture. However, if weeds begin to take over an area you may need to spray with a non-selective herbicide and plant again. After 2 to 3 years the mixture will segregate to a few species and will need to be replanted. If established properly wildflowers can be a great addition to your landscape, requiring no mowing resulting on reduced maintenance costs. When compared to bedding plants wildflowers are more economical with less overall cost and maintenance. Give wildflowers a try and enjoy the natural beauty wildflowers can add to your landscape.

# WASH RACK ENVIRONMENTAL IMPLICATIONS[1]

Larry Gilhuly[2]

[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
[2] Western Director, USGA Green Section, Lake Forest, California.

Water. It's such a critical element to fundamental life on earth. It is constantly under attack from all forms of human impact and yet seems to be available in the Pacific Northwest in a clean form for human consumption. However, the issue of clean groundwater has become an environmental agenda item that is receiving far more scrutiny than in the past. Indeed, it is becoming a common practice to monitor groundwater on golf courses due to the posslble threat of fertilizers and pesticides.

The real question is, "Are the areas where we grow turf the greatest potential threat to groundwater?" Is it possible that a greater threat exists in our maintenance facility where we wash equipment and various other chemicals durlng the normal operations of equipment wash down following mowing operations and chemical applications. The answer, is an emphatic yes! If we can all go away from this conference understanding the importance of this single area in your maintenance operation, the chance for potential problems will be reduced.

There are those among you that may believe this approach is being somewhat reactionary. However, the following was recently enacted in the State of Illinois that offers us a glimpse of the future. An amendment to the Illinois lawn care act has established January 1, 1993 as the official date for requiring turf care professionals to use wash water and rinsate collections devices. The amendment also gave the Illinois Department of Agriculture the authority to permit such devices.

The rules set forth, as a result of the amendment, were developed this past summer by the IDOA, the Illinois EPA and several concerned and interested persons from the turf care industry and related fields.

All licensed applicators in the State of Illinois will receive the rules, a permit application and instructions for meeting the terms of compliance of the rules. The permitting process has been simplified to help reduce the possible increased cost that can result from an extensive engineering plan.

To simplify the permitting process, a general permit class system has been approved. The permit will require the applicant to provide a location map of the facility, a detailed description of the wash pad location, selection of either a Class A, B or C device and the inclusion of a water supply protection device such as a reduced pressure backflow device and any other information required by the IDOA. The permit would be renewable every 5 years.

This is just one example of states beginning to clamp down on wash areas and their potential problems. If you have a situation that requires improvement, there are three methods we have viewed during the past several years that address this issue. While every situation is different, and budgets must be taken into account, you may wish to consider one of these three alternatives for your wash area.

1. A sewer connection. If you can tie the wash area into a sewer, then a series of drop boxes can capture nearly all of the clippings following cleaning operations. An oil/water separator is also necessary with the remaining material entering the sewer system. With this type of operation, it would still be advisable to clean residues from pesticide sprayers or spreaders on areas covered with turf in the roughs.

2. A combination sewer and pesticide containment area. This unique combination was viewed at Eugene Country Club where Mr. Bill Norman has combined a wash area for equipment connected to the sewer and a separate pesticide building/wash area for all herbicide, fungicide and insecticide applications. This innovative approach totally controls all pesticide rinsates by separating residues into individuals tanks. The next time the pesticide operator is slated for an application, the residue accumulated from the previous spraying is used in filling the tank. For those of you who are in the vicinity, a trip to Eugene will be well worth the effort if your budget will allow this type of containment system.

3. Complete self-containment. Many of you have listened to or viewed the containment system installed at Riverside Country Club in Portland. Mr. Tom Christy has gone from one of the worst wash areas to the best we have viewed in the Western United States. Although it is more expensive and minimal maintenance is necessary, it does provide the ultimate answer in containing all wash material from the maintenance area.

It doesn't matter whether you are a private, public, high end resort or municipal golf course. Water still runs downstream or into the ground and the watchdogs of the environmental movement can't wait to nail your golf course with environmental pollution claims. Do yourself, your golf course and our industry a big favor by updating this portion of the maintenance operation.

# PROSPECTING FOR NATIVE GRASSES IN THE PACIFIC RIM COUNTRIES[1]

A. Douglas Brede[2]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
[2] Research Director, Jacklin Seed Company, Post Falls, Idaho.

It's been 40 years since the last American plant breeder made a grass collecting trip to the Peoples Republic of China. Dr. Glen Burton, preeminent plant breeder of the Tif-series of turfgrasses, was the last American to sample native germplasm in the communist nation. China has long been recognized as the birthplace of many important economic crops, including several species of turfgrass, notably zoysiagrass and centipedegrass. No foreign botanists have been allowed to remove germplasm from China since Sino-American relations cooled in the 1950's.

The 40-year ban on plant collecting in China is a result of what the Chinese perceive as a plundering of their natural resources (i.e., plant ecotypes) by foreign capitalists. They cite examples of foreigners who have taken raw plant materials and later return to peddle improved cultivars at inflated prices. Soybeans, a major economic crop that originated natively in China, was believed to have been smuggled out in the pockets of visiting scientists over that past hundred years. Today, China is importing improved soybean cultivars from the west, to the consternation of Chinese officials.

One of the earliest turfgrass collectors in China was the USDA's Frank Meyer. Meyer was a plant collector around the turn of the century who brought new plant materials to the US Department of Agriculture's introduction station in Maryland from all over the Orient. Many of today's crop varieties trace their lineage to plants Meyer brought back from his numerous trips.

But his fourth collecting trip to China in 1916 was to be his last. A steamer trunk containing centipedegrass sprigs was all that was found. His associates suspected he met with foul play, somewhere deep in China.

History is sketchy as to what became of the centipede sprigs in the steamer trunk once they reached the U.S. But it appears that the plant materials for which Meyer forfeited his life did not go to waste. They were established in turf trials at Oklahoma State University and later became the parents of the Oklawn centipedegrass variety.

Opening of this last iron curtain took quite some negotiating. Duane and Doyle Jacklin of Jacklin Seed Company, and Dr. C. T. Liu of the University of Idaho, visited with officials in Beijing in May 1992. Their visit paved the way for my collecting trip the following month. They worked out arrangements for joint cooperation on development of germplasm collected in China. Chinese companies would participate in the seed production of cultivars developed from the collected germplasm.

My collecting trip commenced in Beijing and included several of the eastern provinces of China along the Pacific coast. Specimens of zoysiagrass, bermudagrass, and Kentucky bluegrass were collected from native stands. Processing and shipping the germplasm through diplomatic channels required 6 weeks. The plants are presently growing out in the Jacklin greenhouse in Post Falls and field nursery in Georgia.

A major purpose of my collecting trip was to obtain a diverse base of zoysiagrass germplasm for the Jacklin breeding program. In recent years, Jacklin Seed Company has become the largest marketer of zoysiagrass seed in the U.S. To date, all ofthe seed sold by the company has been Chinese common, sold under the brand name, *Sunrise*.

Much of my collecting in China was along the Pacific sea coast. In the 40 years since Burton collected plants in China, a vast majority of the countryside has been developed for commercial agriculture. Undisturbed, native areas are now rare and are confined to mountain tops and seashore areas. Unlike the U.S. where the seashores are heavily developed, Chinese seashores are desolate, undisturbed areas with outcroppings of native plants.

I collected numerous plant samples growing directly in sea water brine. Some botanists speculate that zoysiagrass may in fact be a halophyte, a plant the "enjoys" salt and may even require it for its metabolism. I noted in my travels that certain strains of zoysia seemed to have more of an affinity for salt than others. Salt tolerance in turfgrasses is becoming a key issue in areas of the U. S., and discovering a salt-loving grass strain may help to revegetate salty turf soils.

# TURFGRASS PHOTOGRAPHY[1]

A. Douglas Brede[2]

[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
[2] Research Director, Jacklin Seed Company, Post Falls, Idaho.

Conveying some of the subtleties of nature onto film takes some coaxing. Humans view a scene in 3 dimensions, with the ability to discern depth, patterns, and textures that 2-dimensional film can't capture. But just as you can fool your camera, it's also possible to fool your film into capturing nature's subtleties.

For example, let's say you're trying to photograph a backfill problem with an irrigation line. The soil above the new pipe settled unevenly leaving a tell-tale dip along the length. You can clearly see the problem with your eyes — but can the camera see it?

Remember, the camera captures images in 2 dimensions. It can't discern a dip, which is a 3rd dimensional feature. So how do you shoot the scene so the dip will show up on film?

The trick is the use of shadows. Take the picture just after sunrise when the sun is low in the sky (a cloudy day won't work - the light is too diffuse). The low angle of the sun will cast a shadow along the dip and make it look quite pronounced on film.

Another example: You're trying to document some segregating patches of grass on your putting green. You suspect a bogus kind of seed was used at one time on the greens, and you're trying to document it. There are patches of different colored grass, 2 to 3 feet in diameter, all across the green.

After getting the photos back from the developer, to your dismay the grass in the photos looks perfectly free from blemish. What went wrong?

Film is tremendously sensitive to a wide spectrum of colors. Unfortunately, film is not particularly sensitive to varying shades of green. Shades of green your eye can see, the film can't.

To capture patterns of green hues in a picture you have to get a bit creative. Try waiting until there's dew or frost on the grass; sometimes different grasses present quite distinctive dew patterns. You might try different sun angles: take the picture of unclipped growth with the sun low in the sky. Shadows may make the patches more distinct. I've even tried the "crowbar" approach, which, incidently does not appear on film as obnoxious as it sounds. I took white string and carefully placed it around the perimeter of the patches. It made for an unforgettable picture that definitely helped document the problem.

## SLIDES OR PRINTS?

For presentations, you just can't beat the impact of slides. For that reason, perhaps 90% of my photography is slides. But there are situations where prints come in handy. I know of a golf course superintendent in Ohio who keeps a scrapbook of print photos of all the courses he's worked at. The scrapbook shows before-andafter shots of every improvement project he's done. It is quite impressive.

If you can't decide which to take — prints or slides — take slides. You can have slides made into prints more easier than prints into slides. Slides can be stored in plastic notebook pages (available at photo stores) that hold 20 slides to the page. A photo scrapbook can be made with slides as easily as with prints.

## DOUG'S TURF PHOTOGRAPHY RULES-OF-THUMB

### What to photograph

1. All new projects before, during, and after completion
2. New plantings as they're being made
3. New plantings as the grass is coming up
4. Nice overall turf shots (remember to take "pretty" shots, not just pictures of diseases and repairs)
5. Variety and product trials at field days
6. Diseases and insect problems
7. Avoid taking posed pictures, or pictures where the crew is standing around; it will make them look lazy; get pictures of them working hard
8. Never take only one shot of something important; film is cheap; but make sure you slightly vary the camera setting each time

## TAKING GOOD TURF PHOTOS

1. Always get closer to your subject than you think; it should fill the screen

2. Squint your eyes before you take a photo; if you can't discern what you are about to photograph, it won't show up on the film

3. If you fill the camera frame with a 4 x 6 ft. turf plot, you won't be able to discern the texture of the turf in the slide; get closer

4. Overexpose green turf shots by 1/2 f-stop (the electric eye in cameras is too responsive to green, and an all green picture will need to be purposely overexposed)

5. Overexpose photos of a bare area or new planting (where there's a lot of light soil in the photo) by 1 to 1 1/2 f-stops

6. A polarization filter helps bring out the green color in a turf photo

7. Never take a hand-held picture at speeds slower then 1/125th second; use a tripod

8. To photograph a large area all at once and have it all in focus, set the lens opening as narrow as possible (ie, high f-stop number)

9. Photographing individual plants is difficult because of the strong color contrast (ie, dark green plants on a near white soil); get the lens as close to the plant as possible, excluding as much soil as possible

10. When photographing individual plants on bare soil, put the nose of the camera within 3 inches of the plant, take an exposure reading, and lock the reading into the camera; then back up and shoot; the grass will be properly exposed; a <u>grey card</u> (cheap and available at any photo store) can also be used for setting exposure

11. Check the rewind knob (on the top left of the camera) to ensure that the film has engaged and is winding; the rewind handle should tighten up as you turn it, indicating the film's properly hitched

12. If the camera immediately seizes up after shooting the last photo on a roll, it probably didn't take; retake it on a fresh roll

13. When loading film, take two and only two shots with the back open; verify that the film is winding before closing the camera back

14. Photos can be taken with the camera held either horizontally or turned vertically; bear in mind that vertical shots do not fit on the screen in most slide presentations; keep vertical shots to a minimum

15. It's a good idea to keep a cheap second camera around for "must have" shots; take photos with two cameras during important events such as hurricanes and tournaments

## PHOTOGRAPHING TITLE SLIDES FROM A COMPUTER SCREEN

1. When deciding on the color scheme on computer-generated slides, stick to one background color per section of your talk; changing background color within a topic implies that you're onto another topic

2. When photographing text on a computer screen, view it from 6 ft. away; if you can't read it, don't photograph it

3. I found that Fujichrome has bolder color for photographing computer screen titles; however, it's a little too bold for outdoor use, in my opinion; many photo stores offer overnight development for Fujichrome and Ectachrome, rarely for Kodachrome

4. In titles, stay away from strongly contrasting colors, such as red letters on a green background; white backgrounds are also touchy; you can't go wrong with yellow letters on a dark blue background

5. Mixed case (upper and lower) text reads more easily than all caps — and from a farther distance

## WHICH SLIDES TO USE IN A PRESENTATION

1. If the slide is too dark to read while holding it up to a white piece of paper on your desk, then it's too dark to use

2. If you have to hold a slide up to a light bulb or ceiling light to see what's on it, it's too dark to use

3. If it's too dark to use, pitch it; don't even file it; the only exception to this rule is if the slide is a one-of-a-kind slide; if it is, get it copied and specify the photo company to lighten it up

4. If it's a text slide, hold it at arm's length; if you can't read it, the audience won't be able to either

5. If the slide is out of focus, pitch it

6. Use slide trays that hold 80 slides as opposed to 140; the 140's jam more easily

7. When timing your talk, plan on 30 sec. for a landscape shot, 1 min. for a text slide, and 2 min. for a graph; complicated graphs may take as long as 5 minutes to explain

8. During the presentation, read and reiterate the axes and meaning of each bar on a graph; assume the audience can't read

9. Always give the audience 5 seconds to view a slide after you've finished talking about it

10. If you have a text slide with a misspelled word or an error in one of the numbers, pitch it; never use it in your presentation; and never but never use it and apologize for it

# SWEATING IT OUT: WATER CONSERVATION IN THE NORTHWEST[1]

Dan Borroff[2]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.
[2] Owner, Dan Borroff Landscape, Seattle, Washington.

In **the Pacific Northwest west of the Cascades population growth** has begun to place strains on all our resources. Our abundant hydroelectric power is now in short supply at times. Greenbelts in urban areas are disappearing. Even in the suburbs **the changes are** apparent. Native forest is being replaced with housing surrounded by lawns and rhododendrons. Water utilities are beginning to make calls for conservation. Why is this so? Despite our reputation as the damp mop of North America our summer months are dry. From May 1st to October 13th, our major growing season, we average 6-7 inches of rain.

On the world scene we receive more rain than Madrid, nearly as much as Rome, guite a bit less than Barcelona, and less than half the precipitation of New York City or Milan. These statistics don't tell the whole story. Evapotranspiration, the amount of water reguired by Bluegrass turf in a given climate in order to maintain vigor, is the real story. The difference between the amount of rainfall a specific region receives and the evapotranspiration rate is called the water deficit. New York City receives more rainfall than it neede to compensate for evapotranspiration for every month of the year except June, July and August. The total water shortfall for these months is 6'. They have a water surplus for 9 months of the year. Portland, by comparison, has a water deficit of 13 for the five months from May to September. In order to keep bluegrass lawn healthy it is necessary to apply more than a foot of water. Bluegrass will survive, but not look its best, with the water deficit of New York but will not survive an average summer in the Pacific Northwest. It is simply too dry for too long Surprisingly, the area of the United States which we most closely resemble in water deficit, USDA hardiness zone, and mild wet winters is the State of Arkansas. Plants native to that state adapted to our cooler summers grow here without irrigation. Other regions of the world mimic our climate. The coolest portions of the Mediterranean climate regions of the world (Southern Europe, South Africa, Tasmania, and southernmost South America) are a resource for plants which are adapted to our hydrologic cycle.

Most of the water supplies of this region are reservoirs in the mountains. Seattle maintains two reservoirs. Their water source is primarily snowmelt. Summer rainfall is a relatively small portion of total precipitation. The main concern is low snowfall years. The Cedar River must, by treaty, maintain sufficient streamflow to maintain the lareest Chinook salmon run in the lower 48 states. The river feeds into Lake Washington to keep the lake level adequate for operation of the Ballard Locks. The Seattle water district supplies most of King County. These charts show water use:

The total water consumption for May through October 1 is nearly Thirty billion gallons. The holding capacity for the main reservoir in the system, the Chester Morse reservoir on the Cedar River, is Thirty billion gallons. This begins to explain why the Seattle Water Department was very nervous about water supply in 1992.

**WATER SOURCES:** Why not dam another valley? Or build a pipeline to Canada? There are several reasons, money, lack of suitable sites, and politics. If money were no object than the several billions it would cost would be no problem but consider what this expense would do to our water rates. Suitable sites is a problem. Anyone who has spent any time in the mountains is aware of this. There aren't many unpopulated unprotected river valleys. But what about politics. It's good to consider that there is a very populous state to the south of this region. It has an immense political voice and a water shortage that makes our problems seem incredibly miniscule. It may be dangerous to set a water grabbing precedent. The possibility exists that they could ask that we share water equably on a national scale. Other resources are available. A large aquifer near Snoqualmie, Wa. may provide relief but its maximum potential is not enough to do more than stave off the day of reconing. Most water districts have determined that conservation is the most economically and politically feasible route to maintaining water service. At this time the emphasis is on reduced landscape water use because our industry has minor political representation. We lack clout. Keep in mind that the biggest single use of water is still the flush toilet. Its elimination would cause major disruptions to our lives. Our sewer systems require its profligate waste of water in order to carry our wastes away. In the summer months some sewer lines go anaerobic which causes odor problems, blockages, and potentially dangerous accumulation of explosive gases. There is a very good argument for reducing landscape water consumption since it occurs in the summer months when our water supplies are stretched to their limits. Thus for the short term the landscape industry will likely bear the lion's share of the burden of conservation efforts. It is vitally important that we focus on reducing indoor water consumption even though we may realize benefits only in the long term.

**LOVELY DESERTS?** How do we create low water landscapes? In my business I'm very frequently asked to make the garden low maintenance. There are plenty of examples of this approach taken to an extreme. Asphalt is remarkably low water use. Junipers also work well although they are not as weed-proof as asphalt. In this area we can let it revert to natural, except that this doesn't happen anymore. Weeds which have arrived oll our shores from foreign lands take over unless we make an effort to plant the appropriate native species and tend them for the decade or so that it takes for them to establish a viable ecosystem we will be doomed to failure. Besides, what people really want are delightful gardens in which they feel at home. To do this we must incorporate good 'technical' knowledge, and 'artistic' sensibility, and a 'belief or philosophy' which carries us through this change in the way we have tended the land. Each of these approaches considered separately not only falls short of the mark but has its downside. 'Technology' can be a monkey on our back carrying us to extreme solutions involving expensive gadgetry and esoteric approaches. High tech drip systems eventually run into reality checks since they are merely like trying to squeeze more water out of a sponge. Why not ask why we keep squeezing it? An excessively 'artistic' approach yields silly designs which congratulate only themselves. We know that 'belief' or 'faith' is of great value but at its worst it can lead to dogma or false hopefulness that can be paraphrased by: 'Let us pray for rain!'. Each of these approaches needs the balance provided by the others They are of greatest benefit when they are integrated into a complete whole.

**BECOMING A GURU:** I was not born to the role of Water Conservation Guru, as I've been called. Perhaps it was the well at my childhood home which supplied enough water for a long shower or washing the dishes, but not both, that steered me in this direction. Perhaps it was the Cuyahoga river which was so polluted that it caught fire 7 times, burning down a large bridge in one bout. This instilled a certain desire to respect nature. Don't get me wrong. My father was a research chemist. I originally was headed for a lucrative career in that field. By a circuitous route I landed in landscaping. Sprinkler systems were a staple of my design work. Several gardens began to steer me in a different direction. One garden owner was dismayed that her recently installed rhododendrons were turning yellow. The concrete patio, mirror glass windows, total lack of trees, and full south exposure were baking the poor plants. The house and patio were not subject to modification. No trees would be permitted. So we changed the plant palette. The Rhodies went to the north of the house as did the Enkianthus which had been baked into a lovely red fall coloration by mid-June. They were replaced by Ilex, Taxus, Geraniums, shrub roses and other sun lovers. The next garden presented us with a new dilemna. The owners wanted to enjoy the sunny part of the garden. This cried out for a deck, an expensive! elevated deck with additional trellising. The remaining budget allowed enough money for either a new sprinkler system or for planting but not both. The choice was simple. The thought of bare ground did not appeal to any of us since the goal was to get people out into the garden not to eliminate any possibility of garden. He worked 60 hours per week while she was worked over full time by their two active boys There was not much possibility that they would spend an inordinate amount of time watering. What to do? We went to the books and patched together a plant palette. Now everyone who walks out on the new porch walks to the railing and sees a brilliant collection of shrubs and perennials and are drawn down the stairs to get a closer look. The inaccessible garden has become an attractive part of the house. This site was on sand, our next project was on a dizzyingly steep clay slope above the Sound.

There was a problem with water on the site. The pilings under the house allowed natural springs to flow freely. In the summer the clay reverted to its summer state as the springs dried out. Since I'd seen a house undermined by a broken sprinkler main line I felt uninterested in repeating the experience on this rather valuable house. The soil was amended heavily with a mixture of coarse and fine organic matter to break up and aerate the clayey soil. We installed plants appropriate to the salt spray, the style of the house, and these clients' taste. So far the house still stands although the road access has not been so fortunate.

These plants were appropriate to thelr sites and fit the program. Not all plants that we lavor in our landscapes fit our environment. How did we get to this juncture? We desire plants which live only as long as we keep the juice flowing. We've been strongly influenced by Japan and by England, a country known for its damp climate Most of the British Isles deserve this reputation. From England we have aquired an idyllic image of the good life, large expanses of lawn and lush perennials. These images are powerfully ingrained on our psyches. Diminishing the influence of these images will be a formidable task. For the last several years most of the South and East of England have been under an onerous watering ban called a hose pipe ban. In the midst of the last ban I visited Sissinghurst Castle Gardens. My camera aimed at the 'White Garden', one of the most famous gardens in the world. Suddenly it dawned on me that all the plants in the picture frame were on the drought tolerant list.* Everywhere I looked on the grounds the plants fit. Lawns were turning brown but the beds were lush. This part of the country receives only 15 inches of rain per year. Though it is evenly distributed through the year and summers are cool it is not an excessive amount of moisture by any meas. Here is an example of a water conserving garden of exquisite beauty. Japan, as well, has been a dominant influence upon modern landscape design The great American melting pot has absorbed and transformed this influence to the point that it is almost unrecognizable but quite pervasive. Japan receives 5 inches of rain every month of the year, except for late fall, nearly equal to our five-month summer total. In the North of France lawns remain an important part of landscape but in the south of France, whose climate is closer to that of Southern Oregon, lawn is an anomaly. The northern shore of the Mediterranean shares a climate with similarities to our own. Summers are dry but a bit hotter. Winters are cool and rainy with only occasional snowfall. On a trip to Italy I spent a good bit of time looking for sprinklers in their gardens or for evidence of watering Even at Villa D Este at Tivoli, known for its abundant waterworks dating from the l6th century, I found no sprinklers, not even a hose bib in the gardens! Surely in this garden the opportunity was; available to supply supplemental water to the plantings. Instead there seemed to be a total absence The gardens were designed with plantings which were adapted to the climate. The lesson which came to me was that these countries which represent the greatest landscape traditions in the world had utilized only plants which were in tune with their climates. We would not consider these gardens to be second rate because they limited the plant palette yet we Americans grow a preponderance of plants which are not compatible with our climate

**SOIL - BRIEFLY:** In my practice we amend our soil heavily with whatever organic matter is available: bark, wood chips, compost manure. Our emphasis is on quantity first, quality second, and the inclusion of some chunky lignaceous material to produce a slower breakdown and better aeration These are amended with and Agro (Pace/Agro of Renton, Wa) called Deluxe Nursery Mix 10-15-10 with micronutrients at the rate of 5-15 pounds of fertilizer per cubic yard of organic matter. The primary reason for this amendment is to grow a wide enough variety of plants to get people as excited about their gardens as we have been by beautiful gardens around the world. Those of us who garden in Pugetopolis were dealt some of the poorest soil in the world. We average between 1-3" of topsoil overlaid on glacial subsoils or high water table riverbottom silts. They're lacking in both air and organic matter. With amendment they maintain plants through both our dry and our soggy seasons.

**NATIVES - AN OVERVIEW:** We hear on an all too regular basis that the real solution to our problems is to plant native plants. This is an admirable goal but we feel it is shortsighted and likely to produce a setback for native plantings and restoration of natural systems unless it is tempered with a realistic knowledge of how these plantings function. The dominant ecosystems in the northwest are forest, wetland, and prarie.

Each of them is difficult to integrate into urban settings. We parcel up land into chunks which are too small to support these systems. The controversy over wetlands is just the tip of the iceberg. Oregon's growth management policies may make it easier to incorporate appropriately scaled ecosystems. Forest systems are definitely too large for most private properties in the city, especially where views are involved or density is high. There are plenty of appalling examples of butchered conifers to dissuade anyone with a pragmatic viewpoint. Wetlands offer a tremendous boost to migratory birds. Even the smallest bits offer valuable diversity. They also offer us the unwanted thrill of mosquitoes and other 'underappreciated' virtues. The burning that is crucially necessary to the maintenance of prairies is a drawback to their compatibility with development. In addition to all these problems there are three other basic problems. The majority of our native deciduous trees are marginal species not climax species. Their lifespan is about 70 years. At about 30 years they begin to disintegrate. They become hazardous. Maintaining a safe buffer between these trees and people is a challenge since they tend to be prolifie colonizers. A second basic problem with native plantings which is particularly troublesome in my residential landscaping is linked to their drought tolerance. Most go dormant early when soil moisture becomes depleted. There's not much more daunting task than convincing clients that their plants are healthy when leaves begin to brown early in August. It's a challenge, not an impossible task, to design to make these characteristics visually acceptable to the average homeowner. The last drawback to planting natives is that most native plants are not adapted to the intense light and wind which exist around most medium sized buildings Considering most of these problems it is still very worthwhile to include native plants whenever poasible. Our native vegetation is under seige. Every day hundreds of acres vanish under the bulldozer. There are an amazing number of superb plants available and a greater number which are not yet being produced in landscape sizes.

**BUT.......... IT <u>LOOKS</u> BBBRROOWWWNNN!!** It's important to rejoice in the aesthetics of our dry summers. The golden fields of the Willamette Valley have inspired a friend of mine to acknowledge that brown is a color He's incorporated this aspect of late summer into his garden designs in an elegant manner. This works well as long as the garden appears to be the result of a concious decision, that it looks intentional. One brown leaved plant or a single golden grass looks like a mistake. It's important to plant lots of plants on a scale large enough to fit the site. On a whimsical note we can evoke the beauty of Spain or Mexico. This approach can be as simple as adding a small terrace and chairs, or an oil jar shaped container in a bed of flowers. All styles, from formal to cottagey can be successfully achieved. There are many excellent examples. Barbara Ashmun in Portland has provided one of the clearest examples of zoning for water conservation that I've encountered. Her front yard, on a busy road, is not watered. She doesn't want to spend much time on the front yard because of the noise. This reduced watering reduces weeding.

There are many more issues to address than those that I have addressed in this article. The input of all of us will influence the course of water conservation and set a precedent for resource management in the future. My experience has been that the more cooperative and creative means of achieving this end we bring to the bargaining table the less we will be forced to accept the full brunt of all water regulations. We will need some political bargaining chips to be asked to join in the discussion and to be taken seriously. The pressure we exert to reduce the appalling waste of our current flush toilet plumbing system will be of the utmost importance.

**THE FUTURE:** Years ago I saw an interview with Bill Moyers of a prominent historian. Mr. Moyers asked the historian what characteristics were particular to the last 35 years. The historian replied: "Posterity! The total absence of the word from our vocabulary. It formed the dominant philosophical ideology of the founders of this country. Its absence from our everyday consciousness has resulted in many of the most serious problems which we face today. We have lost the benefits of incorporating this simple tenet in our lives and are in danger of losing much of what has made this a great country." What we do today to begin to give to the earth instead of considering only what benefit it can provide for us will be the legacy of our children. We live in one of the most beautiful places on earth. The bounty of this land is astonishing. We can show our respect for it in the way we manage our parcels of land.

# UNDERSTANDING AND PREVENTING LANDSCAPE LAWSUITS[1]

W. O. Robinson[2]
Theodore W. Stamen[3]

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[1] Presented at the **47th Northwest Turfgrass Conference**, Holiday Inn, Yakima, Washington, October 11-13, 1993.

[2] Attorney, Polsky, Robinson & Jones, San Bernadino, California.

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"Understanding and Preventing Landscape Lawsuits" was presented by Theodore W. Stamen and W.O. Robinson. Mr. Stamen is an Urban Horticulture Advisor with the University of California Cooperative Extension, Riverside County. Mr. Robinson is a Partner with the law firm of Polsky, Robinson & Jones.

Mr. Stamen and Mr. Robinson reviewed and analyzed 14 horticulture related lawsuits. Most of the lawsuits could have been prevented by the arborist/landscape maintenance contractor had he or she taken following steps:

First, arborists/landscape maintenance contractors should not act negligently, but rather perform work as ordinary and reasonable prudent arborists/landscape maintenance contractors do.

Second, arborists/landscape maintenance contractors should maintain concise written and photographic records regarding conditions at job sites and work they perform.

Third, arborists/landscape maintenance contractors should properly supervise, train, and educate their employees.

In addition to the steps set forth above, Mr. Stamen and Mr. Robinson stressed the importance of an arborist/landscape maintenance contractor selecting the proper attorney at the correct time in order to avoid a lawsuit and/or minimize the costs of a lawsuit.

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