Proceedings

Of The

44th Northwest Turfgrass Conference

September 17-20, 1990

Rippling River Resort
Welches, Oregon

PREFACE

One of the primary objectives of the **Northwest Turfgrass Association** is to disseminate current turf development and maintenance information available from research, study and experimentation to interested persons. The annual **Northwest Turfgrass Conference** and **Exhibition** 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

PRESIDENT'S MESSAGE

William J. Johnston

On behalf of the Board of Directors of the Northwest Turfgrass Association I would like to thank the members, their colleagues, employers, spouses, and friends, for supporting this year's NTA Conference and Exhibition. The 1990 Conference at the Rippling River Resort and Conference Center at Welches, Oregon was an excellent program thanks to the hard work of Bill Griffith (Education Program), Pat Nibler (Commercial Exhibits), Al Nielsen (Golf Tournament), Becky Michels (Hospitality and Spouse/Guest Programs), and the NTA Executive Director Blair Patrick and staff Jerry Crabill. Pat and Al also conducted the Turfgrass Facilities Tour.

Our featured speakers, Dr. A.J. Turgeon of Penn State University and Dr. Robert Sherman of University of Nebraska-Lincoln were outstanding. Many other excellent speakers provided over 30 presentations on a wide range of turfgrass related topics. The "optional" afternoon sessions were a new feature this year. Attendance at the computers and sprayer selection sessions greatly exceeded our expectations.

A special thank you for support goes to our exhibitors at the table-top trade show. The new format was a success and along with the NTA hosted hor d'oeuvres made for a fun and educational evening. Profits from the exhibition go directly to support research and scholarships. Hopefully next year's exhibition will have an even greater participation.

On a personal note, I would like to thank everyone who has helped make my year as your president a pleasant experience. I wish our new president Bill Griffith and the new board a successful year of progress.

I hope you will all make it to Coeur d'Alene for the 1991 NTA Conference and Exhibition.

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TURFGRASS MANAGEMENT IN THE 90'S[1]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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What will the decade of the nineties hold for the turfgrass industry? Let's get out our crystal ball and speculate on our future and what challenges and opportunities that we might anticipate.

Brainstorming the future can be an awesome mental exercise, but it can also be a great deal of fun. It should help us deal more effectively with change, since we have had the opportunity to speculate and anticipate situations that may occur. This anticipation will place us in a proactive as opposed to a reactive mode. Let's face it. Our industry will be subject to a number of changes as we adjust to the nineties. We need to prepare for change as best we can.

The decade of the nineties has already been dubbed the "Environmental Decade." The public is showing increasing concern over their environment and the quality of life. Activists from the "Ecology Era" of the late sixties have now matured into influential decision makers, and they comprise an important part of the voting populace. This group will lead the fight on environmental issues. They are a concerned public that is highly motivated, but they may not always be the best informed individuals on technical aspects concerning our environment. If we wish to deal with these environmental concerns, we need to show our interest and demonstrate a conscientious effort toward the maintenance of environmental quality. We also will need to work with environmental activists in attempts to find common ground. The turfgrass industry has demonstrated a concern for the environment and has developed integrative pest management (IPM) approaches, whenever feasible. We need to take a proactive stance in regard to our role in sustainable environment issues, and the contributions of turfgrasses to urban environment and the quality of life.

Representatives of the turfgrass industry will need to actively work toward involvement with development of regulations and policies that influence our industry. There will be more regulations proposed as environmental concerns are raised government agencies become involved in seeking solutions to these concerns. If the turfgrass industry is not to be overwhelmed by this process, we must hone our own skills, experiences, and technical background to develop a better offensive approach, regarding regulatory issues.

World population is projected to double by early in the 21st Century. Most of this increase will occur mostly in third world countries. There will be increased pressure on agriculture to supply food, feed, fiber and fuel anddemands of the world. Population increase will also impace the turfgrass industry in developed countries. There will be increased interest in the "Green Industry." Turf and urban forestry will be afforded additional emphasis and opportunity as population, leisure time, and interest continue to increase in the future.

In the U.S. there will be trends toward fewer single family dwellings. Homes will have smaller lawns, and there will be increased interest turfgrasses that require low inputs and reduced maintenance.

Golf course members will increase on both domesticand international levels. In the U.S. the rate of golf course development will continue to lag behind demand due to increased regulation and demand for extensive environmental impact assessment. Courses being built in association with housing or office-complex development will be a major trend for construction. The Golf Foundation has predicted that the golfing population will grow by 7 million over the next ten years. This growth will result in a golfing population of over 30 million people by the year 2000. An additional 4,000 golf courses will be needed to accomodate this growth. The Golf Foundation estimates that 400 courses be developed each year to accommodate this trend. In 1989, the National Golf Foundation reported construction of 290 courses. About half of these courses were daily fee or public and about half were developed in the sunbelt or southern states. These figures reflected a 37% increase over the 1988 figures, but were still far below the projected 400 courses needed annually. The lag in numbers of courses built, most likely reflects difficulties in obtaining clearance to build courses due to environmental impace assessment and other regulations.

Some government regulations, such as the Endangered Species Act, set some unusual precedents, but may also reflect future regulation complications. All pesticide applicators, with the exception of those who make indoor applications, are subject to the Endangered Species Act. The Federal Fish and Wildlife Service is responsible to map endangered species areas. Pesticides that threaten endangered species cannot be applied above the minimum level in these mapped areas. The pesticide label will refer to the mapping, but will not specifically describe the map and the endangered species locations. For the first time, we will be required by law to get additional information not on the pesticide label to comply with more application procedures.

Pesticide use will be more restrictive, during the 1990's. Fewer pesticides will be available will be more specific in their pest activity than many of those presently used. These pesticides will also have reduced residual potentials to enhance their dissipation and minimize their potential movement in the environment. In the nineties, turfgrass managers will have increased opportunities to select and use biological controls and biopesticides that are derived from plants and other natural processes.

Agricultural sustainability will be an issue during the next decade. Environmentalists are concerned about agricultural production effects on the environment. Sustainability will emphasize soil conservation, water and environmental quality, and the maintenance of profitability. The acronym, LISA, has been used to describe low input sustainable agriculture. LISA may not seem to be applicable to the turfgrass industry, but it is. The sod production is directly involved and the growing public interest, relating to reduced inputs in turfgrass management are indirectly involved inthe LISA concepts.

We should think about this political issue. Perhaps, the turfgrass industry needs to be more proactive on this issue to protect our interest in the nineties. Who knows, maybe we should coin an acronym of our own, like "LIST" (Low Input Sustainable Turf). We definitely are interested in sustainable turfs and we have interest in protecting our environment. Let's jump on the bandwagon rather than be drug along by it.

We can continue to expect changes in equipment, during this decade. Some of these changes will be dictated by regulation and some through the enhancement of technology. There will be a continuing trend toward light-weight, energy-efficient mowing equipment.

The retail market will emphasize mulching mowers and considerable effort will be placed on engineering units that effectively mulch and recycle clippings. Pesticide and fertilizer applications in the lawn care industry will move watrd greater emphasis on granular materials. Liquid materials will be applied through injection systems that place materials beneath the soil surface. Thus, eliminating thatch interations and reducing volatilization, drift, and surface movement. Other liquid applications will be made to targeted pests on a spot treatment basis.

We will see new designs in spray systems for applications of chemicals on larger turfgrass areas. Applicators will have less contact with chemicals and pesticides applied. Remote sensing devices will also be used with spray systems designed to identify pests, such as weeds in turf. Pesticides will be applied only on those areas where the pest exists, simply through computer imagery differentiating the weed from the desirable turfgrass. Rinsate problems will also be reduced through development of spray tanks designed to allow more complete use of tank contents. Systems designed to inject chemicals into the spray stream will also be emphasized during the nineties. These systems will reduce applicator exposure, rinsate amounts and pesticide disposal problems.

Considerable emphasis will be placed on the role of the computer in turfgrass management during the 90's. This role will range from information processing to control of irrigation scheduling. Obviously, the computer will play more of a role in equipment, as design and function turfgrass equipment become more sophisticated and technical. Computers will serve the industry by providing networks for information exchange and retrieval. We will be able to access useful data bases without leaving our work sites. The USGA Turfgrass Information File (TGIF) is a good example of a data base that is already available to our industry. We will also use computers to access data pertaining to models used for the prediction of disease and other pest problems. These models will help turfgrass managers make more informed decisions on when and how to best control a pest problem. Computer models will also be used to schedule irrigation needs and to help turfgrass managers conserve water with more efficient irrigation management.

It is reasonably easy to envision that the future of the turfgrass industry is bright, and that it will afford challenges and opportunities. I think that our industry is up to these challenges and that we will make the most of our opportunities. See you in the 21st Century!

CULTURAL PRACTICE EFFECTS ON TURFGRASS ROOTING AND WATER USE[1]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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Cultural practices directly and indirectly influence turfgrass growth, development, and water use. These responses can be manipulated to enhance turfgrass water use, conservation, drought avoidance mechanisms, and irrigation and pest management. Turfgrass managers may or may not experience water conservation mandates, but many times they are interested in enhanced drought avoidance mechanisms and improved irrigation and pest management practices. Much of the information shared here is a result of research supported by the United States Golf Association, and are a result of efforts to reduce water and energy requirements of turfs.

Mowing, fertilizing (nutrition), and irrigating are considered to be primary cultural practices, while practices like core cultivation, vertical grooming, power raking, top dressing, and pesticide applications are secondary cultural practices. Primary and secondary cultural practices alone or in combination can be manipulated. Intensity of these manipulations can be used to develop energy and water saving cultural practice systems. These savings increase the sustainability of turfs and enhance conservation through reduced inputs.

Mowing is fundamental to turfgrass culture. It directly influences turfgrass growth and development. Turfgrasses tolerate mowing, but do not prefer it. Turfs are mowed to obtain their desired function, quality and appearance.

Turfgrass water use declines with mowing height. Water use may decline as much as 56% when mowing height is reduced from 1.0 inch to 0.25 inch. Similarly, root production and distribution decline as mowing height is reduced. Effects on rooting are greatest when mowing heights drop below the optimum range for a turfgrass species or cultivar. Increased root production and distribution associated with higher mowing heights generally enhances turfgrass drought avoidance characteristics. Higher water use rate associated with increased mowing height is offset by the turf's ability to draw upon more soil volume as a water reservoir due to its increased depth and extent of rooting. Where water conservation and not drought avoidance is the primary concern for turfgrass managers, reduced mowing height can be used to conserve water as long as heights are maintained within the species or cultivar mowing height tolerance range. Mowing height and frequency can be combined to reduce water use and enhance drought avoidance. Frequent mowing decreases turfgrass vertical elongation rate, increases canopy resistance, and decreases water use. Therefore, for a given mowing height, water use can be further reduced by increasing mowing frequency. Turfgrass managers interested in enhanced drought avoidance should mow as high as is acceptable for their turf use to increase depth and extent of rooting, and should mow frequently, rather than infrequently to maintain desired canopy resistance and its associated reduced water use.

Mowing with a dull mower has been hypothesized to increase turfgrass water use due to increased wounding and exposing more surface area for water loss. Research has shown that water loss actually declines as a result of dull mowing. It is not recommended to use dull mowing as a water conservation practice, since the reduction in water use is associated with reduced root production, and a decline in turfgrass appearance and quality.

Nutrition influences turfgrass growth rate and canopy resistance characteristics. Nutrition also influences the root production and distribution, Fertilizing above (nutrient excess) or below (nutrient deficiency) the optimum range for a species or cultivar, generally reduces root production and distribution. Water use rate is both reduced and increased with nutrient excess or deficiency. For example, water use increases with increasing nitrogen nutrition, but decreases in response to increasing potassium nutrition. The nitrogen response occurs in conjunction with increased growth rate and decreased canopy resistance. Turfs receiving nitrogen in excess of their nutritional needs wilt more rapidly than those receiving adequate nitrogen nutrition. This response occurs due to higher water use coupled with reduced root production when compared to those properly fertilized.

Turfs deficient in potassium have higher water use rates than those receiving adequate potassium nutrition. Studies in Nebraska demonstrated increased root production, enhanced root distribution, and reduced water use with increased potassium nutrition. These studies led to recommending nitrogen and potassium nutrition levels with a 1:1, particularly where drought avoidance and reduced water use are of primary concern to the turfgrass manager.

No one nutritional element can be manipulated without influencing other essential elements. Care should be taken to keep all sixteen essential elements available in adequate, but not excessive amounts. Rate and timing of fertilizer application can be used to influence turfgrass rooting and water use. Late-season fertilizer applications are beneficial for cool-season turfgrass root development. These applications result in earlier green-up and reduced leaf elongation rates in the spring, when properly applied and when compared to more traditional spring applications. Fertilizer should not be applied in late-season if the turf is dormant. Active turfgrass root growth is needed to ensure nitrogen uptake and minimize nitrogen leaching. On sandy soil sites or turfgrass sites with highly modified soils, fertilizers should be applied in light, frequent applications so that uptake is enhanced and potential leaching is reduced. Slow-release nutrient sources can be used in these conditions to reduce potential leaching loses. These approaches also reduce water use and enhance root growth through maintenance of more consistent turfgrass growth rates.

Turfgrass irrigation amount and frequency influences growth rate, and depth and extent of rooting. Growth rates are impaired by drought, and turfgrass death may occur if drought stress is prolonged. Light, frequent irrigation, that maintain soil moisture levels at or above field capacity, produces shallow but extensive turfgrass root systems. This root system is adequate for turfgrass performance as long as soil moisture is not limiting or atmospheric drought conditions are not prevalent. A shallow, extensive root system requires more frequent fertilization and irrigation than a deep, extensive root system. Drought avoidance is enhanced by deep, extensive root system. Tall fescue is a species that demonstrates excellent drought avoidance even though it has a high water use rate. Its extensive root production and ability to distribute roots deep in the soil profile offsets its higher water use.

Infrequent irrigation enhances turfgrass root production and distribution. Frequency of irrigation should be dictated by turfgrass need. Watering when signs of visual moisture stress (wilting) are evident can result in water savings in excess of 30%, when compared to daily irrigation. Irrigation frequency is interactive with turfgrass nutrition. Turfs receiving irrigation based on 60% of potential evapotranspiration (ETp) and potassium at 4 to 8 lbs. K/lOOO sq. ft./season, used 52% less water than those watered at 100% ETp and fertilized with no additional potassium. These turfs maintained the same turfgrass quality, even though soil potassium level and ET demand were high. Studies conducted in Nebraska on bentgrass greens with a sand growing medium have demonstrated similar responses with turfgrass root production and distribution increased as potassium nutrition increased from 0 to 8 lbs. K/lOOO sq. ft./season. Wilting tendency declined as potassium nutrition increased when these turfs were exposed to drought stress.

Turfgrass managers interested in water conservation and drought avoidance should carefully manipulate their nutrition programs. They should take advantage of potassium for enhanced stress tolerance.

Secondary cultural practices also influence turfgrass rooting and water use, but these practices have been less extensively studied. Soil cultivation enhances depth and extent of turfgrass rooting. Data exist to demonstrated greater soil moisture extraction under compacted soil conditions, when soils were cultivated, but no data exists to demonstrate higher ET rates being associated with these conditions. These results likely demonstrate more effective rooting rather than higher ET rates.

Applications of surfactants to a Kentucky bluegrass turf growing on a silty clay loam resulted in reduced water use rates for three to four weeks after application. ET rates increased for one to two days following application and then declined for the remainder of the three to four week response period. Similar responses have been observed when assessing ET immediately after irrigation. It is assumed that the evaporative component is high in turfs as long as free water exists in the turfgrass canopy. Surfactant applications would reduce water held in the canopy.

Studies with plant growth regulators demonstrated reduced water use with no detrimental rooting responses. Reduction of water use was maintained throughout the effective vertical elongation suppression period. Rates increased when the suppression response subsided. PGR treatments reduced total water use by 11% to 29% depending upon type and rate of application.

Turfgrass managers have a number of tools at their exposure to conserve water and enhance rooting responses. Proper use of cultural practices and development of cultural practice systems, that rely on the interactive manipulation of mowing, fertilizing, irrigating, and appropriate secondary cultural practices, are among these tools. Therefore, it is important for turfgrass managers to realize that water conservation and enhanced rooting responses require a systematic approach to the use of culture practices for best results.

TURFGRASS GROWTH AND DEVELOPMENT[1]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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The capacity to sustain a dynamic and complex turfgrass community depends, in part, upon a thorough understanding of how turfgrasses grow and develop. The turfgrass plant, a low-growing monocot, differs substantially in structure and growth pattern from typical dicotyledonous species. Tolerance to frequent defoliation by mowing and to traffic are unique featured of turfgrasses. These tolerances exist because of the position of the growing point atop an unelongated stem, called a crown, located at or near the surface of the ground. Leaves continually arise from the growing point to provide a contiguous cover of green shoots. Because older leaves eventually fall to the surface of the ground and are replaced by newly emerging leaves, under a specific set of environmental conditions, a relatively constant number of leaves per shoot is maintained. Under some conditions, the growing point may undergo changes that result in the emergence of a flowering culm. This is eventually followed by the death of the shoot, since the growing point has changed morphologically and can no longer give rise tonew leaf primordia. Axillary buds, located art nodes along the crown, develop into new tillers that emerge from within enclosing leaf sheaths. Alternatively, the axillary buds may give rise to horizontally growing shoots, called rhizomes and stolons, that burst through the enclosing leaf sheaths (if still attached) and grow outward from the parent shoot. Rhizomes and stolons can, in turn, give grow outward from the parent shoot. Rhizomes and stolons can, in turn, give rise to new shoots at their terminals or nodes. Roots develop adventitiously from nodes along the crown and grow into the underlying soil or growth medium.

THE GRASS PLANT

The most obvious components of grass plants are the leaves that occur alternately along the shoot. The lower portion of the leaf, called the sheath, is tightly rolled or folded around the main axis of the shoot, while the upper portion, the leaf blade, is relatively flat and extends outward at an angle from the sheath. Thus, mature leaf blades appear as separate structures while many emerging leaves are not entirely visible because they are enclosed within other leaf sheaths.

At the base of the leaves and partially hidden within the enclosing leaf sheaths is the crown. In the vegetative stage of growth, the crown is a highly compressed stem with a succession of nodes separated by very short internodes. Elongation of the internodes occurs during flowering, which signals a transition fromvegetative to floral growth and development. A flowering culm emerges from within the enclosing leaf sheaths and terminates in an inforescence.

Roots of a grass plan are of two types: seminal and adventitious. The seminal develop during seed germination. These survive for a relatively short period. Adventitious roots arise from nodes along a stem, and, in a mature turfgrass community, these usually constitute the entire root system.

In addition to the crown and flowering culm, other stems of the grass plant include those contained within rhizomes and stolons. Rhizomes grow below the surface of the ground and give rise to new shoots at their terminals and nodes. Adventitious roots may also develop at the nodes. Likewise, stolons produce new shoots and adventitious roots; however, they differ from rhizomes in that they grow along the surface of the ground.

Germination and Seedling Development

Mature florets harvested from the inforescence of flowering grass plants constitute what is commonly called grass seed. The floret is composed of a caryopsis sandwiched between two floral bracts; the inner bract is the palea, and the outer bract is the lemma. The caryopsis, or dried fruit, contains the true seed surrounded by the remnant of the ovary wall called the pericarp. The true seed is composed of a seed coat, an embryo (actually , a miniature, mobile plant), and the endosperm, which is the food supply for sustaining this plant during germination until it is capable of producing its own food photoshythetically.

The germination process begins when water is absorbed by the seed. This stimulates the scutellem, a protective structure between the embryo and the endosperm, to release hormones that stimulate the production of hydrolytic enzymes inthe aleurone layer just inside the seed coat. The enzymes function in breaking down starch in the endosperm to simpler carbohydrates for nourishing the embryo.

The first structural development evident during germination is the enlargement of the coleorhiza, a structure at the base of the embryo that produces root hairlike structures that anchor the embryo to the soil and, presumably, aid in water absorption. Then, the primary root, or radicle, pushes through the coleoriza and penetrates into the soil and grows downward. At about the same time, the coleoptile, a sheath of translucent tissue surround the embryonic growing point, emerges from the seed and grows upward. The first leaf elongates and pushes out through a pore at the tip of the coleoptile. Photosynthetic activity begins and the seedling soon becomes entirely independent of the endosperm for its food supply. If the seeds are buried too deeply in the soil, however, food reserves in the endosperm may become depleted before the seedling is capable of manufacturing its own food, and seedling mrtality results.

The growing point of the seedling is enclosed within the coleoptile; consequently, the second leaf also grows through the coleoptile withers away and only leaves are evident above the soil surface. Each succeeding leaf develops from the growing point and upward within the older enclosing leaves.

The next seedling structures that form are the adventitious roots, which develop from nodes at the base of the new shoot. Thus, two types of roots may be present in a newly planted turf. Eventually, the seminal root system dies; so, in a mature turf, the entire root system is adventitious.

Successful seedling development and subsequent survival following planting are dependent upon: planting depth, available moisture, temperature, sufficient light, and the amount of food contained within the endosperm. Emerging seedling are highly prone to desiccation. Since their capacity to secure moisture from the soil is limited by a relatively undeveloped root system and rapid water loss by evaporation from the surface soil. In heavily shaded environments, the seedling may not receive sufficient sunlight for photosynthetic production of food in quantities necessary to sustain growth. Finally, where the endogenous food supply is inadequate to sustain the seedlings until they are photosynthetically self sufficient, death may occur. This condition is frequently associated with deep planting of seed, or with the use older seed in which viability has been reduced.

Leaf Formation

Turfgrasses are highly adapted to frequent mowing because leaf formation continues after each defliation. As long as the plants continue vegetative growth, virtually all meristematic tissues (those that contain cells capable of dividing to produce new cells) remain near the surface of the ground and below the mower blades. The growing point, located at the top of the crown, continually forms leaf primordia which eventually develop into fully expanded leaves. These appear initially as small protuberances just below the apical meristem. The number of leaf primordia visible at any time varies from a few to as many as twenty or more depending upon sppecies, plant age, and environmental conditions. Most turfgrasses have from five to ten leaf primordia present in various stages of development.

Leaf Primordia arise due to cell division below the apical meristem. Rapid division of cells at the midpoint of each leaf primordium results in the formation of the leaf tip. Subsequent meristematic activity is restricted to the basal portion of the leaf primordium, establishing the intercalary meristem. Thus, two types of meristems are present in the growing point: the apical meristem which produces new cells to continue stem development at the top of the crown, and the intercalary meristem which produces leaves below the apical meristem.

As the leaf primordium continues to develop, its intercalary meristem divides into two distinct meristems: an upper intercalary meristemwhich produces cells for growth of the leaf blade, and a lower intercalary meristem which remains at the base of the leaf to continue development of the leaf sheath. Cell division at the upper intercalary meristem usually ceases by the time the leaf top emerges from the enclosing leaf sheaths. Further expansion of the leaf blade is due to cell elongation, primarily at its base. Meristematic activity at the base of the leaf sheath usually proceeds for some time after the leaf blade has been fully formed. Thus, the oldest portion of a leaf is the tip, while the youngest is the base of the sheath. Leaf expansion may continue after a portion of the leaf blade has been removed by mowing. Following the emergency of a new leaf above the enclosing leaf sheaths, the new blade and sheath assume different shapes. The blade unfolds (or unrolls) to form a relatively flat structure while the sheath remains in a folded or rolled configuration surrounded by older leaf sheaths. As newer leaves originate from higher positions along the crown, each succeeding leaf sheath occurs at a higher position than the next older leaf sheath.

Eventually, a turfgrass leaf undergoes senescence, beginning at the tip and extending downwards, and falls away from the shoot. As the number of leaves per shoot generally remains constant under a specific set of environmental conditions, the rate of new leaf emergence is approximately the same as the rate at which older leaves die. Measurements of the photosynthetic rate and contribute photoassimilates to various growing parts of the plant plus some for storage, principally in the crowns. Older leaves contribute little to the rest of the plant since their photosynthetic activity declines as they approach senescence. Prior to the initiation of photosynthetic activity, emerging leaves are totally dependent upon carbohydrate reserves in storage organs and from other leaves. Hence, excessive defoliation from mowing may severely reduce turfgrass vigor. Leaf growth rate varies with age; the youngest leaves grow most rapidly while the oldest leaves cease growing.

Vertical development of a leaf is generally coordinated with that of the next leaf in succession. As the tip of a leaf begins its upward movement within the shoot, the next older leaf initiates sheath elongation. Subsequent expansion of the sheath occurs at approximately the same rate as that of the enclosed leaf blade. Thus, growth of different morphological units of each leaf in a pair is synchoronized so that little or no friction is generated until elongation of the enclosing sheath ceases.

The rate at which new leaves appear varies among different turfgrass species and, presumably, cultivars. Climatic conditions and fertilization practices also effect appearance rate. The time interval between the appearance of successive leaves is called a platochron and is usually measured in days. The shortest plastochrons occur under optimum temperatures, high light intensities, high levels of nitrogen fertilization, and optimum soil moisture conditions.

Turfgrass Stems

Three principal types of stems occur in turfgrasses: the crown, flowering culm, and the lateral stems associated with rhizomes and stolons. All but the crown have elongated internodes and are easily recognizable as stems. In contrast, the crown is a highly contracted stem with its nodes appearing to be stacked one on top of the other. Given its position at or below the surface of the ground and the face that its upper portions are entirely enclosed within the bases of several leaf sheaths, the crown is an elusive organ that is difficult to visualize or comprehend. Yet, the crown is a key organ giving rise to leaves, roots, tillers, and elongated stems of the turfgrass plant. Crowns also serve as storage organs for carbohydrate reserves to support the growth of new plant organs.

Crowns form wherever new shoots develop: from the embryo of germinating seed, from axillary buds and terminals of rhizomes and stolons, and from axillary buds on the crown that develop into new tillers. The highly contracted nature of crowns is what establishes the mowing tolerance of the several dozen grass species used for turf. Other stems of importance in turfgrasses are contained within horizontally growing rhizomes and stolons. These are elongated stems that arise from axillary buds on the crown. A newly developing lateral stem breaks through the enclosing sheaths (if still present), a process called extravaginal branching. During early internode elongation, the entire stem segment between nodes may be meristematically active. As the internode continues growth, cell division becomes restricted to regions directly ahead of each node forming the stem intercalary meristems.

Stolons grow along the surface of the ground and form roots and new shoots at the nodes. A new aerial shoot may also arise from the stolon terminal if the stem apex turns upwards. Branching may occur at the nodes forming a complex network of lateral stems. Stoloniferous turfgrasses include creeping bentgrass, rough bluegrass and zoysiagrass.

Rhizomes grow beneath the surface of the ground and may be of two types: determinate and indeterminate. Determinate rhizomes are usually short and turn upwards to form a new aerial shoot (rhizome daughter plant). Growth of these rhizomes occurs in three distinct phases: downward (plagiotropic) growth from the parent shoot, horizontal (diageotropic) growth, which accounts for most of the elongation of the rhizome, and upward (negatively orthogeotropic) growth to a position near the surface where light interception results in a cessation of internode elongation and the formation of a new aerial shoot. Turfgrasses having determinate rhizomes include Kentucky bluegrass, creeping red fescue, and redtop. Of these, Kentucky bluegrass is the most vigorous rhizome former. Its rhizomes grow with a boring-type (circumnutational) motion that aids penetration of compacted soils.

Indeterminate rhizomes are long and tend to branch at the nodes. Aerial shoots arise from axillary buds along these submerged stems. Bermudagrasses have indeterminate rhizomes and may also be stoloniferous, depending upon the relative position of the lateral stems with respect to the surface of the ground. The extent of rhizome growth varies from almost none (rhizome tip turns up almost immediately) to several inches or longer. Unlike roots, the rhizome does not merely add cells at the tip but, rather, grows in somewhat the same fashion as an aerial shoot. It is composed of alternately arranged leaves, a growing point, nodes, internodes, and axillary buds. The rhizome differs from an aerial shoot in that the internodes elongate, and its leaves (cataphylls) are usually bladeless, and scalelike in appearance. The rhizome tip is a conical leaf that encloses the growing point. On older parts of the rhizome, these leaves hang loosely at each node and partially conceal the next internode. In the axil of each leaf is an axillary bud that can give rise to a branch rhizome or an aerial shoot. Adventitious roots may develop near the axillary buds. The rhizome tip is pushed through the soil by cataphyll elongation initially, then by internode elongation. Some cataphylls have very short blades at the tip. Blade development usually signals an upward turning of the rhizome and subsequent formation of an aerial shoot. When the bladed leaf reaches the light, elongation of the internode beneath it develops similar to the found in young seedlings.

Tillering

The process by which new aerial shoots emerge intravaginally from axillary buds is called tillering. In contrast to rhizome and stolon emergence, tillers grow upwards (apogeotropically) and within the sheaths of enclosing leaves. The result is a dramatic increase in the number of new shoots occurring immediately adjacent to the parent shoot. Considering the impact of tillering in conjunction with lateral growth of stolons and/or rhizomes, which also produce tillering shoots, one can visualize how an entire turfgrass community can eventually develop from a single seedling. Although turfgrass establishment from a single seed is never recommended, it is not necessary to seed so heavily that a contiguous seedling cover is achieved. In fact, a satisfactory turf can be developed from a relatively sparse stand of seedlings where rhizomatous or stoloniferous grasses have been planted. In an existing turfgrass community, individual shoots eventually die and must be replaced by new shoots to maintain a desired density level. Turfgrasses are perennials not because individual shoots survive indefinitely, but because the plant community is dynamic, with dying members continually being replaced by new shoots and roots. The life of an individual shoot is usually not more than one year, and frequently it is less. Tillers formed in the fall are important to winter survival and spring regrowth of the turf, but may die during summer. Tillers formed in the spring may, in turn, be important for summer survival. Under conditions of environmental stress, the newly formed tillers are usually the first to die. Those tillers initiating inflorescences in spring usually die before the end of summer.

A young tiller is dependent upon the parent shoot for photoassimilates until it has developed several leaves and an adequate root system. Although a mature tiller may appear to function as an independent entity, some relationship apparently exists between tillers interconnected by a common vascular system. Thus, a grass plant appears to be a highly organized system rather than a collection of competing tiller entities.

Turfgrass Roots

The root system of grasses may include two types: the primary roots that develop from the embryo during seed germination, and the adventitious roots that emerge from nodes of the crown and lateral stems. Primary (seminal) roots usually do not live beyond the first year following planting. Adventitious roots begin forming soon after the first leaf emerges from within the coleoptile following seed germination, and subsequent formation occurs from lower nodes of rhizomes and stolons. Although root initiation usually takes place at or below the surface of the ground, root formation may occur above the surface in dense turfs where a favorable microclimate exists.

The life span of adventitious roots may be as long as that of the shoot they support; however, climatic stresses unfavorable soil conditions may cause death of roots while their associated shoots survive. This is most likely to occur in cool-season grasses turfgrasses during midsummer stress periods. Most root initiation and growth of cool-season grasses occur in spring and, to a lesser extent, during cool weather in the fall. Root growth of warm-season grasses is most active during the summer months. Turfgrasses differ in the extent to which their roots are replaced each year. Kentucky bluegrass retains a major portion of its roots for more than one year and is referred to as a perennial rooting grass. Some bentgrasses and perennial ryegrass and rough bluegrass replace most of their root systems each year and are considered annual rooting types.

The root is made up of an organized arrangement of cells produced by division of meristematic cells located just behind the root cap. The root cap protects the root meristem from abrasive effects of soil particles as growth proceeds through the soil. Meristematic cells of the root apical meristem replenish the root cap and provide for tip growth of the root itself. Following division, the new cells elongate and push the root cap through the soil. Maturation and differentiation of elongated cells results in the development of specialized tissues for absorbing and transporting water and nutrients to other parts of the plant. This upward movement of substances absorbed from the soil is called acropetal transport. Downward movement of photoassimilates from leaves to the roots is called basipetal transport and is essential for sustaining root growth and respiration. Within the zone of differentiation and maturation, root hairs arise from epidermal cells. In some grass species, only specialized epidermal cells, called tricoblasts, can produce root hairs. These delicate extensions of the root epidermis greatly increase the surface of the root for absorbing water and nutrients. Acropetal transport of these materials is through the xylem tubes located within the stele. The stele also includes phloem tubes for basipetal transport of photoassimilates. Movement of materials between the epidermal cells and the stele is by diffusion through the living cortex cells (symplastic movement) or in pores within the cell walls (apoplastic movement). Separating the stele from the cortex is a layer of specialized cells called the endodermis. The radial walls of endodermal cells are lined with a pectinaceous material forming the Casparian strip, which restricts apoplastic movement of water and other materials. Movement of materials into the stele occurs through membranes of living cells and, therefore, is dependent upon energy from respiration. Where turfgrasses are growing in severely compacted or waterlogged soils, oxygen for root respiration may be so deficient that transport of materials within the roots is restricted. This condition can result in wet wilt and other adverse effects commonly observed in turfgrasses.

Recently initiated roots appear thick and white. With age, roots become thin and darker in color. Root decay begins in the cortex and eventually spreads to the stele. The cortex may slough off (decortication) in older portions of a root; however, the bare stele may still be capable of transporting water and nutrients from the region of absorption to aerial parts of the plant.

TURFGRASS EDAPHOLOGY[1]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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Edaphology is defined as the study of that facet of soil science dealing with the capacity of soils and other media to support plant growth; thus, turfgrass edaphology deals with the capacity of various turf media to support the growth of associated turfgrass communities. These media include the full range of naturally occurring soil types, as well as the array of artificial media that are sometimes constructed for greens, athletic fields and other turfs. They also include materials generated by a turfgrass community that subsequently become part of the media supporting its growth.

THE BASICS

In attempting to understand what is needed or desired in a turf soil , let's begin with some basic information. A soil is a mixture of solids, including both mineral and organic materials, permeated by an array pore spaces of various sizes and shapes. Some of these pore spaces may be filled with water and some with air. An "ideal" soil is one which is well aerated, contains ample supplies of plant-available water and nutrients, and has a slightly acid-to-neutral pH. These conditions reflect the specific physical, chemical and biological properties of a soil.

Soil physical properties are texture, structure, moisture and aeration. Soil texture is determined by the size of soil particles and their relative proportion. Soil particles range in size from less than one to two thousand microns (1.0 micron = 0.001 millimeter) in diameter. Depending upon their size, soil particles are grouped into various soil separates: sand (including five different textural groups: very coarse, coarse, medium, fine, and very fine), silt and clay. The relative proportion of sand, silt and clay determines the soil textural class; these are: clay, sandy clay, silty clay, clay loam, sandy clay loam, silty clay loam, loam, silt loam, silt, sandy loam, loamy sand, and sand. Clay is important in chemical reactions involving the adsorption and exchange of plant nutrients. The pore sizes in a predominantly clay soil are so small, however, that much of the water contained in them is generally unavailable to plants. Silt pores are larger and retain higher amounts of plant-available moisture, while sand pores may be so large that they contribute little to water retention; however, sand is important in promoting soil aeration and drainage. Soil structure refers to the physical arrangement of soil particles. Clay forms aggregates in which individual particles are held together in various configurations. If soil aggregates are sufficiently stable, a well-aggregated soil can serve as an excellent medium for plant growth. Aggregates differ in their structural stability, however, depending upon the specific clay minerals present and the strength of the binding agents holding particles together. Also, traffic, splashing rain or irrigation, and cultivation tend to destroy soil structure. Usually, the best soils for turfgrass growth are those that contain a reasonable proportion of various soil separates and that possess a favorable soil structure that has been promoted and sustained through proper cultural practices. Soil moisture and aeration reflect the distribution of large, medium and small pores throughout the soil. In a well-structured soil with favorable pore-size distribution, water quickly drains from large (aeration-type) pores following rainfall or irrigation due to gravitational force. The "gravitational water" thus removed is replaced by air pulled into the soil from the atmosphere. At this point, the soil is said to be at "field capacity." The water remaining in the soil is held in medium and small pores, and as thin films on the surfaces of soil particles. The portion that can be absorbed by plant roots is called "available water" and is important in providing moisture between precipitation (rainfall and irrigation) events. And the portion retained in the small pores, and held so tightly that plant roots are unable to absorb it, is called "unavailable water." Soil porosity generally increases as soil texture becomes finer. A given amount of water will saturate a smaller volume of clay than sand due to the greater porosity of the clay. The rate at which water moves through clay will be much slower, however, as this is determined more by pore size than by total porosity. Thus, sandy soils require more frequent but less intensive irrigation than clayey soils to adequately support turfgrass growth. In a "compacted" soil, the total soil volume has been decreased (compared to its well-structured counterpart) resulting in reduced porosity, especially the aeration-type (large) pores so essential for proper drainage and aeration. Soil "aeration" specifically refers to the exchange of soil air with atmospheric air. Because of respiratory activity in the soil by plant roots and various macrofauna and microorganisms, the soil air tends to become depleted in oxygen and enriched by carbon dioxide and other potentially toxic gasses. Unless the oxygen concentration in the soil is replenished by atmospheric oxygen, the resulting oxygen deficiency can adversely affect a broad array of soil biological activities, including the growth and proper functioning of turfgrass roots.

Soil chemical properties influence the chemical reactions that occur on colloidal surfaces in the soil. Soil colloids include small soil particles measuring 0.2 microns or less in diameter. Clay and humus make up the colloidal component of a soil. Clay colloids are made up of planes of oxygen atoms with silicon and aluminum atoms holding the oxygens together by ionic bonding. Several of these planes make up each crystal layer within a clay particle which has many layers stacked like a deck of cards. "Isomorphous" substitution of magnesium, iron or zinc for aluminum, or of aluminum for silicon, results in unsatisfied negative charges in adjacent oxygen atoms; the net effect is the colloid's negative surface charges. Other sources of negative charges, including ionized hydrogen from hydroxyl groups (OH) in clay as well as in organic materials, account for the soil colloids' capacity for attracting and retaining cations. As many important plant nutrients occur as cations in the soil, this property of soils is important for providing a reservoir of nutrients, including those supplied through fertilizers, to support turfgrass growth.

In sandy soils containing small concentrations of soil colloids, nutrient retention (actually, "cation exchange") capacities are relatively low. These soils serve as relatively poor reservoirs of plant-available nutrients. Some of the nutrients supplied through fertilization may leach through the soil profile and contaminate local groundwater resources. Nutrient pollution is of greatest concern with the negatively charged nitrate ions resulting from the microbial oxidation of ammonium ions (NH4+) to nitrate (N03-) through a process called "nitrification." While ammonium ions are electrostatically attracted to soil colloids, the negatively charged nitrate ions are repelled and move rapidly through the soil profile with percolating water. Soil reaction is an indication of the acidity or alkalinity of a soil and is measured in units of pH. Soil pH is actually the negative logarithm of the hydrogen (H+) ion concentration. The pH scale extends from 0 to 14; each whole-number unit reflects one magnitude of change in the hydrogen (or hydroxide OH-) ion concentration. At a pH of 7, the H+ and OH- concentrations are equal and the soil is said to be neutral. Above 7, the soil is alkaline; below 7, it is acidic. As the pH decreases to 6, the H+ concentration increases (and the OH- concentration decreases) ten-fold to produce a slightly acidic soil. Turfgrasses vary somewhat in their tolerance to various levels of acidity or alkalinity; however, optimum growing conditions usually exist where the pH is neutral to slightly acid (7.0-6.0). Soil pH influences the availability of essential plant nutrients; however, the most important detrimental effect of excessive acidity is the high solubility of aluminum and manganese which can reach phytotoxic concentrations in acid soils.

PRACTICAL EDAPHOLOGY

Turfgrasses can be successfully grown on almost any medium. Recall the famous SCOTT's Windsor sodded lawn planted on asphalt. With careful attention to all cultural operations, this lawn was maintained at an acceptable level of quality for several years. (Given the way many sodded lawns have been established on poorly prepared planting beds, the experience with the SCOTT's lawn may not be all that unique!) But sustaining a healthy, wear-resistant, stress-tolerant, vigorously growing turfgrass community requires a firm, well- drained, resilient, moist and fertile growth medium. This usually means a uniform and well-structured soil profile in which oxygen, moisture and essential plant nutrients are in adequate supply.

I recall an incident that happened in the mid 1970s that illustrates how importantly the composition of a soil can influence turf quality. A gentleman called for advice in solving a problem with his new greens. He followed instructions that he was given for constructing a rootzone of soil, sand and peat (1:1:1) for fall establishment only to have the new greens die early the following summer. When he arrived with six-inch cores extracted from the failed greens, the cause of his problems was immediately apparent. From top to bottom, the cores showed distinct two-inch layers of soil , then sand, and finally peat. Apparently, no one had instructed him to mix these constituents together to form a uniform medium! While the clay loam topsoil would not have been a very good rootzone medium for a putting green, situating this soil atop sand and peat layers made it especially unfavorable. Let's examine why.

Layers within a soil profile have a disruptive effect on the movement of water and other materials through the soil. This can be an important advantage or a serious disadvantage in the successful implementation of a cultural program. Generally, water will not move from a finer-textured medium to a coarser- textured medium until and unless a sufficient hydraulic head exists to force the water across the interface between the two media. Therefore, if a finer-textured soil is situated atop the coarser-textured one, surface application of water will be followed by downward movement at a rate determined by: the application or "precipitation" rate of the water, and the hydraulic conductivity of the soil. When the wetting front reaches the interface between the two soils, downward flow will stop and a "perched water table" will form above the interface. This soil layer may become completely saturated if, because of the layer's shallowness and texture, a hydraulic head of sufficient size does not develop to force water into the underlying, coarser-textured medium. Conversely, where a relatively deep surface layer exists, such as in a USGA green, the perched water table at the lower portion of the layer is actually a reservoir for water and some nutrients in an otherwise droughty medium with very limited water- and nutrient-retention capacities.

Where a coarser-textured medium is situated atop a finer-textured one, the initial water infiltration rate will be fairly rapid; however, when the wetting front reaches the interface between the two media, percolation will slow to a rate reflecting the hydraulic conductivity of the underlying soil. Where this is slower than the precipitation rate, a "temporary water table" will develop and persist until the underlying soil can fully absorb all of the applied water. The coarser-textured medium may develop as a result of sand topdressing, or it may be a predominantly organic medium derived from the accumulation of thatch at the soil surface.

Thatch has been defined as a "tightly intermingled layer of living and dead leaves, stems and roots that develops between the zone of green vegetation and the soil surface." From an edaphological perspective, a more appropriate definition might be: "a layer of undecomposed or partially decomposed organic residues situated above the soil surface and constituting the upper stratum of the medium that supports turfgrass growth." Edaphic characterizations of thatch have shown it to be physically analogous to coarse sand with respect to water- and nutrient-retention properties. Thatch typically has a lower bulk density than either the underlying soil or the surface soil from a thatch-free turf. Since the soil underlying thatch may contain few roots or rhizomes, it tends to be more compacted than thatch-free soils in which these organs grow extensively. This illustrates the favorable effects of root and rhizome growth on soil physical conditions. The thatch layer may contain appreciable amounts of soil. Much of the soil may have been carried by earthworms to the turfgrass surface during the spring and fall. In intensively cultured turfs, soil can also accumulate in the thatch as a result of topdressing, core cultivation and vertical-mowing operations. The effects of incorporating soil into thatch include: increased bulk density, increased nutrient and water retention, reduced pesticide leaching, and accelerated decomposition of the organic residues comprising the thatch. Since thatch is typically regarded as an organic medium that is essentially devoid of soil, the inclusion of soil into the thatch results in a thatch-like derivative (sometimes called mat) with entirely different physical and chemical properties. Physically, thatch is analogous to coarse sand in that it has large pores. This property means that thatch has better aeration than most soils, as well as better resistance to compaction under traffic. However, the large pores readily lose water from drainage into the underlying soil and evapotranspiration into the atmosphere. An additional problem is that upward water movement stops at the thatch-soil interface where the continuity of capillary pores is disrupted.

Because of the poor water-retention capacity of thatch, and also because of restricted rooting, thatchy turfs are especially prone to wilting during prolonged droughts. When completely dry, thatch may become hydrophobic and thus repel water. Consequently, thatchy turfs generally require more irrigation than thatch-free turfs. The frequent waterings required to sustain thatchy turfs during hot, dry weather tend to leach nutrients and pesticides through the thatch; thus, these materials have to be applied more often than would be necessary on a thatch-free turf. This condition is exacerbated by the low nutrient-retention capacity of thatch. When nutrient-retention capacity is expressed as the cation-exchange capacity (CEC) in meq per 100 g of soil/thatch, the values for thatch may be relatively high compared to most soils. This is largely due to the low bulk density (BD) of thatch, typically, 0.25 g/cc, compared to soil bulk densities that average in excess of 1.0 g/cc. When CEC is expressed on an undisturbed-volume basis (CEC*BD), these values provide a reasonable comparison of the relative nutrient-retention capacities of different media. The CED*BD of thatch is typically much lower than that of a loamy soil . This, coupled with the large aeration capacity of thatch, accounts for the rapid leaching of soluble nutrients through the thatch layer of many turfs. Selection of slowly soluble or slow-release nitrogen formulations reduces the nitrogen leaching potential and thus increases the efficiency with which this nutrient is used by the turfgrass.

Another problem associated with fertilization of thatchy turf occurs because soil-testing laboratories routinely discard the thatch before testing samples from turfgrass sites (if, in fact, the thatch is received with the soil). If most of the turfgrass root system is confined to the thatch layer, the value of soil-test results in determining fertilizer requirements is questionable. A valid test should include the thatch as part of the sample, and separate analyses should be conducted for the thatch and soil layers. Pesticides applied to thatchy turf initially contact the thatch, not the soil; thus, the mobility, metabolism and action of pesticides in thatch determine the efficacy, persistence and selectivity of these chemicals, Attempts to characterize pesticide activity based upon studies conducted in soil media may lead to inaccurate conclusions when applied to turfgrass systems with thatch. Field studies conducted at the University of Illinois showed that several preemergence herbicides were substantially more injurious to thatchy turf than to thatch-free turf. Corresponding laboratory studies showed that these herbicides were more mobile in thatch than in silt loam soil. Thus, the herbicides were allowed to contact the turfgrass roots and rhizomes in the thatch, but were held above these plant organs where they occurred in the soil in a thatch-free turf. This work established two dimensions of potential turfgrass injury from preemergence herbicides: the inherent susceptibility of turfgrasses to injury from herbicides that contact their roots and rhizomes, and the accessibility of these plant organs to surface-applied herbicides due to the nature of the media containing these organs.

There are two fundamental approaches to controlling thatch in turf: the first involves the physical extraction and removal of organic debris to directly reduce the amount of thatch, and the second involves the incorporation of soil into the thatch either through a recycling of soil contained within the turf- soil profile or through topical application of soil from a different location. The first approach usually employs a vertical-mowing machine, with knives or tines mounted along a rapidly rotating, horizontal shaft, that, when set to the proper depth of penetration, extracts portions of the thatch and deposits the debris onto the surface of the turf. Where a substantial thatch layer exists, this procedure usually results in the deposition of large amounts of debris that must be removed from the site to avoid further damage to the turf. Depending upon amount of thatch present and the distribution of roots and other plant organs in the thatch-soil profile, this procedure can be moderately to severely injurious to the turf. Thus, a long period of recovery and some replanting may be required following vertical mowing to re-establish the turfgrass community. Furthermore, if the original cause of thatch development is not adequately corrected, the thatch condition will probably redevelop. The second approach - soil incorporation - is directed at accomplishing two objectives: first, to convert the thatch into a more- favorable growth medium through modification of its edaphic properties; and second, to promote the decomposition of the organic residues comprising the thatch. Successful accomplishment of the first objective is dependent upon the thoroughness with which the soil is dispersed throughout the thatch layer. Depending upon the thickness of the thatch layer and its bulk density, some vertical mowing may be necessary to reduce and/or open up the thatch layer and thus facilitate the soil incorporation process. The second objective is also dependent upon thorough incorporation of soil into the thatch; however, as decomposition is a biological process, a much longer period of time is required to realize this effect.

As indicated earlier, soil incorporation may be accomplished with screened soil applied as a topdressing and matted into the turf. Care should be exercised to ensure that the topdressing soil is texturally similar to the soil underlying the turf, and that subsequent topdressings use the same or very similar soils. A less-expensive alternative is to recycle the soil from the thatchy turf; this is accomplished by core cultivation and subsequent reincorporation of the soil from the cores, or by deep vertical mowing to pull soil up and into the thatch layer. Obviously, these cultivation methods will not produce results as uniform as those obtainable from topdressing; however, for large sites, they may offer the only practical means for effectively incorporating soil into the thatch.

WILDFLOWERS IN PARKS, AND ON GROUNDS AND GOLF COURSES[1]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
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The popularity of wildflowers is growing each year as people become aware of the possibilities they offer in landscapes. Wildflowers create a colorful naturalized look with moderate maintenance once established. This paper will cover what to look for when purchasing seed, how to establish wildflowers and the maintenance requirements for wildflowers used in parks, grounds and golf course roughs.

When purchasing a wildflower mix there are several factors to consider. First what kind of mixture to buy. A mixture containing all annual species can be planted and reseeded yearly producing a broad range of colors and textures. After flowering is completed they can be mowed and a non selective herbicide can be used to control weeds before reseeding each spring.

A mixture containing annual and perennials together, achieves color with the annuals flowering the first summer after a spring planting. Cold winter temperatures vernalize the perennials initiati8ng flowers the following spring, a year after planting. Herbicides can be used prior to the initial planting for weed control. After the annual species die out the bare areas will be open to weed invasion, so they should be reseeded with more of the mix each spring until the perennials take over.

Non aggressive bunch grasses can also be used in mixtures for soil stabilization to fill in areas, where annual flowers die out. A bunch grass such as sheep's fescue adds a blue-gray color to the mix and can be helpful to compete with weeds, while not crowding out the flowers. In a mixture study with 5%, 15% and 60% Bighorn sheep's fescue mixed with Bloomer's wildflower mixture, 60% Bighorn provided to much competition leaving only a few wildflowers surviving. Five percent Bighorn didn't really help to compete with weeds, but 15% sheep's fescue was a good mixture with plenty of flowers and enough grass to fill in the bare areas. Hand weeding must be used after planting if there are undesireable weeds in the stand.

Individual species may also be used by planting complimentary colors, heights, and flowering times where desired. A single species may be appropriate in an area where a more uniform look is wanted. A wider range of chemical weed control methods would then be available.

Always check the quality of the seed, including purity, germination and noxious weeds. The germination requirements for each species vary because of dormancy and indeterminant flowering habits. The lowest allowed is 40% for the Coreopsis sppecies. Noxious weeds to watch out for are curly dock, annual bluegrass, and quackgrass. The mix should not have a high percent of one or a few components which would then take over in a year. This happens when a cheap filler is used in the mix to lower the overall cost. A few examples of fillers would be grasses, Baby's breath, Bachelor Buttons, or Chicory. Note the number of seeds per pound of each species, a high number would justify a lower percent of a species in the mix since there would be a high number of plants produced per pound of seed.

Aggressive species should be avoided or reduced in proportion so they don't dominate and take over the stand. Chicory, Yarrow, Butter and Eggs, Ox-Eye-Daisy, Snow-in-Summer, Missouri Primrose, and Cosmos are a few examples of aggressive species which if used, should be at a low percentage of the mix.

Flowering periods are critical to maintaining a wide range of flowers for a extended period of time in a mixture. Some species produce flowers for up to 90 days depending on water availability while others produce flowers for only 19 days, with most flowers lasting 30 to 40 days. Tables will be presented showing the variation between species for early and late flowering following a spring seeding. A few early Spring and Summer flowering species are Blue Bells, Baby's Breath, Sweet Alyssum, Johnny Jump-Up, Iceland Poppy and Forget-Me-Not. While New Englandster, Purple Coneflower, Prairie Coneflower, Mountain Phlox, and Rocket Larkspur produce flowers during late Summer and early Fall.

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 or cultivation no deeper than 3 inches or a combination of the two. 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 disking and then dragging or raking smooth. For 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 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 difficult 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, too much water will encourage foliar growth and less flowers. No fertilizer is needed unless the soil is depleted. Maintenance requirements are to mow once after flowering and seeds are set in the fall about 4 to 6 inches removing the debris. This helps to scatter the seeds so they can reseed for next year. If there are weed problems, they can be spot-sprayed out with round-up, or pulled out and reseeded with more mix each year.

When purchasing wildflowers there are several factors to keep in mind which have been presented. Wildflowers can add an exciting array of color with a different combination of flowers blooming throughout the spring and summer. With the proper establishment and maintenance wildflowers can be a success in parks, grounds or golf courses creating a naturalized setting for people to enjoy.

RECOMMENDED STORAGE PROCEDURES FOR PESTICIDES[1]

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Before a pesticide storage facility is built, thought must be put into the type of material to be stored, sites available and the operational procedures to be performed in that area. The site itself should have a soil type and structure that will not flood and prevent any runoff from the area. The area should be contained whether it is a natural or artificial barrier. An emphasis should be placed on personal safety, accident prevention and detecting potential problems.

The actual physical recommendations for building a storage facility are not published by the WSDA or OSDA, but some of these items are generally common sense type of considerations. The WSDA updated their regulations relating to the general use of pesticides after holding public hearings throughout the State of Washington in January of 1990. The regulations specifically relating to pesticide handling and storage are contained in WAC-16-228-185. The storage procedures went into effect in June of 1990 and posting requirements in July of 1990. Any questions dealing with pesticide storage records are handled by the Department of Labor and Industries, and all questions relating to pesticide rules and applications are handled by the WSDA. The actual storage facility should be a dry, well-ventilated, separate room, building or covered area where fire protection is provided. It is wise to have a switch on the outside of the facility to control ventilation and lights, and ideal to secure the storage facility by a climb-proof fence. Minimum protection would be to keep all doors and gates locked. Identification signs should be placed on rooms, buildings and fences to advise of contents and their hazardous nature. Any equipment used to handle pesticides at the storage site should be labeled with "pesticide use only", and a decontamination area should be provided for personnel and equipment. This area should be paved or lined with impervious material and include gutters. A wash basin and shower with a delayed- closing pull chain valve should be provided and all contaminated water should be disposed of as excess pesticide. Measure all application areas, mix up only the pesticide needed for the job and rinse all measuring equipment into spray equipment. Spray all equipment rinsate back on the site if at all possible to limit the amount of rinsate stored. The drainage system from this facility can not discharge into a storm sewer or sanitary system or any water source or system.

Post the rules for personal safety in the personnel areas as a safety precaution. No food or beverages or smoking is to be allowed in either storage, loading or pesticide areas. Rubber gloves, goggles, and protective clothing should be worn while handling the pesticide concentrates. Washing of hands immediately after using pesticides is important, as well as having cholinesterase tests and physicals given to those employees regularly working with organophosphate and N-alkyl carbonate pesticides.

The local fire department, hospitals, public health officials and the police department should be informed of the hazards of pesticides in case of fire. Provide the fire department with a floor plan of different pesticide classifications in the storage facility and make sure to supply emergency telephone numbers of the person responsible for the storage facility. The outside of the storage area should be labeled with "DANGER", "PESTICIDE STORAGE" signs, with a list on the outside of the storage area of the types of chemicals stored. It is recommended to install smoke detectors and monitor the temperature of the storage facility. Any electrical equipment in the storage area should be shielded against sparks to reduce explosion risks.

Accident prevention is very important. Containers should be inspected, handled properly and no unauthorized persons should be allowed in the storage area. Ideally, an environmental monitoring system should be considered for the area around the storage facility. Samples from ground and nearby surface water should be analyzed for a baseline reading and then sampled on a regular basis.

Washington's Department of Labor and Industries now requires storage records to be posted or updated on the day a pesticide is put in storage or removed. The last date of entry must reflect the amount of pesticide remaining in storage. With a small inventory, all pesticide records can be kept on one sheet, while a large inventory with a frequent turn-over may require a single record sheet for each pesticide. Storage records are not required for storage periods of 24 hours or less. All storage and application forms must be kept in a location readily accessible to employees and in a location where they will not be destroyed. Records must be kept for at least 7 years for evaluation and in case of an illness or unplanned exposure.

Good housekeeping practices shall be maintained for all pesticides and their containers. Each pesticide formulation should be segregated and stored under a sign, with the containers stored upright and off the ground. It is better to store wettable powders above liquids and accumulate containers in rows with the labels visible and lanes to provide access to the pesticides. Containers should be checked regularly for leaks and absorptive clay, hydrated lime and/or sodium hypochlorite should be kept on hand for use in case of a leak or spill.

If pesticides are being applied, they are not considered unattended at the loading site if the operator maintains visual contact or returns at closely spaced intervals. When unattended, Category 1 pesticides with the signal word "DANGER" and their containers must be stored in an enclosure that can be locked to prevent unauthorized entry. Category 2 pesticides, with the signal word "WARNING" and Categories 3 and 4 with "CAUTION" should also be secured.

Category 1 pesticides should be posted using the skull and crossbones symbol with "Danger/Poison Storage Area/Keep Out" in letters large enough to be seen at 30 feet. These signs should be posted at each entrance, on each exterior wall and on each exterior wall within 30 feet of the pesticide storage area and from the main entrance if the storage area is contained in a larger multipurpose building. Posting of the main entrance is not required if a sign is visible at the entrance which would clearly identify the possibility that pesticides could be on the premises.

Some suggestions for pesticide storage facilities from Fred Haskett of Greenworld in Ohio are to divide the facility into two areas; a primary containment area, and a secondary containment area. The primary containment area contains the chemical concentrates and has a 6-inch dike (1000 gallons holding capacity) surrounding it. It also contains an eye wash fountain, shower and sink, with all of them draining into a sump which isolates the chemicals. The secondary containment area has a 4-inch dike (3000 gallons holding capacity) , with daily operations taking place there as well as trucks and fertilizer being stored in this area. The water line for filling in this area is attached to an anti-siphon device to prevent backflow out of the secondary area.

A well-planned chemical storage area can give the employer a savings on insurance premiums due to extra precautions that have been taken. It is well worth the time and effort to keep these facilities up to date and reduce the liabilities for your operation.

GROUNDWATER PROTECTION[1]

Gwen K. Stahnke [2]

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Water quality is of extreme interest and concern to our industry and the public in general. It is difficult to speak about groundwater without also including the definite influence of surface waters as well. One-half the population of the U.S. and 95% of rural Washington residents utilize groundwater as their drinking water source. Our primary concern is to be proactive and prevent contamination or foreign elements from being detected in amounts above the background level in our water sources. Naturally occurring levels of each element in the water source should be determined before safety levels are established. The baseline amount contained in the water may be higher than the limits established. Natural levels of elements in groundwater are approximately 1000 times lower than in soils. Prevention of contamination is far more effective and lest costly than cleaning up polluted aquifers.

It will be necessary to develop best management practices (BMP's) for our industry. We will use pesticides and fertilizers with low leaching tendencies and through integrated pest management and improved turfgrass cultivars, try to reduce pesticide and fertilizer use. We must ensure that these practices are agriculturally feasible, as we continue to research health effects and possible contamination through pesticide transport. Chemical contamination can occur via industrial or non-industrial means. Here are some of the sources.

Industrial Contamination
1. Landfills
2. Waste water impoundments
3. Chemical leaks from storage
4. Domestic wastewater
5. Vapor condensate

Non-Industrial Contamination
1. Road runoff
2. Municipal landfills
3. Junkyards areas
4. Accidental spills

Let's now look at some factors affecting pesticide transport. We must consider the pesticide used, soil at the site, environment of the site and its management. The pesticides persistence and mobility are very important to understand. The persistence of a pesticide can be estimated using its half-life. The half-life is the time required for one-half of the original pesticide applied to be degraded to its metabolites. There are many processes involved in the breakdown of a pesticide, but several of these to consider are microbial degradation, photodecomposition, volatilization, hydrolysis, adsorption, runoff and plant uptake.

A pesticide has a greater possibility of leaching if it is very soluble, has a longer half-life, is less volatile and is not strongly adsorbed to the soil or thatch layer. When we look at pesticide solubility, we see that pesticides can be ionic compounds, polar molecules or neutral molecules. The ionic compounds are the most soluble, while polar compounds are variable insolubility and the neutral compounds are the least soluble.

Soil adsorption deals with soil organic matter and clay fractions adsorbing the pesticides. Clay, which has negatively charged sites, has the ability to bind positively charged pesticide molecules, while organic matter with its charged and uncharged areas binds a variety of pesticides to its surfaces. In summary, the insoluble, neutral pesticides and positively charged pesticides are bound tightly to soils or thatch, while polar pesticides are variable in their binding. Negatively charged pesticides, due to the like charges on the soil, are repelled and not bound to the soil. In determining the adsorption of a pesticide, we use KD' a property known as the adsorption coefficient.

$$K_D = \frac{\text{amount adsorbed on soil}}{\text{amount remaining in solution}}$$

The higher the KD value, the more tightly the pesticide is adsorbed. This is good, however, for only one soil type. In order to compare pesticides over all soil types, we must use the KOC or pesticide partition coefficient.

$$K_{OC} = \frac{K_D}{\text{organic carbon content}}$$

By adding the organic carbon content, the pesticide can be compared over all soils. This works very well unless there is a very low organic matter content and inorganic clay could dominate the adsorption. Basically, with sandy soils and low organic matter, there is a low retention of pesticides and a greater risk of movement.

Water movement is responsible for most pesticide transport. Pesticides are more likely to move through a highly permeable soil because of less retention. With drier soils, not all pores are filled with water and there is greater area for soil-pesticide contact. The flow through the soil will be slower and there should be greater retention. Wet soils, however, have the larger pores already filled with water, so there is less area available for soil pesticide contact and flow through the soil will be faster with greater possibility for transport. The greatest pesticide movement occurs after a heavy rainfall or irrigation.

Climate also plays an important part in pesticide reaction in the environment. Temperature and soil moisture affect the rate of microbial degradation. Excess heat or cold limits microbial processes and excess water or drought also limits microbial processes. In looking at these conditions, late fall-applied an dearly spring-applied pesticides would be the most likely to leach. Considering pesticide use, we must be concerned with a total management system. This management system involves the following criteria:

1. Application rate.
2. Application history.
3. Placement of pesticide.
4. Application uniformity.
5. Timing of application.
6. Irrigation.
7. Clean-up and disposal

All of these are items which are required for your pesticide application records and should help you evaluate your practices.

Fertilizers need to also be considered for their properties, soil types to which they are applied and environmental conditions. Larger quantities of fertilizers are used, but they are less toxic. There area also less different nutrients used and it is easier to generalize about fertilizers. Nitrogen and phosphorus are the two main nutrients to consider. Nitrogen is the greatest threat to groundwater due to its mobility in the nitrate (N03-) form. Phosphorus is tightly bound to the soil and usually moves by soil erosion. Eutrophication or over production of vegetation can occur in lakes due to excess phosphorus.

Models or equations have been and are being developed to describe pesticide transport through the soil. To do this, we need to know what situations will pose a risk, as well as verify these models using field results. A sample model would consist of:

Model Inputs

1. Pesticide properties (adsorption, degradation rate.)
2. Climate (precipitation, evapotranspiration)
3. Soil (texture, organic matter, permeability)
4. Management (application rate, irrigation)

We can look at an example of the areas actually treated on an average golf course. Using figures which have been estimated by Tom Cook (2) at Oregon State University, we see that:

Total areas		Portion of total acres (%)
Greens	2 acres	1.5
Tees	2 acres	1.5
Fairways	30 acres	25
Roughs	86 acres	72
Total	120 acres	100

Greens and tees are the highest maintained areas and comprise only 3% of total acres of the golf course. Pesticides are generally not applied to fairways or roughs, and if they are applied, it is usually a spot treatment only. Fertilizers are also applied mostly to greens and tees at 6-8 and 4-8 lb N/lOOO ft2/yr, respectively. Fairways are generally at about 2-3 lb N/lOOO ft2/yr and roughs are not usually fertilized.

Case studies indicate that groundwater pollution by golf courses is rare except in areas where aquifers are close to the surface and soils are sandy (Cape Cod). The Cape Cod study (1) began in 1985 and was completed in 1990. Sixteen wells were monitored on four golf courses which were selected for their hydrogeologic vulnerability. No currently registered pesticides were detected at toxicologically significant concentrations. Nitrate levels were generally below the 10 ppm federal standard. When nitrates were found in the groundwater, lower nitrate concentrations resulted when less N, slow-release N, or both were applied. Seven of the seventeen pesticides applied were never detected. Only chlordane/heptachlor epoxide came close or exceeded the federal health advisory level (HAL). This material had not been applied in eight years. Since chlordane is immobile, the possibility exists that movement occurred through macropore flow such as earthworm burrows or decayed root channels. A second possibility exists that contamination could have occurred if the bentonite plug failed during well installation.

Research at Penn State University (4) indicates that pesticide runoff or leaching is minimal on heavy soils with good turf cover. A dense turf acts as a filter to prevent leaching of pesticides and allows time for biological breakdown.

A two-year study comparing nitrate-nitrogen losses to groundwater from septic systems, forests, home lawns, and urea-and-manure-fertilized silage corn was conducted by Gold et al. (3) in Rhode Island. The septic system and corn silage treatments had concentrations of nitrate-N in excess of 10 mg/l for at least one of the two years. Forests and fertilized and unfertilized lawns had nitrate-N concentrations of less than 1.7 mg/l. These results demonstrate the importance of unfertilized land use types in maintaining water quality.

It is wrong to assume that most pesticides applied to golf courses will eventually show up in the groundwater. However, it is also wrong to assume that the thatch, the dense plant system and the bioactive root zone will answer all surface water and ground-water concerns. Fertilizer and pesticide use is highly site specific and care must be taken when making general statements.

We need to be aware of potential risks, and consider the mobility, persistence and toxicity of pesticides applied, especially near sensitive water supplies. It does not appear that golf courses or turf areas are a serious threat to the environment. Looking at turf from another angle, the plants and thatch provide a biological filter system, produce oxygen for the environment and provide cushion, wear and aesthetic quality for recreation and urban areas. These are very positive qualities to be added to our living areas and should be promoted as contributing to the betterment of our environment.

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EDUCATION AND INFORMATION IN TURFGRASS[1]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
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The field of Turfgrass Management is one of the fastest growing career areas in agriculture. With predictions such as the need to open a golf course per day until the year 2000 AD and the rapid growth of the lawn care industry, good career opportunities should continue. As turfgrass management becomes more scientific and technological, turfgrass managers will require an ever increasing level of education. As we shall see, this education can be obtained as formal training at the community college and university level or through short courses, seminars, correspondence courses, etc.

Career Opportunities in Turf

At Washington State University, approximately 75% of our incoming turf majors want to become golf course superintendents upon graduation. It is the "glamor" career and often their only exposure to turfgrass has been through golf or is golf course related. The golf course superintendent falls under a much broader career heading of Grounds Superintendent. As a grounds superintendent one might work on a golf course, but one could also be employed at an athletic facility, recreational facility, institutional grounds, government facility, transportation facility, business facility, or residential complex. In addition, there are other turf career areas to choose from, e.g., Manufacturing/Sales Representative, Professional-Service Contractor, Technical Writer, and Scientist/Educator.

Turfgrass Education at Washington State University

Due to my familiarity with Washington State University most of my comments will be related to education opportunities at WSU; however, turfgrass training is offered at other universities in the Pacific Northwest. Tom Cook in the Proceedings of the 33rd NTA Conference reviewed education opportunities at OSU.

How does one enter the WSU turfgrass program? Historically, most students came to WSU directly from high school . However, this is no longer the case. We now receive most of our students after they have received some higher education elsewhere, be it at another university or, more likely, a community college. If you choose to attend a community college prior to attending WSU, be sure the courses you take at the community college will transfer to WSU and are not merely "filler" courses. Talk to the community college counselors and study the WSU transfer guide for community colleges. This is an important process and will save you time and money in the long run.

If you choose to attend WSU, and fulfill all the requirements I am about to discuss, you will graduate from the Department of Agronomy and Soils as an agronomist. The word agronomist comes from the Greek and can be roughly translated to mean one who manages the field. As an agronomist, you will receive training in a common core curriculum that all agronomists receive. You, as a turfgrass major, will then receive specialized training in the Turfgrass Option.

Of the 120 credits Required to graduate from WSU, 82 to 86 credits are in the Core Curriculum. In the core there are courses in biology, agronomy, chemistry, soils, computer science, botany, genetics, mathematics, plant pathology, and entomology. Also included are the general university requirements (GURs) in English, speech, social science, humanities, and intercultural studies.

Courses in the Turfgrass Option will hone your skills and training in your chosen career area. These courses include turfgrass culture, business management, plant materials, entomology or plant pathology, soils, engines and tractors, small engine repair, turfgrass irrigation, and irrigation and drainage. Students will also do a "special. Problem" on some turf related project or topic. As you can see, the Turfgrass Option contains a balance of courses in the sciences and applied or practical areas. Additional hands-on experience can be obtained through the co-op program which at WSU we call the Professional Experience Program. In this program students are placed in turf related jobs and receive training and college credit as they work. If you are interested in hiring a turf student to work with you, contact PEP/Career Services, WSU, Pullman, WA 99164-1120, phone (509)335-9519. Tom Cook has a similar program at OSU. This is an excellent opportunity for the student to receive hands-on training and for you, as an employer, to hire turf students.

Courses by Correspondence

WSU offers several courses, including Turfgrass Culture, by correspondence. Correspondence courses can accommodate the needs of many place-bound individuals. Students can begin courses anytime and, since they have a year (or two years with an extension) to complete the work, set their own pace and schedule. Students can even interrupt their study for reasonable periods (e.g. , in the summer when job demands are the greatest) without falling behind. The graded assignments provide continuous feedback from the instructor and are an excellent source of review material. The one-to-one relationship between instructor and student can be as productive as that developed in the traditional classroom setting.

If you are interested in taking Turfgrass Culture, Soils, Entomology, etc. by correspondence contact: Independent Study, 204 Van Doren Hall, Washington State University, Pullman, WA 99164-5220, phone (509)335-2339 or toll-free in Washington 1-800-999-0714. Ask for the Courses by Correspondence Catalog. The catalog gives the courses offered, cost, how to enroll, etc.

Sources of Turfgrass Information

Your #1 source of turfgrass information should be your Extension Service county agents and/or Extension Service specialists. The Directory of the Northwest Turfgrass Association (which you received with your paid membership) lists all the county offices in Oregon and Washington. Those for Idaho and Montana can be found in the telephone book under county government/Cooperative Extension Service. The NTA Directory also lists the state specialists for the Pacific Northwest.

Another good source of regional turfgrass information is the university bulletins, pamphlets, circulars, etc. available from each state university. A complete listing of these turfgrass and related publications is given in the NTA Directory. These are a good, cheap (often costing less than $1.00 each) source of information. An example of one you should have on hand is PNW0299, Seeding Recommendations for the Pacific Northwest, published in 1987, and available for $0.75. It is a good idea for every turfgrass manager to have a complete collection of state publications for their region.

In addition to Extension Service publications another sources of information are NTA Proceedings, NTA Turfgrass Topics, professional journals (e.g., Agronomy Journal) , magazines (Grounds Maintenance, etc.) , the WSU Puyallup Field Day publication, the NTA Directory, and local group publications (such as those put out by the local golf course superintendents associations.

As we move into the 1990s, computer accessed information will become more common. One such user service now available is the United States Golf Association's Turfgrass Information File (TGIF) service. Some 14,000 bibliographic records are now in the USGA/TGIF database and more than 2,000 records are added each year. All you ever wanted to know about a turfgrass subject (in most cases more than you wanted to know) is now available via your computer. If you are interested in this service contact the Turfgrass Information Center, W-212 Library, Michigan State

University, East Lansing, MI 48824-1048, phone (517)353- 7209.

A source of information often over looked, or taken for granted, is the local meeting. Support your local turfgrass organization. The local organizations have speakers that can address local issues, often better than "out-of-town"

experts. Also, the word-of-mouth information you receive from another turfgrass professional is often a valuable piece of information that can be used immediately.

In summary, always strive to become a well educated, well informed turfgrass professional. Attendance at the NTA annual meeting is evidence that you are well on your way to attaining this goal.

SULFUR, PHOSPHOROUS AND CALCIUM ON PUTTING TURF[1]

Stan Brauen[2]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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Athletic turf, such as, putting greens and athletic fields are commonly constructed with sand that have low nutrient holding capacity. The establishment and maintenance of these turfs is a precise balance of many factors and understanding the significance of these factors is important in maintaining quality turf and botanical composition.

In a recent review of mineral nutrition of golf greens (Isaac and Canaway, 1987) it was noted that phosphorous (P) is required in only small quantities by Festuca and Agrostis species as there is sufficient levels in the soil so no further P applications should be made. Weed grasses, such as, annual bluegrass (Poa annua L.) have a high P need and P limitation can be used as means of controlling weed ingress. The application of P at relatively high rates, encourages the invasion of annual bluegrass (Goss et al. , 1975) . Turfs grown on sand, however, may show symptoms of P deficiency and have some small P requirement. Work by Paul (1981) showed that a level of 3 ppm of P in sand was critical for growth of creeping bentgrass (Agrostis stolonifera) while Christians suggested that P was not limiting to growth or quality of creeping bentgrass at 2 ppm. However, P availability in very acid soils is low and this condition may become important where acid fertilizers are used without pH correction. Lime application further impacts these findings.

Lime application has been reported to discourage colonial bentgrass (Agrostis tenuis Sibth.) and increase the invasion of annual bluegrass into putting greens (Lodge et al.) . In this recent study unlimed plots with high N regime produced a large increase in death of Agrostis castellana, and the phenomena was particularly evident in the fall. The percentage of annual bluegrass increased rapidly in limed plots but only increased slightly in unlimed plots. High levels of P application increased annual bluegrass cover in limed plots. Moss was promoted by liming and low N. Sulfur (S) , a needed element in western Washington turf as well as nitrogen (N), impacts the relationship of these elements. In order to understand the application of nutrients to sand based systems, the following work was begun to examine the impact of phosphorous, sulfur, and lime [calcium] (Ca) on turfgrass growth, turfgrass quality, and tissue nutrient and soil extractable P and Ca.

METHODS

The experimental area had been established to 'Penneagle' creeping bentgrass (Agrostis palustris Huds.) for seven years and had been maintained with no lime and very low P and S so that soil extractable P and Ca and bentgrass tissue P and Ca were low and bentgrass P deficiency symptoms were present from the start of the study. The top 2 .5 cm (1 in) of turf and thatch had a pH of 5.2 to 5.5. The 2.5 cm turf was removed from the experimental area, the top 20 cm (8 in) of sand was removed, new sand replaced and the sod relayed over the experimental area. The experimental area was designed in a split split split plot with 72 experimental units. The first split consisted of two S levels. The S treatments consist of nutrition parameters in which the nitrogen (N) and the potassium (K) is applied with sulfate containing sources and elemental S on blocks where S is applied. The N and K is applied with non-S containing sources and with out elemental S on blocks where S is not applied.

The second split consists of four levels of P. They are 0, 0.25, 0.5, and 1.0 kg P 100 m^{2-1} (0, 0.51, 1.03, and 2.05 lb P/lOOO sq ft) . The P is applied as dilute phosphoric acid in three applications per year; one each in April, June, and October. The third split consists of three levels of Ca. They are 0, 4, and 8 kg Ca 100 m^{2-1} (0, 8.19, 16.39 lb Ca/lOOO sq ft). The Ca is applied as granular fine calcium carbonate limestone in three applications per year; one each in April, June and October. Clipping yields are made at several times per year and soil samples collected at each date of harvest. Plots are sampled before and after each application of P and Ca. Turf quality, density, and deficiency symptoms are noted on a continual basis.

RESULTS

This report deals only with early findings and results will change as the study matures. Phosphorous in very low amounts of 0.083 kg P 100 m^{2-1} (0.17 lb P/lOOO sq ft) applied in October quickly eliminated P deficiency symptoms and improved turf quality and growth throughout the winter (Fig. 1 and 3) . This result occurred following the first 1/3 yearly application of P. Higher application levels of P at 0.166 kg P 100 m2-1 (0.34 lb P/lOOO sq ft) did not improve turf quality but did increase bentgrass growth. Additional application of P at 0.332 kg P 100 m2-1 (0.68 lb P/ lOOO sq ft) tended to reduce growth (Fig. 2) . Extractable soil P increased with the rate of P applied (Fig 3) but bentgrass tissue P increased at P rates of 0.83 and 0.166 kg P 100 m^{2-1} (0.17 and 0.34 lb P/lOOO sq ft) but did not increase further with the 0.332 kg P 100 m2-1 (0.68 lb P/lOOO sq ft) rate (Fig 4). These same trends continued following applications in April and June.

The application of lime (Ca) had no significant impact on turf quality or bentgrass growth (Fig. 5 and 6) during most of the year even though sand extractable Ca and bentgrass tissue Ca was significantly increased (Fig. 7 and 8) . Thus, sand extractable Ca above 250 ppm did not impact bentgrass performance. Although bentgrass tissue Ca increased in late spring and summer, 2000 ppm tissue Ca seemed adequate for nutritional needs. Differences in bentgrass turf quality with Ca application did appear in late summer and early fall (visual observation in mid-September but data not reported) indicating that Ca may have significant impact on bentgrass performance in some seasons or a later date. Soil and plant tissue analysis have not been completed on the most recent sampling dates.

SUMMARY

This study is designed to provide a record of P and Ca levels in sand growth medium and in bentgrass tissue as it relates to turf quality performance and bentgrass putting turf nutrient deficiency symptoms. It is also intended to identify the impacts of these nutritional schemes on bentgrass persistence and annual bluegrass invasion. As a result of the first year's performance, P deficiency symptoms and tissue P levels were established. These data indicate that P deficiency symptoms will occur when bentgrass leaf tissue is below 0.5% P although this level may be slightly lower (about 0.4% p) during summer. Sand extractable P was less sensitive in distinguishing a possible nutritional deficiency in bentgrass. Bentgrass grown on sand with P levels from 0.65 to 0.90 ppm P showed strong P deficiency symptoms while sand P levels from 1.5 to 3.4 ppm did not show symptoms. Between the values of 0.9 to 1.5 ppm tissue P, deficiency symptoms were mild or difficult to view. Very low liquid application of P (0.17 lb/lOOO sq ft) corrected the bentgrass deficiency and increased growth to non- deficiency levels. Calcium did not impact turf performance during most of the year but late season observations suggest responses may occur in the future. Recent data reported from England suggest the application of lime , like P, is important in the increase of annual bluegrass (Poa annua L.) cover into bentgrass/fescue turf on golf greens. Sulfur was effective only in improvement of bentgrass turf quality during the first year. Sand pH and soluble aluminum have not been evaluated at this time.

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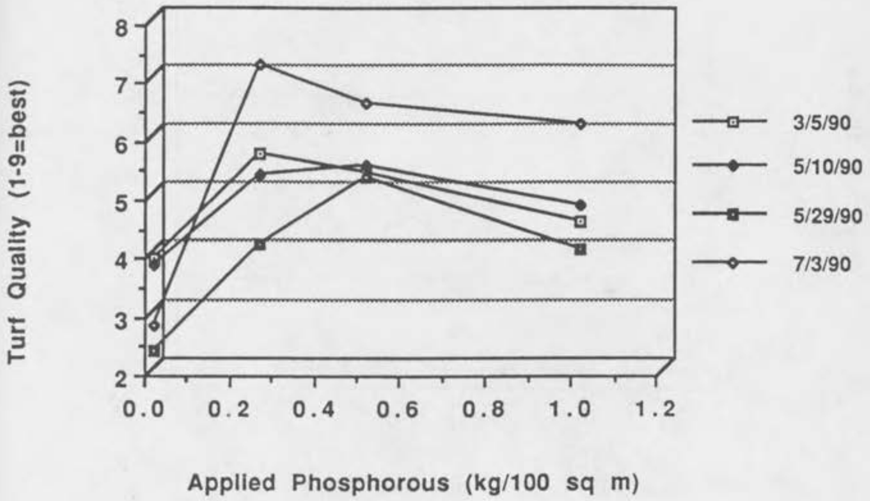

Fig. 1. Effect of P Application on Turf Quality of 'Penneagle' Creeping Bentgrass.

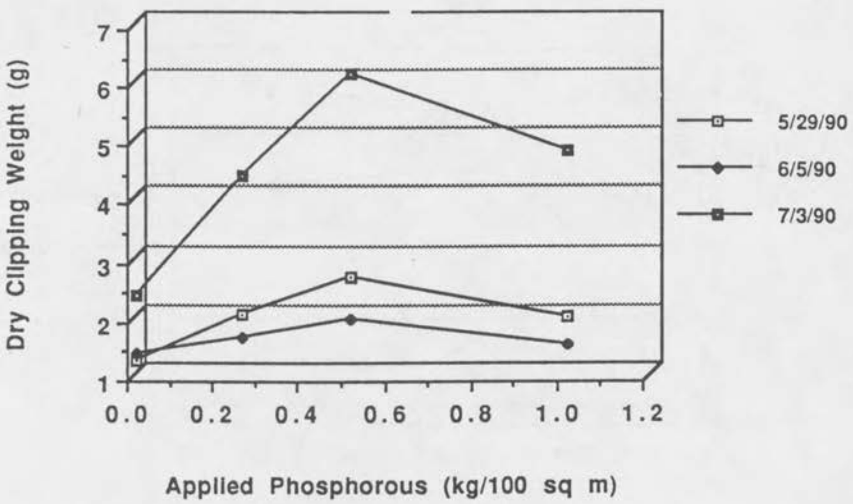

Fig. 2. Effect of P Application on Growth of 'Penneagle' Creeping Bentgrass.

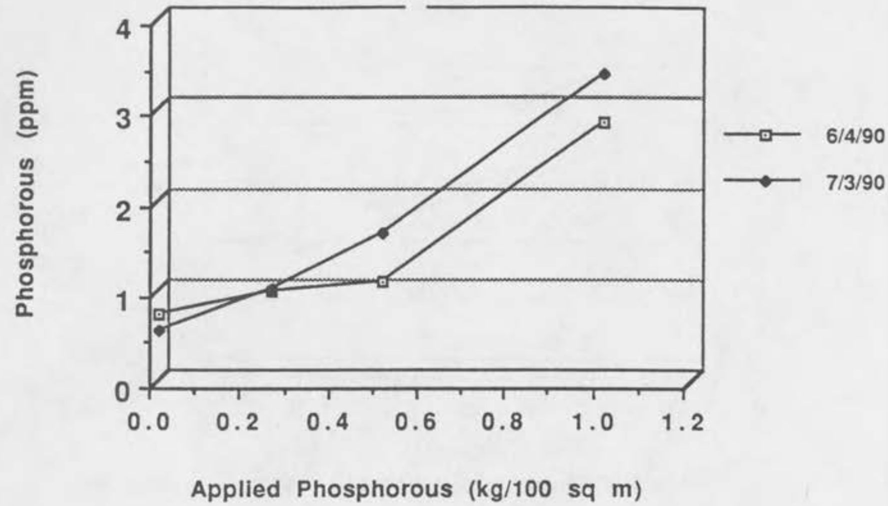

Fig. 3. Effect of P Application on Extractable P from Sand

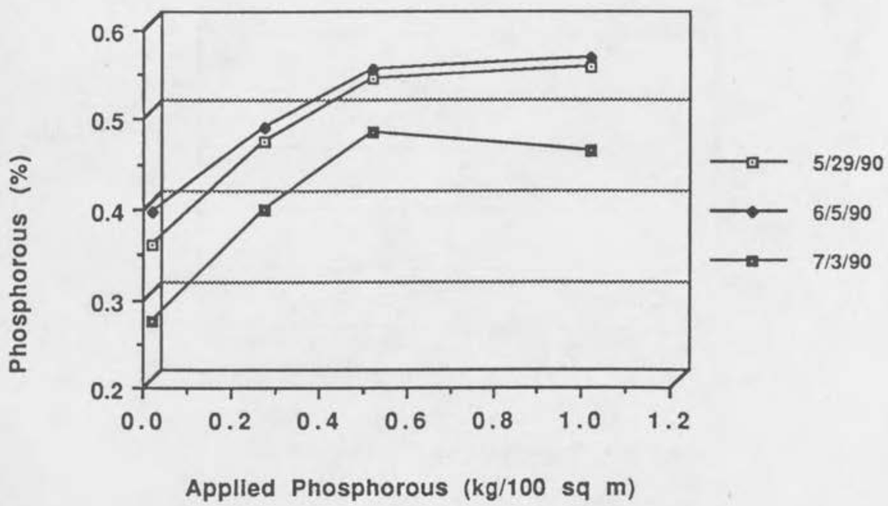

Fig. 4. Effect of P Application on Tissue P of 'Penneagle' Creeping Bentgrass.

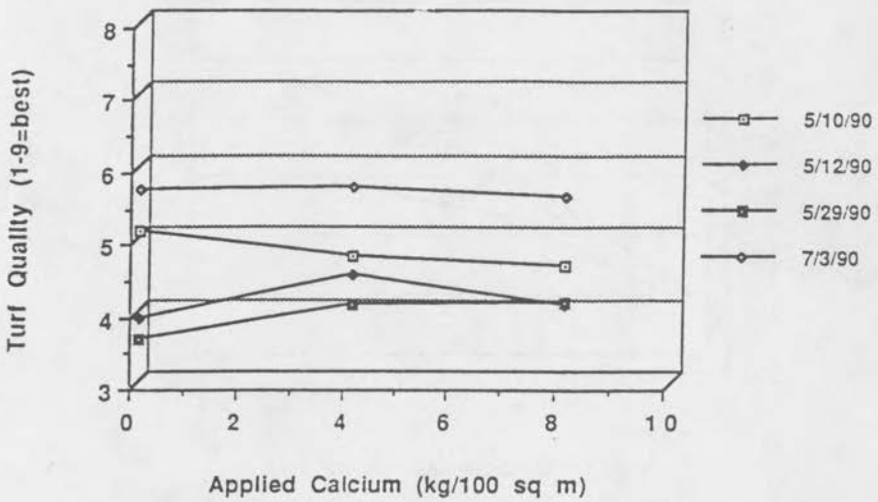

Fig. 5. Effect of Ca Application on Turf Quality of 'Penneagle' Creeping Bentgrass.

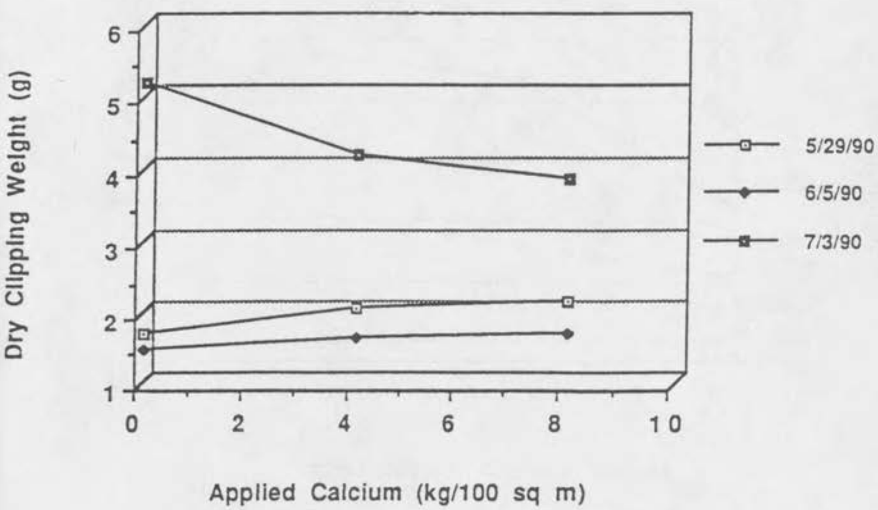

Fig. 6. Effect of Ca Application on Growth of 'Penneagle' Creeping Bentgrass.

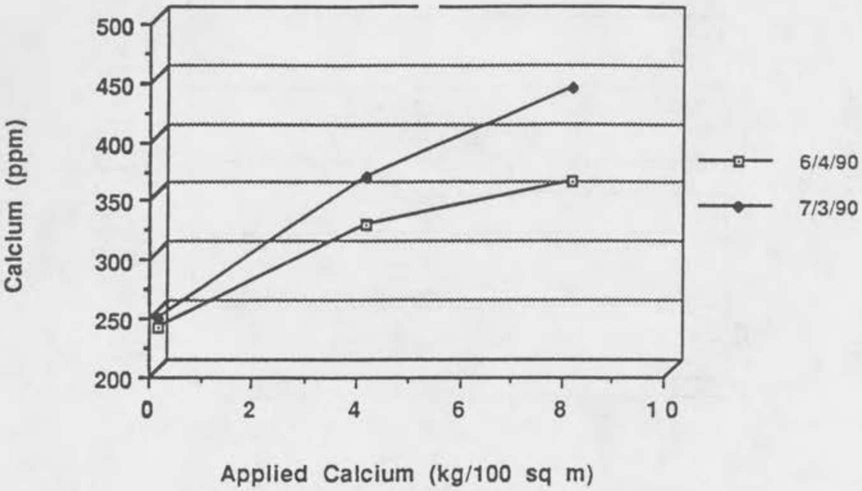

Fig. 7. Effect of Ca Application on Extractable Ca from Sand.

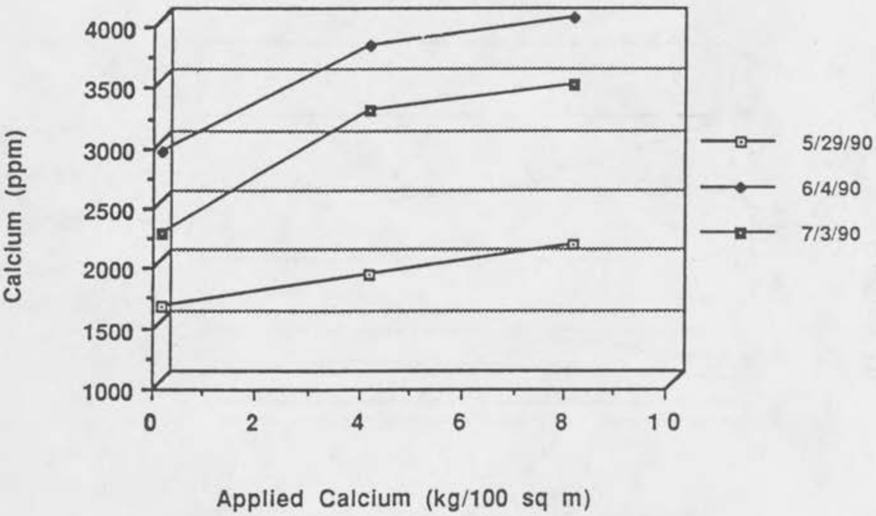

Fig. 8. Effect of Ca Application on Tissue Ca of 'Penneagle' Creeping Bentgrass.

MANAGEMENT OF RED THREAD IN THE PACIFIC NORTHWEST[1]

Gary A Chastagner/ John Staley and Stan Brauen[2]

[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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In 1983, Kaplan and Jackson, working in Rhode Island, showed that red thread and pink patch, which had commonly been thought to be different phases of the same disease caused by Corticium fuciforme, were actually two distinct diseases. They showed that red thread was caused by the fungus Laetisaria fuciforme and that pink patch was caused by the fungus Athelia fuciforme.

Symptoms of red thread and pink patch are very similar. Initially, symptoms of both diseases consist of water-soaked, then tan-to-bleach shrivelled leaves that are commonly matted together by pink fungal mycelium. Diseased turf occurs in irregular areas from 2 to 24 inches in diameter and infected leaves may be interspersed with healthy leaves, giving the patches a ragged or diffuse appearance. The difference between the symptoms of red thread and pink patch occurs when the disease is well developed. At this stage, light pink to red fungus needle or antler-like red threads are typically found on the tips of leaves affected with the red thread disease.

Red thread can cause serious damage on fescue and perennial ryegrass and also occurs on bentgrass and bluegrass during periods when the grass is growing slowly. pink patch occurs most commonly on certain types of fescues and perennial ryegrasses. Kaplan and Jackson showed that the pathogen that causes pink patch grew much faster than the red thread pathogen and that the pink patch pathogen had a greater growth at 59F than 68 or 82F. Although the red thread pathogen grew at 59F, its rate of growth was three times faster at 68 and it did not grow at 82F.

Kaplan and Jackson also found that these two pathogens differed in their sensitivity to fungicides in laboratory tests. Both pathogens were sensitive to iprodione (Chipco 26019) , triadimefon (Bayleton 25DF) , and chlorothalonil (Daconil 2787F) , but only the red thread pathogen was sensitive to benomyl (Tersan 1991).

Besides the differences in red thread symptoms, these pathogens can be separated based on the presence of specialized structures on the fungal mycelia known as clamp connections. These structures are evident upon examination of samples with the microscope. The Laetisaria fungus has clamp connections, while the Athelia fungus does not. O'Neill and Murray have reported that both fungi are widely distributed on turfgrass and especially prevalent in the eastern United States. Pink patch does not appear to be present in the Pacific Northwest, although only a limited amount of work has been done to determine the prevalence of this disease.

The importance of red thread in the Pacific Northwest and elsewhere appears to be increasing, probably due to the increased use of fescue and perennial ryegrass turf which can be highly susceptible to this disease. Conditions which favor development of this disease include prolonged periods of moisture, cool to moderate temperatures, low vigor due to low temperatures, drought, inadequate fertility and the use of certain pesticides and growth regulators.

During periods of the year when environmental conditions are favorable for growth of the turf, red thread can be controlled by maintaining adequate nitrogen and using a balanced fertility program to promote turf vigor. In the Pacific Northwest, it is recommended that 4 to 6 lb of available nitrogen be applied per 1000 ft^2 each year. In addition to nitrogen, phosphorus and potassium should be applied in a 3-1-2 ratio. The nitrogen can be applied in four applications, one in late fall (mid-November to early-December), one in mid-April, one in late-June, and one in mid-September.

In some instances where a highly susceptible turf is being grown, a fungicide application may be needed to control red thread. In addition, fungicide applications may be needed under conditions of low turf vigor, such as late fall and during the winter. Work by Dernoeden et al., at the University of Maryland, has shown that the use of some fungicides, such as benomyl, on perennial ryegrass actually increases the severity of red thread. They found that even though the red thread pathogen was sensitive to benomyl, the use of benomyl on perennial ryegrass in a preventative disease control program resulted in an increased problem with red thread even two years after the last applications of benomyl were made. Their work showed that benomyl use indirectly predisposed the perennial ryegrass to red thread by reducing turf vigor.

During 1989-90, an experiment was conducted on 'Pennfine' perennial ryegrass turf at Washington State University's Turf Research Facility near Puyallup, Washington to determine the effect of late fall fertilization and fungicide applications in controlling red thread. Four fungicides were applied at approximately 14-day (October 5, 19, November 3, 16, and 30, and December 14, 1989, and January 2, 1990) and 11 fungicides were applied at approximately 28-day intervals (October 5, November 3, November 30, 1989 and January 2, 1990) to fertilized and unfertilized turf. The Fertilized turf received 1 lb of nitrogen from ammonium sulfate on October 6 and 1/2 lb of nitrogen on November 30, 1989.

Results from this experiment indicate that applications of nitrogen in October and November reduced the overall amount of red thread by about 50% (Table 1). On the unfertilized turf the amount of red thread exceeded 40% in the nontreated checks on January 10, 1990 (Table 2). Applications of benomyl (Benlate 50W) significantly increased the level of disease while applications of a number of fungicides significantly reduced the level of red thread. On the fertilized turf, the level of red thread was 20% in the nontreated plots on January 10, and applications of Spotless, Terraclor, Fore and the experimental fungicides ASC66608 and ASC66518 had the lowest amounts of disease (Table 3).

The data from our 1989-90 test confirm the importance of nitrogen in reducing red thread and indicate that a number of fungicides currently available, as well as some experimental materials, are effective in controlling red thread when multiple applications are made during late fall and the winter. During 1990-91, we plan on evaluating the effectiveness a single application of fungicides during late fall in controlling red thread.

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Table 1. The effect of ammonium sulfate applications on the percentage of Pennfine perennial ryegrass with red thread[1]

Fertilizer	10/20	11/16	11/30	1/10	2/5	Average
Ammonium sulfate	10 a[2]	10 a	15 a	14 a	8 a	11.4 a
None	16 b	30 b	22 b	30 b	22 b	24.0 b

[1] Ammonium sulfate applied at 1 lb N/1000 ft^2 on October 6 and at 0.5 lb N/1000 ft^2 on November 30, 1989.

[2] Numbers in vertical columns followed by the same letter are not significantly different, $P \leq 0.05$.

Table 2. Effect of fall fungicide applications on the control of red thread on Pennfine perennial ryegrass.

Fungicide	Rate[1]	Interval[2]	% of turf with red thread Nov 30, 1989	% of turf with red thread Jan 10, 1990
Benlate 50W	4	28	36 a[3]	60 a
Check	0	0	31 ab	44 b
Banner 1.1EC	2	28	24 bc	29 cde
ASC66608	7.5	28	24 bc	26 cde
Rubigan	2	28	23 bcd	32 bcd
ASC 66518 75W	2	14	23 bcd	27 cde
ASC 66811 100EC	0.15	14	22 cde	32 bcd
ASC 66811 100EC	0.3	28	22 cde	29 cde
Bayleton 25W	2	28	22 cde	34 bc
Daconil 2787F	6	28	21 cde	26 cde
Chipco 26019	2	28	20 cde	26 cde
Daconil 2787F	3	14	20 cde	28 cde
ASC 66518 85FG	1.75	14	19 cde	27 cde
ASC 66811 100EC	0.6	28	19 cde	28 cde
ASC 66608	5	28	19 cde	19 cde
Bayleton 25W	1	28	19 cde	30 bcd
Fore 80W	9	28	17 cde	19 de
Spotless 25W	2	28	16 de	21 cde
Terrachlor 75W	16	28	15 e	16 e

[1] Oz product/1000 ft^2

[2] Application interval in days.

[3] Numbers in vertical columns followed by the same letter are not significantly different, $P<0.05$, Duncan's multiple range test.

Table 3. Effect of fall fungicide applications on the control of red thread on Pennfine perennial ryegrass fertilized with ammonium sulfate[1].

Fungicide	Rate[2]	Interval[2]	% of turf with red thread Nov 30, 1989	Jan 10, 1990
Benlate 50W	4	28	26 a[3]	23 a
Check	0	0	24 a	20 ab
ASC66608	7.5	28	18 ab	12 cdef
ASC66811 100EC	0.15	14	18 ab	15 bcd
Bayleton 25W	2	28	15 bc	18 abc
Banner 1.1EC	2	28	15 bc	16 bcd
Daconil 2787F	6	28	15 bc	13 cde
Rubigan AS	2	28	15 bc	14 cde
ASC66811 100EC	0.6	28	14 bc	14 cde
ASC66811 100EC	0.3	28	13 bc	16 bcd
ASC66518 85FG	1.75	14	13 bc	11 def
Chipco 26019	2	28	13 bc	15 bcd
ASC66608	5	28	13 bc	14 bcd
Daconil 2787F	3	14	13 bc	13 cde
Bayleton 25W	1	28	12 bc	16 bcd
Fore 80W	9	28	11 bc	9 ef
Terrachlor 75W	16	28	10 c	8 f
Spotless 25W	2	28	9 c	11 def

[1] Plots received 1 lb of N on Oct. 6 and 0.5 lb N on Nov. 30, 1989 from ammonium sulfate.

[2] Oz product/1000 ft^2

[3] Application interval in days.

[4] Numbers in vertical columns followed by the same letter are not significantly different, P<0.05, Duncan's multiple range test.

STRATEGIES FOR TURFGRASS RENOVATION[1]

Tom Cook[2]

[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
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Is renovation a fool-proof method for improving or replacing turf infested with weedy grasses or damaged beyond repair by insects or diseases? Is it the easy way to convert your lawn to the latest miracle grass created by turfgrass breeders? The answer is yes or no, depending on what you do, when you do it, and how carefully you do it. Like all cultural practices, renovation requires good judgement and proper timing to give top quality results. The purpose of this paper is to guide you through some of the critical steps in renovation and to point out where mistakes are likely to occur. In addition, it will summarize the key steps necessary to achieve success with renovation.

What is Renovation?

Renovation involves establishing new turf from seed without removing the old sod or preparing a seed bed via tilling and grading. We normally renovate turf areas in order to 1) improve the quality of existing turf and/or 2) change the grass species or cultivar to achieve a new look, improve wear tolerance, increase disease resistance, etc. To achieve these goals, there are three basic strategies you might use.

1) Simple overseeding

The plan here is to simply introduce seed into existing turf by whatever means you have available. The most effective planting technique is to use a slicer-seeder machine which cuts a slit in the turf and drops seed directly into the slit. Seeding can also be done by coring the turf area, broadcasting seed, and then dragging the seed into the aerifier holes and turf canopy. In heavy wear areas, seed can be broadcast on the surface, followed by sand or Soil topdressing. Of the three techniques, slicer seeding is probably the most reliable. Simple broadcast seeding is sometimes very effective when used on the center of football fields once most of the turf has been destroyed through heavy use. Overseeding is generally least effective on dense turf areas, such as putting greens and home lawns.

2) Overseeding following suppression of existing turf

This technique is useful when you want to change the species composition of a turf that is dense and vigorous at the time you wish to renovate. The existing turf must be suppressed long enough to allow germination and early establishment of the overseeded grasses. The most common procedure here involves severe dethatching, followed by scalping to thin out the existing grass enough to allow establishment of the overseeded grass. A general rule of thumb is to get close to bare soil with the dethatcher before seeding. Because plant competition may be severe, it is important to select overseeding grasses that germinate rapidly and are competitive in the seedling phase. Perennial ryegrass is often the only suitable grass for this method, but we have had success with chewings fescue seeded into Kentucky bluegrass. The best method for planting is probably the slicer-seeder operated in two directions because it assures good contact between seed and soil. It's difficult to get uniform establishment with broadcast seedings unless they are mulched with a thin layer of sawdust or other available material to help maintain a moist surface environment for germination. It is important to avoid heavy fertilizer applications at the time of seeding because the existing grasses will grow too much and may out-compete the seeded grasses.

Chemical suppression of existing grasses with a plant growth regulator prior to renovation is an idea that has some merit. We haven't conducted any trials to see how well this would work. If successful, this could streamline the renovation process by reducing or eliminating the need for the dethatching or scalping process. Potential negative effects of the growth regulators need to be determined.

3) Complete renovation

In this case, you generally will kill the existing turf via a non- selective post-emergent herbicide, dethatch to remove thatch and debris down to the soil level, fill in any potholes, plant the seed, fertilize, water, and watch for your new lawn. When all goes well, this is a very effective method of renovation, but there are several steps you need to perform properly to get the results you want.

One of the most important steps in this approach involves killing the existing grasses. There is a big difference between spraying and killing weedy grasses. In the rush to get the job done and look professional, most people simply spray the existing turf with glyphosate and a week later prepare and seed the area. Often, within a year the undesirable weedy grasses have recovered and you have the same mess you started with. Obviously, you didn't kill the grasses you were trying to get rid of. What is the secret to controlling weedy grasses prior to renovation? First, you need to know what the weedy grasses are. Bentgrasses, roughstalk bluegrass, velvetgrass, tall fescue, quackgrass, bermudagrass, and, of course, annual bluegrass are our most common weedy grasses in the Pacific Northwest. Colonial bentgrass, quack grass, and bermudagrass have rhizomes (underground shoots) that may not be affected by foliar sprays if conditions aren't perfect. Velvetgrass has a pubescent leaf surface that may not absorb herbicides readily. Velvetgrass under drought stress may not absorb glyphosate and thus will often survive sprays. Annual bluegrass is easy to kill, but will quickly reinvade from seed if pre-emergence herbicides are not used to prevent germination.

To get a thorough kill of weedy grasses, you need to stimulate vigorous growth with water or fertilizer, quit mowing for a few weeks, and time sprays properly. Most grasses are easy to kill in the spring when they start to flower, and in the fall when growth slows. At both times, translocation of herbicides to crowns, roots, and rhizomes occurs, which enhances herbicide activity and maximizes kill of regenerative structures. Velvetgrass (Holcus lanatus) is difficult to kill most of the time, but is susceptible in the spring when flowering occurs. I prefer to spray in the spring at flower time, wait for several weeks, and respray as needed if recovery occurs. If your goal is to get rid of unwanted grasses, you need to pay attention to the above comments. If you don't, you may find you wasted your time. Remember that the easiest grasses to kill in a lawn are often the desirable ones.

Annual bluegrass presents a special problem because it often comes back from seed after mature plants have been killed with herbicides. Until recently, there was no way to control annual bluegrass in new seedings, either chemically or culturally. With the development of ethofumesate (i.e. Prograss) we now have a chemical that can be sprayed on new seedings and renovation sites and selectively control annual bluegrass from germination up to the 3-4 leaf stage. Best results occur when new plantings of perennial ryegrass are sprayed at the 1-2 leaf stage. Ethofumesate works best on moist soils low in organic matter. We normally irrigate after application to work this herbicide into the soil. Our tests show that commercially available cultivars or perennial ryegrass are quite tolerant to ethofumesate, even at the one leaf stage of development. Limited tests indicate tall fescue is also tolerant, but other cool season grasses, particularly the fine fescues, are not tolerant to ethofumesate. Currently, it is registered for use only on seedling stands of perennial ryegrass. Testing at OSU has consistently given 100% control of annual bluegrass in new seedings and renovated sites that were broadcast seeded. On no-till renovated sites planted with a slicer-seeder, we generally get 90-100% control of annual bluegrass.

Regardless of the type of renovation you are attempting, there are several key steps that you should keep in mind to assure success. Some of them have already been discussed, but are worth reiterating here.

1) Choose grasses suited to renovation

Grasses that germinate rapidly and establish quickly increase your chance for success. Throughout the Pacific Northwest, perennial ryegrass has the highest success rate regardless of the actual type of renovation. Of the fine fescues, red and chewings are most competitive and will work where turf is suppressed or sprayed out prior to seeding. Hard fescue works best when existing grasses are killed prior to planting. Tall fescue is similar to red and chewings fescue. Bentgrass can work on suppressed turf or where existing turf has been killed. It is often quick to germinate, but somewhat slow to develop. We have had good success with bentgrass/ryegrass mixtures broadcast on complete renovation sites. Generally, the ryegrass dominates early and the bentgrass shows up as the turf matures. Kentucky bluegrass is difficult to establish on overseeded or suppressed turf sites because it is so slow to germinate and has a weak juvenile period. Your best chance with bluegrass is on completely renovated sites where existing grasses have been killed, eliminating competition.

2) Insure good seed soil contact

Establishment of renovated sites is often slow and stands are often very spotty. Many times this is due to poor germination because seed was sitting on the surface of compacted soil or hung up on top of thatch or organic debris. Planting with a slicer-seeder will generally avoid this problem, though small seeded grasses like Kentucky bluegrass may not emerge from deep slits. The slicer-seeder is perfect for perennial ryegrass. Broadcast seedings are generally much more successful when mulched with sawdust, compost, or straw. In fact, this is one of the most important keys to success on renovated sites. In spite of the ease of renovation, it is very difficult to produce a seed bed as good as that achieved by tilling and grading. For this reason, you need to do everything you can to enhance uniform and rapid germination.

3) Seed relatively heavy

Since surface conditions on renovated sites are often suboptimal, I try to compensate in any way I can. My rule of thumb is to increase seeding rates by about 50% of the normal seeding rate. In the case of perennial ryegrass, I usually increase the seeding rate from 5 lbs/lOOO sq. ft. to 7-8 lbs/lOO sq. ft. A similar approach works for most other grasses.

4) Plant at optimum times

Spring and fall are good times for renovation. Throughout the Northwest, August 15-September 15 is hard to beat. The combination of warm days and cool nights promotes rapid germination and development. Mid-summer is a very poor time because it's hard to keep seed moist enough to germinate without increasing the chances of damping off from fungal pathogens. If you renovate in mid-summer, either use treated seed or spray fungicides for damping off shortly after planting. Remember that root initiation is poor in the heat of summer, so stand development is slow. Often, lawns renovated in July are no further along in October than lawns renovated in mid-August. April through mid-June works very well in many areas and is a great time to renovate athletic fields needed for fall sports.

5) Fertilize intelligently

On complete renovations where existing grasses have been killed, I encourage people to push young plantings to speed fill-in and promote dense turf. This usually means a complete fertilizer applied at planting with nitrogen rates of 1-2 lbs N/lOO sq. ft. followed 4-5 weeks later with a second application at the same rate.

On simple overseedings and renovations on suppressed turf, fertilizer is counterproductive. Nitrogen will stimulate growth of existing grasses and help them outcompete the seeded grasses. On these sites, I try to starve the existing grasses by withholding fertilizer and removing clippings during mowing. Once the seeded grasses are up and somewhat mature, resume fertilization but don't push the stand. High rates of nitrogen may favor the existing grasses more than the seeded grasses. This is more of a problem with the fescues, bentgrasses, and bluegrasses than with perennial ryegrasses.

6) Water carefully

Properly planted, renovated sites require no more water than new seedings. In both cases, the goal is to keep the seed consistently moist to encourage rapid and uniform germination. Heavy irrigation on broadcast seedings may cause seed displacement, so light, frequent irrigations are the best approach. This is less of a problem when seed is planted via a slicer-seeder.

Summary

Renovation is both easy and hard. It's easy to go through the motions and get something to grow. It's a lot harder to get rid of unwanted grasses and achieve the uniformity and quality we all have in mind at the outset. By following the suggestions I've outlined in this article, you should be able to achieve better results than you may have had in the past.

FENOXAPROP-ETHYL AND HOE46360 WEED CONTROL AND PHYTOTOXICITY IN TURF[1]

Charles Golob and William J. Johnston[2]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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'Acclaim' (fenoxaprop-ethyl) 1EC is a selective postemergence grassy weed herbicide manufactured by Hoechst Roussel Agri-Vet. It is formulated as an emulsifiable concentrate with 1 pound fenoxaprop-ethyl (active ingredient) per gallon. Acclaim can be applied to all cultivars of the following turfgrass species: Kentucky bluegrass (Poa Dratensis), perennial ryegrass (Lolium perenne), fine fescue (Festuca rubra), tall fescue (Festuca arundinaceae), annual bluegrass (Poa annua), zoysiagrass (Zovsia spp.), and bentgrass (Agrostis palustris). Several annual grassy weeds can be controlled with Acclaim: smooth crabgrass (Digitaria ischaemum),hairy crabgrass (Digitaria sanquinalis), goosegrass (Eleusine indica), barnyardgrass (Echinochloa crusqalli), foxtail species (Setaria spp.), panicum species (Panicum spp.), Johnsongrass (seedling) (Sorghum halpense), and sprangletop (Leptochloa spp.). Investigations at Washington State University over the last four years have concentrated on using Acclaim to control crabgrass (Digitaria ischaemum and D. sanguinalis) in turf. Acclaim has shown much promise for the control of crabgrass in eastern Washington and northern Idaho.

Acclaim is a postemergence herbicide that has limited translocation ability within the target species. Although Acclaim will translocate from site of contact on the plant to meristematic tissue (growing points), it will not translocate from one tiller to another tiller on the same plant. Therefore, to control a target species with more than one tiller, it is essential to get complete coverage of the plants leaf surface with the herbicide.

The "growth window" one needs to shoot for in order to control crabgrass with Acclaim is after it has emerged, but before it reaches 5 tillers. According to label recommendations applying Acclaim when crabgrass has 3 to 4 tillers will require 3 times more material than if the crabgrass was sprayed before it tillers. Not only will that save money by applying Acclaim early to control crabgrass, but it will be environmentally safer.

The visual symptoms that develop on crabgrass following treatment with

Acclaim will show up as a yellowing (chlorosis) in 4 to 10 days, followed within 12 to 21 days after treatment with the leaves turning red or purple, and ultimately the plant turns brown and decomposes for a "clean kill".

Crabgrass is common throughout much of the United States. The heaviest densities of crabgrass are found in the southern regions with light densities of crabgrass found in the northern regions. Germination of crabgrass in the Pacific Northwest is generally anywhere from the last week of May to the first part of June. Applications of herbicides in our investigations were generally made when crabgrass was between the 2-leaf and the 2- tiller stage of growth in eastern Washington and northern Idaho. Herbicides were applied with a COa Pressurized bicycle sprayer at 40 psi delivering 25 to 30 GPA with 8002 spray tips.

In 1989, Acclaim was tested for crabgrass control and phytotoxicity at Lewiston, ID and Pullman, WA, respectively. Acclaim tank mixed with several different broadleaf herbicides was tested in 1987 at Lewiston, ID. In 1990, Acclaim was tested for phytotoxicity at Pullman, Wa.

In 1989 at Lewiston, ID, Acclaim applied at 0.18 lb a.i./A, which is the label recommended rate to control crabgrass at 1 to 2 tillers, and H0E46360 (single isomer of Acclaim) applied at 0.09 lb a.i./A, gave excellent control of crabgrass (Fig. 1). It is important to note that H0E46360 which was applied at half the rate of Acclaim provided equal crabgrass control.

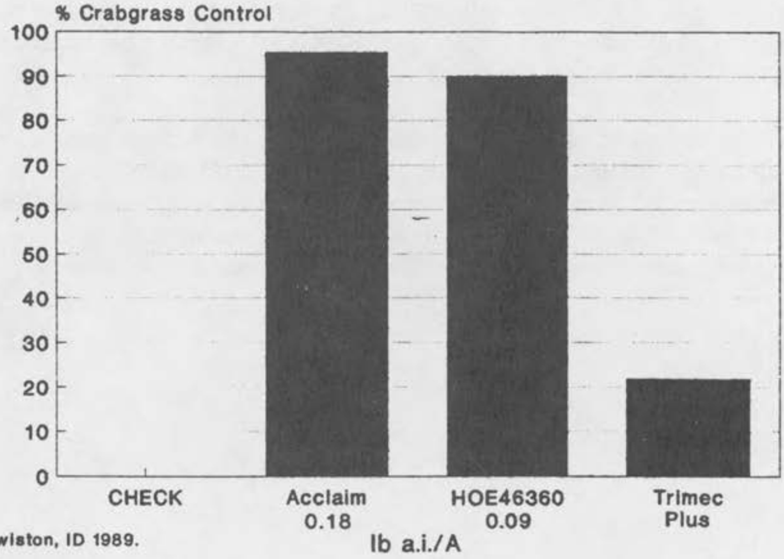
Since Acclaim has no effect on broadleaf weeds, it would be desirable to tank mix Acclaim with broadleaf herbicides. In 1987 at Lewiston, ID, Acclaim applied alone or in combination with various broadleaf herbicides showed differing levels of crabgrass control (Fig. 2). Acclaim alone gave excellent control of Crabgrass. However, when Acclaim was tank mixed with Trimec there was a significant reduction in crabgrass control. Although not significant, Acclaim plus Turflon and Acclaim plus Buctril tended to reduce the efficacy of Acclaim to control crabgrass.

In 1989 at Pullman, WA, Acclaim and H0E46360 were applied to a low maintained pure stand of 'Pomeroy' Kentucky bluegrass (KBG) turf. Visual phytotoxicity ratings taken 2 and 4 weeks after treatment showed only slight injury to the turf (Fig. 3 and 4).

In 1990 at Pullman, WA, three rates of Acclaim, three rates of H0E46360-18H, and two rates of H0E46360-05H were applied to examine their Fhytotoxicity on a high maintained pure stand of 'Pomeroy' KBG turf. Phytotoxicity increased with increased rates for each herbicide 1, 2, and 4 weeks after application (Fig. 5, 6, and 7). Acclaim applied at 0.32 lb a.i./A, which is the recommended rate to control crabgrass at 3 to 4 tillers, H0E46360-18H applied at 0.081 and 0.162 lb a.i./A, and H0E46360- 05H applied at 0.113 lb a.i./A, gave unacceptable injury to the KBG up to 2 weeks after treatment (Fig. 5 and 6). Although lower rates of both H0E46360 single isomers of Acclaim were used, they showed higher levels of phytotoxicity compared to the rates used for Acclaim. However, 4 weeks after treatment all treatments showed acceptable turf (Fig. 7).

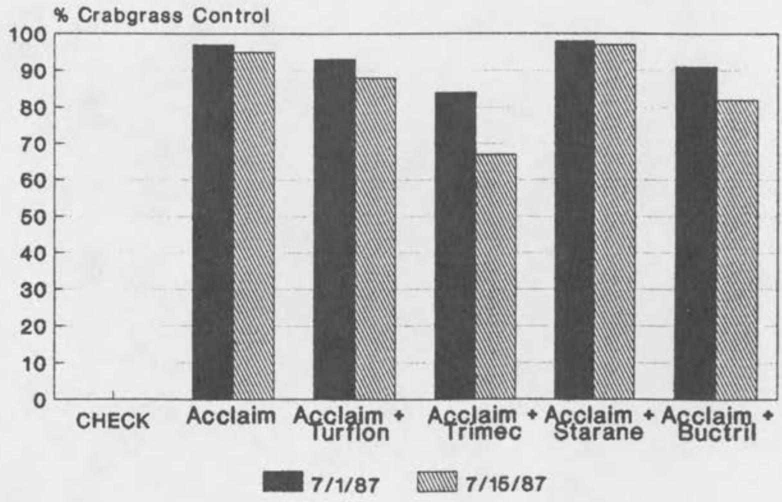
In summary, several conclusions could be drawn: (1) Acclaim and H0E46360 gave excellent postemergence control of crabgrass, (2) tank mixing Acclaim with broadleaf herbicides may reduce crabgrass control, and (3) high rates of Acclaim, H0E46360-18H, and H0E46360-05H may result in unacceptable injury to well maintained actively growing mature KBG up to 2 weeks after application.

Fig. 1. % Crabgrass Control 8-9-89
4 Weeks AT



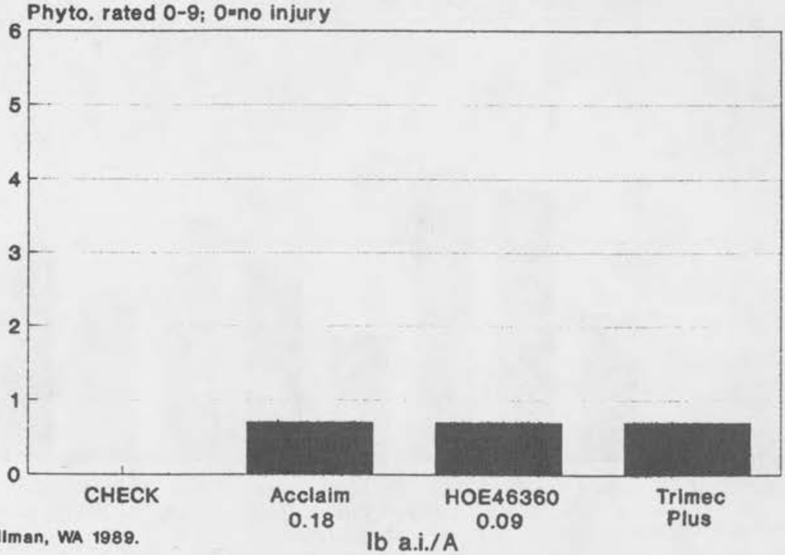
Lewiston, ID 1989.

Fig. 2. % Crabgrass Control 1987
1 and 3 Weeks AT



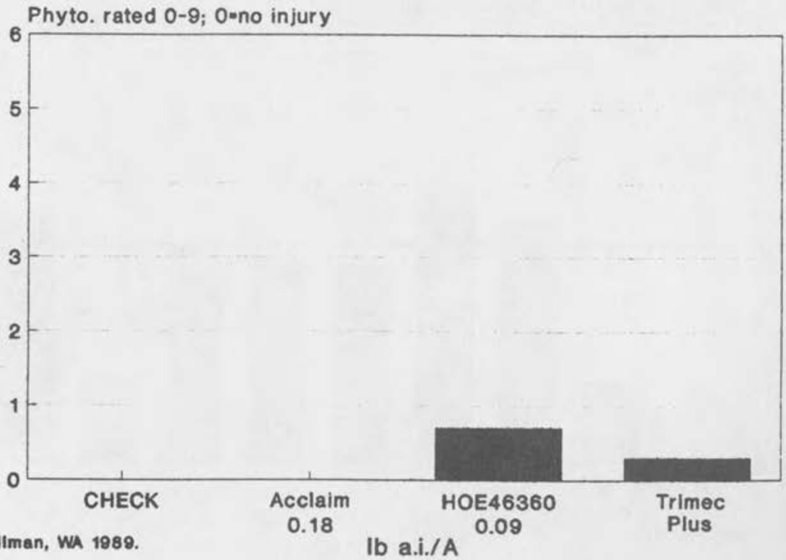
Lewiston, ID 1987.

Fig. 3. KBG Phytotoxicity 7-26-89
2 Weeks AT



Pullman, WA 1989.

Fig. 4. KBG Phytotoxicity 8-9-89
4 Weeks AT



Pullman, WA 1989.

Fig. 5. KBG Phytotoxicity 7-20-90
1 Week AT

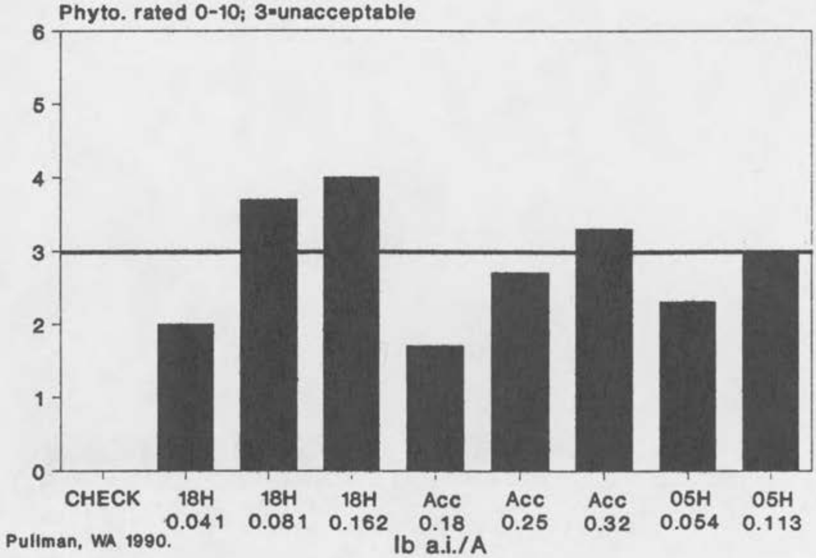


Fig. 6. KBG Phytotoxicity 7-27-90
2 Weeks AT

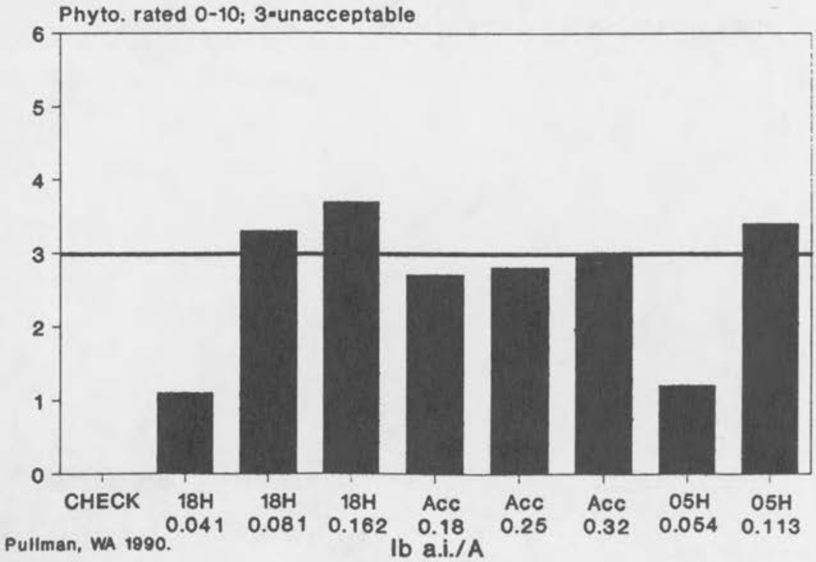
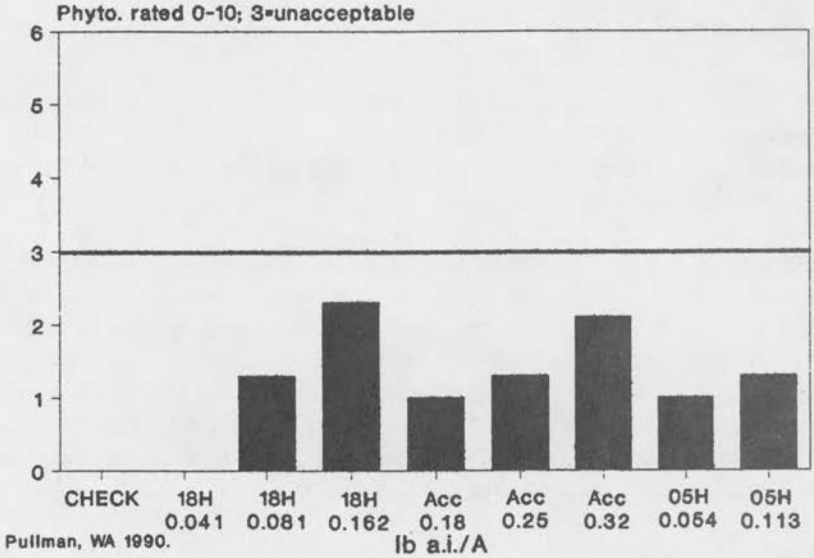


Fig. 7. **KBG Phytotoxicity 8-10-90**
4 Weeks AT



TREE FERTILIZATION IN ESTABLISHED LANDSCAPE[1]

Steven G. Varga[2]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.

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Abstract: Golf courses and parks have some of the most highly maintained turf areas in the country. Many of us are familiar with the effect and reasons for fertilization of turfgrasses. We may also be familiar with the results of over-fertilization and the damage that may occur if poor choices are made. Trees and shrubs, while not showing the same radical appearance changes as turfgrasses, respond to carefully planned feeding. This paper reviews some of the main methods of delivering the nutrients to the plant, formulations, fertilizer chemistry deficiency symptoms, and some basic rules to tree fertilization.

Introduction

Phenology - The study of a plant's responses to environmental influences.

We all live in a dynamic environment where things are always changing. We tend to pay more attention to the things that change quickly and give little notice to lingering or slowly changing events. Grass plants, when actively growing, react quickly and actively to changes. Some of these changes include temperature, sunlight, and the availability of water and nutrients. During a typical season, many of us will jump if we note a lawn changing from green to brown or yellow. However, many of us seldom pay attention to that old or established tree overhead. All of the above environmental changes also play a large part on the future health and appearance of trees. In this session, we will look at some of the basic parts of a tree fertility program.

Fertilizer Considerations

In most landscapes, trees are often considered to be carefree plants that need little care. Sure, we spray them for an insect problem or disease; we may even prune them now and then. But often their nutritional needs are ignored. This may be due to our up-bringing. Many of us have seen trees live and thrive after hundreds of years in the same spot with no fertilizer added to their soil. So why should we fertilize them?

The fact is that the trees in the forest cannot be compared to a tree in the middle of a golf course, park, or landscape. Why, you ask? Here are a few reasons.

- Soil Mycorrhiza organisms that help tree roots of the forest trees absorb nutrients often exist in small numbers or not at all in man-made landscapes.

- Healthy soil structure often aids in the movement of soil air and water. This keeps the tree's root system strong and able to absorb nutrients. Urban soils are often compacted so tree roots may not be able to absorb nutrients from the soil unless they are at higher than normal concentrations.

- The accumulation of organic debris in the root zone helps forest trees recycle and build up nutrient reserves for the future. Urban trees starve in the name of a clean landscape.

- The lack of a native environment often contributes to the poor health of a tree. A tree that is not native to the area may need a higher concentration of soil nutrients than in its native area to compensate for unnatural stresses.

- Trees, native or not, that withstand construction damage to the root system or to above ground parts go through a healing process that increases the need for soil nutrients.

- Turfgrass is a strong competitor for soil moisture and nutrients.

- Turf will intercept most of the nutrients and may even eliminate many of the feeder roots in the upper three inches of soil, which is often the best soil.

These are just a few of the many possible reasons that a tree may need additional fertilization. Even if none of the above situation exist, you will always have the problem of getting a new plant established. And, in many areas, this may take five or more years.

In most cases, unless there is a unique nutrient deficiency discovered by a soil or plant tissue test, most trees will generally only need the following five nutrients: nitrogen, potassium, magnesium, iron, and manganese. In the case of new trees or trees that have sustained root damage due to construction, the addition of phosphorus is also important. The use of phosphorus with mature, established trees is up to debate. It is of course critical to consider the type of soil conditions and types of trees you will be working with before adding all these nutrients to your mix when all you may need is nitrogen.

Fertilizer Chemistry

Two important considerations when choosing a formulation are slow vs. quick release and the salt index of the nutrient source. A tree that under stress from drought, damage, soil compaction etc., does not need and additional stress from a high salt diet. When choosing a fertilizer, always choose the lowest salt index per concentration of nutrient. The other consideration is the speed at which the nutrient (nitrogen) becomes available for use by the plant. My preference is a quick release applied when the tree needs it. This provides you with more control over when the tree gets to use it. In addition, the activity of a slow-release formulation can be unpredictable when injected into the soil. This is often the case due to the fact that temperature, oxygen level, and micro-organism activity is often very different on the surface versus six inches below. However, the slow release forms are useful when it is impossible to apply the nutrient to all trees at the proper time.

Rates

The following rates are for general tree maintenance. If you have an unusual problem or if the following formulations don't give good results, you should have a plant tissue or soil test done. However, the main problem is that not much work has been done to develop fertilizer thresholds, the amount of nutrients the plant should have, with ornamental trees and shrubs. Because of this, it may be difficult to determine how much is enough with some species.

There are two methods that can be used to determine the proper amount of fertilizer to apply. One is the square foot method. This method uses the amount of square feet of soil area covered by the branch canopy of the tree. While this method is common, I do not recommend it due to the great variance in the shape and dimension of trees. An example would be a wide spreading Maple or Horsechestnut compared to a tall narrow Birch or weeping Redwood. These trees would have a tremendous difference in the amount of canopy area coverage. My favorite method is the trunk diameter method. With this method, you would use the diameter of the trunk at about four feet above the soil level. This not only gives you a better representation of the actual size of the tree, it also eliminates a lot of time-consuming mathematical calculations.

Nutrients

Nitrogen — When using the trunk diameter method, you should apply 1/4 pound of nitrogen per inch of diameter. Some recommendations call for increasing the rate per inch with larger trees, but I don't feel that this is necessary. Larger and older trees will usually have many more probing roots, so if it is planted in reasonable soil, it will be able to probe other sources. When using the canopy square foot method, you should apply three pounds of nitrogen per thousand square feet.

Phosphorus & Potassium — When making general fertilizer applications, you will also need to apply these elements. A good general use formulation should contain these elements at about 1/3 the amount of nitrogen applied. So, if you apply six pounds of nitrogen, you should also apply two pounds of phosphorus and two pounds of potassium.

Deficiency Symptoms

There are many books and charts describing the symptoms of various nutrient deficiencies. Unless you have extremely low levels of particular nutrients, you will seldom see a classic textbook case. However, the following are common:

Nitrogen — Pale green foliage color, smaller than normal foliage, older leaves are often affected first.

Magnesium — Yellowing of the leaf edge, common in sandy acidic soils,

Iron — Very yellow foliage with green veins.

Manganese — Very similar to iron, in severe cases you may also find dead patches or spots.

Methods of application

Surface Feed — This can be done by applying liquid or granular fertilizers under the canopy. The main problems include the potential for turf grass or ground cover burn and the tie up of elements in the organic matter on the soil surface, which can reduce or eliminate much of the application. Even nitrogen can be affected which tends to leach into the soil easily. With this method, you must apply the fertilizer in a circular band around the tree. The band should extend one-third of the branch canopy radius inward and outward from the drip line. A high percentage of the feeder roots are within this zone.

Soil Injection — This method is my choice because it is not only quick, it also tends to aerate the soil and add water at the same time. These extra benefits tends to amplify the effects of the fertilization, especially during dry weather. The use of a soil injection needle gets the fertilizer into the root zone and thus eliminates most of the tie-up associated with surface feeding. It also permits the fertilization of trees in lawn areas. To inject into the soil, you must use a deep root feeding needle attached to a tank, pump, and hose line. When injecting, you should apply the liquid in two concentric rings one-third inside and one-third outside the drip line. The needle should extend two to four inches under the soil surface.

Drill and Fill — This method is an old but still effective one. However, it tends to be difficult due to the fact that you must use a powerful drill to bore holes into the soil in concentric rings and pour granular fertilizer into each hole. This method is very time-consuming but does allow some of the same benefits as soil injections. When using this method, you again must drill the holes one-third inside and outside the drip line.

Trunk Injections — This method relies on an injection or implant in the cambium layer that taps directly into the tree's vascular system. This is mainly used when the tree cannot naturally take nutrients in through the root system. Some examples include trees planted in the middle of paved areas or those that have sustained severe root damage or restriction.

Foliar Sprays — This method is useful in helping to correct micro-nutrient deficiencies. However, the effects are short-lived and often do not work well on plants with hardened off summer foliage.

General Rules

Without going into great detail, a good general set of rules for tree fertilization is:

1. Never fertilize dry soils without the addition of irrigation.

2. Fall is generally the best time to fertilize because of the active root growth. But, fertilization can be done at any time as long as the soil is moist.

3. The addition of phosphorus and potassium is helpful a planting time or for young trees.

4. Fertilizer should never be applied to plants that are under drought stress.

5. Fertilizer rates should be reduced for fast growing trees (silk trees), fire blight-prone plants (crab apple), and conifers.

COMPUTERIZED IRRIGATION CONTROL SYSTEMS-PANEL DISCUSSION[1]

Gary Sayre[2]

[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
[2] Certified Golf Course Superintendent, Overlake Golf and Country Club, Medina, Washington.

There are many types of computerized control systems on the market today from which to choose. My main experience has been with the Rainbird System so I will make most of my comments in regard to that system.

Computerized Central Irrigation Controls:

- We run our irrigation system with an IBM AT computer with a 30 meg hard drive that has a built in modem.
- The way the system is designed. not having a computer dedicated for the irrigation only, we can run all sorts of other software also.
- Our field satellites are electromechanical and are very durable.

Computer To Satellite

This system can run any combination of times on each station of the satellite in whatever order you want. The run times can be controlled to the nearest one minute time intervals.

The computer can also monitor all irrigation that is taking place and keep record of what irrigation has occurred through the field monitor.

- The computer automatically contacts the field satellites to download its information through the PCI and in turn keeps (unloads) data as it occurs on what happens and puts it in a data storage area on the disk. Anything that happens in the field is monitored.
- We have hundreds of schedules that we use with tables that dictate times through the weather data we enter. This is called Water-Budgeting. We now have ET in the new software that Rainbird has provided us (free) which allows us to set the

water in a more simple and less time consuming manner. The ET software will automatically change all our times and keep our system in balance.

- The computer also uses priorities that you give schedules so the most important ones occur at the times you need them to.

- We can also do dry runs so that if we want to monitor what we have set up before it happens, we can. This helps us when we want to inject materials through the system to different areas.

Flexibility Provided By The Computer:

My computer uses tables that I have entered information into to help it give me the optimum pumping performance. This way my irrigation gets done in the shortest time possible and it balances out the flow of water from the pump station. This saves electricity and money. This past year I would say that we have saved up to 20% in our pumping costs relative to the weather conditions and cost of power.

Because of this feature I can also maintain cycle and soak times even though I am frequently changing the total amount of water I apply for differing weather conditions. When I change ET rates mv cycles will be added to or deleted from rather than rounding off to the nearest time so I get a true water amount that I want.

After a couple of seasons you can have your irrigation system so well balanced and fine tuned that several simple adjustments can be done each day with ET factors to control the entire irrigation system. I have been able to see a time savings as a result both in programing time and pumping time which is saving money and cutting down on maintenance costs. I don't need a calculator anymore to figure out my start times for satellites!

Some golf courses that have the newest hardware have a weather station which communicates to the computer how much the ET is for the past 24 hours so watering can be done as needed.

COMPUTERIZED IRRIGATION CONTROL SYSTEMS-PANEL DISCUSSION[1]

William B. Griffith[2]

[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
[2] Golf Course Superintendent, Veterans Memorial Golf Course, Walla Walla, Washington.

Motorola Osmac controller system was installed by the City of Walla Walla, Veterans Memorial Golf Course, in early May of 1990. The system consists of 26 satellites (called RDR50) each capable of controlling 1-64 valves, a desk console for addressing the satellites, a computer program (you supply the computer, ours is an IBM PS/2 MODEL 30 with a 20 megabyte hard disk), and optional portable DTMF radio(s).

The RDR50 satellites contain a radio receiver with microprocessor (the same as is used in the popular BRAVO pagers) and from 1-8 valve control cards each capable of controlling 8 valves or stations. These RDR50's are connected to a 110 volt power source and to each valve station and communicate with the desk console via radio frequencies (no hard wiring to the central is required). Each RDR50 is assigned a number through a switch in the unit and then responds to that number. Effective range is 1/2 to 1 mile depending on topography, trees, buildings, etc., but can be boosted dramatically by the addition of external antennas on the RDR50's. The biggest difference between this type of satellite and most others is that you don't go to each satellite to perform normal irrigation functions. Addressing the satellites is done either through the desk console, the computer program, or portable hand held DTMF radios by using numerical codes (for example 025/7512/010020304 would tell number 8 green heads 1-2-3-4 to turn on for a syringe cycle for x minutes then turn off).

The desk console has a numerical key pad for addressing the RDR50's and also acts as the interface for the computer program. It is also connected to a phone line which allows you to issue any command from a touch tone phone (example, call in and the console asks you for the RDR50 number you wish to communicate with, then the message you want communicated, such as 256/7500, which would tell every RDR50 to turn off every valve until a turn on code is given), which gives the ability to effectively shut down the irrigation system in the event of an unexpected rain from any phone anywhere.

The computer program allows you to set up watering programs for your nightly watering either valve by valve or by groups of valves regardless of which RDR50 they are connected to. Valves can be set for any time or sequence you desire as well as any schedule also. There is also RDR50, group, and global factoring from 0-200%. Our programs are designed around a flow management concept which keeps our pumps running at a consistent G.P.M. throughout the night. There is no limit to the number or variety of different programs that you create and use, as you simply load the one you have chosen for that given period of time into the computer. The computer program also allows for you to do manual functions with the irrigation system without losing your dedicated program. There is also a feature for power failures that re-boots the program and starts the next scheduled watering automatically.

Since installing this system in early May 1990 I haven't once touched a satellite except to adda valve card and put additional valves on line. All commands are generally done through the portable radios or through the radio in my pick-up (its' range is approximately 5 miles). In addition to the desk console allows me to make and receive telephone calls through my pick-up radio or the portable radios within their effective range.

The system, having been in operation for one season, has experienced no mechnical or component failures and support from the area distributor and Motorola has been excellent.

IT'S A MATTER OF QUALITY[1]

Larry Gilhuly [2]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
[2] Western Director, Green Section, United States Golf Association, Tustin, California.

Quality! The very word conjures up plush, verdant acres of turfgrass maintained at a perfect mowing height to produce the perfect round of golf. For others, it simply represents a complete turf cover in areas that were previously trodden down by the thundering herds of excess players. The point is, you can have top quality conditions at your facility if you possess several key ingredients as a golf course superintendent and your golf course is willing to address fundamental problems to achieve maximum results.

What is it about those golf course superintendents that have been successful for so many years producing good results? Is it their fertilizer programs, their understanding of the game, their irrigation practices? While all of these factors are important, nearly all of the top superintendents possess most of the following traits:

Q Questions.

U Unflappable.

A Accessible.

L Leader.

I Intelligent.

T Teacher.

Y Yeoman.

Superintendents should ask plenty of questions to find answers to their problems. They should be unflappable in the face of adversity and be able to answer questions from any member (regardless of that member's blood pressure) in a calm and forthright manner. They should be accessible to the members to answer questions before they become major problems and they should have the ability to lead the membership in the proper direction while appearing to follow. The quality superintendent is intelligent and achieves this level of intelligence in his field by attending all available conferences and learning in the field. They are teachers for the maintenance staff and above all, they must be prepared to do a yeoman's job during the growing season with 15 and 16- hour days quite common.

While these are not all of the attributes of a quality golf course superintendent, you can take these and add every imaginable positive to the superintendent's personal makeup and it won't be worth a plug nickel if the membership does not address a certain set of criteria that usually plagues golf courses from achieving top quality.

Q Quagmires.

U Unacceptable traffic.

A Atrocious soils.

L Lousy irrigation.

I Inventory defiencies.

T Too many trees.

Y Your expectations.

If a membership or public golf facility is not willing to address basic drainage, traffic control, poor soils, out- dated irrigation, equipment that is held together by bailing wire and tape and be prepared to eliminate a few trees, then the hopes of achieving top quality will not occur.

What can be done to achieve higher levels of quality if the person's responsible for decision making will not address the fundamental problems? Perhaps one of the best tools that can be used to assist you in this area is through the use of an outside agency that is non-biased. The use of local universities extension agents and the USGA Green Section specialize in this area to assist golf course superintendents in explaining basic problems for members or city officials that do not deal with golf courses on a regular basis. This "tool" can assist in the setup of a long-range plan to address problems in a systematic manner according to priorities. Improved quality can be achieved if those responsible for decision making can be sold on the need!

Now I am sure that there are many of you who would say, "That's a great plan except for one problem. My club/city simply has no money. How do you achieve improved quality without changing the budget drastically?" After viewing many courses in this situation, it has become quite apparent that quality can be approved by addressing the areas that you control. IA other words, a well-trained staff that understands proper course setup can do more to bring quality to a golf course than any other single item short of major capital improvements. The maintenance staff must understand the importance of the little things on the golf course. Picking up garbage, maintaining well-painted and clean cup liners and flagsticks, having water in the ball washers, providing clean towels on the ball washers, fixing ballmarks before mowing greens, proper irrigation during times of stress and well-maintained bunkers are just a few of the areas that are within your control. This may not produce top quality but it will head your golf course in the right direction to achieve the maximum benefit within your budgetary limitations.

As a closing note, perhaps the best advice that can be given to improve your golf course comes from an old idea that is certainly not hi-tech. That is, every morning after the maintenance staff has started their duties, walk your golf course (do not drive) to get a true perspective of what needs to be done. Besides the positive aspects of good exercise, it allows you the opportunity to escape from the accursed telephone for at least two hours to converse with your employees in their environment and keep tabs on your golf whether you are achieving the highest quality possible, take a hike! You'll be glad you did.

SOIL TESTING AND INTERPRETATION[1]

Kraig D. Klicker [2]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
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Soil testing and the proper interpretation of a complete soil test can be a useful tool, and should be utilized in turfgrass production to:

1. distinguish some areas from others that require different soil nutrients.

2. establish what nutrients are deficent, sufficient, and excessive in order to make proper soil fertilizer applications.

3. see that fertilizer dollars are maximized by spending money on only the nutrients needed to ensure balanced soil fertility and healthy plant growth.

When using a soil test to assist us in our decision making we must first realize that a soil test is only as good as the way in which it was pulled. The key to any good accurate sample is to have it representative of the area or material one is sampling. Some important guidelines need to be followed when soil testing on golf course greens, tees, and fairways.

First, sample randomly to a depth of 6 to 8 inches or to the depth of the modified soil mix if it is less. Don't mix two unlike materials - e.g. modified soil mix anda clay subbase. This is the depth of soil that one wants to ensure the correct soil fertility in order to provide a conducive environment for roots regardless of the roots present depth. If a soil mix green or tee has been recently aerified and the holes filled with a pure sand, it is now part of the soil mix and will affect fertility levels. Do not try to sample all aerifier holes filled with sand, a representative sample is required for accurate results.

Second, pinch the thatch off of all samples. This eliminates any contamination from recent spray or fertilizer applications and removes any lime or other material that may be caught in the thatch. On greens, step on the hole where the core was removed, (to shrink it so thatch won't fall to the bottom of the hole) replace the thath and step on it again to level it. This is necessary to restore the putting surface. On tees one can replace the thatch or throw it out as you would do on the fairways. Also, it is a good idea to clean one's soil probe between samples of any materials that may stick to it with a finger or a rag.

Third, determine which are the best, mediocre,and worst greens, and get at least one sample fromeach category. Or one may want to sample them all to have an inventory of all the greens. This also applies to tees and fairways. Greens and tees are often rebuilt over the years anda golf course may have several different modified soil mixes on it. Before sampling, try to determine what different kinds of mix there are and sample accordingly. This will help in determining nutrient requirements for each mix rather than guessing. Fairways at times can be grouped according to soil types. Sample only one fairway in each grouping (don't mix soil from several fairways), and then treat that grouping the same. This way if one or more of the unsampled areas responds differently than the grouping in which it is, it can be sampled separately to determine its special needs.

Sampling once a year is generally satisfactory, however special treatment should be given to low cation exchange capacity soils. Since there is very little buffering and holding capacity in these modified mixes it is necessary to monitor them every 4 to 6 months (depending on the length of the growing season). This will help to calculate leaching rates and keep track of pH. Since we are dealing with a monoculture, it may be advisable to, on occasion, sample at different depths (0-2, 2-4, 4-6 inches) to see how the fertility is moving in the soil profile. Be sure to mark the depth of the sample taken on the sample bag as this can affect the soil report readings. Many laboratories are set up for running a standard six inch or twelve inch test unless otherwise notified.

A complete soil report can supply one with the information needed to make proper soil fertilization applications. A complete soil report should contain test results for; cation exchange capacity (C.E.C.), pH, organic matter (O.M.), nitrogen, phosphates, sulfates, calcium, magnesium, potassium, sodium, exchangeable hydrogen, boron, iron, manganese, copper, zinc, aluminum, molybdenum, and base saturation percent. An explanation of terms and what the numbers being reported represent should be included as part of a complete soil test. Finally, desired levels or values for your specific crops require different nutritional requirements. Another reason for establishing desired levels is because of the several different laboratory extractions used to arrive at a numerical value for the same element.

Some laboratories provide their own interpretations that accompany their soil reports, others, such as my affiliate, Brookside Farms Laboratory Association, Inc., provide an independent consultant as a direct link to the superintendent or grower, but most reports are subject to the interpretation of a fertilizer salesperson, superintendent, or grower himself. In my opinion, any of these avenues are acceptable as long as the person making the fertilizer suggestions is confident that he or she has an understanding of what constitutes a balanced soil fertility and what procedures are necessary to obtain a balanced soil fertility condition.

Interpretation of soil reports can be difficult especially when one has no foundation of which to base his or her interpretation. Over the years, two forms of soil fertilization philosophies have evolved. First, the Sufficient Level of Available Nutrients (SLAN) philosophy that concentrates on maintaining all nutrients at a particular level in order to provide optimum plant growth. Second, the Base Cation Saturation Ratio (BCSR) philosophy, where calcium, magnesium, potassium, phosphorus, hydrogen, and pG are balanced according to what crop is being grown and the capacity of the soil.

When interpreting soil samples I personally, along with the other soil fertility consultants associated with Brookside Farms Laboratories, incorporate both soil fertilization suggestions. Both philosophies have merit, and working together a blanced soil fertility can be achieved. We use the SLAN concept when considering levels for the nutrients nitrogen, sulfur, phosphorus, boron, manganese, zinc, copper, and molybdenum and we use the BCSR concept to balance the cations that most directly relate to soil pH which are calcium, magnesium, potassium, hydrogen, sodium.

Those nutrients that fall into the SLAN category will have different desired levels depending on what laboratory and what extraction methods are used, so as I stated earlier, it is important to have those levels supplied to the person interpreting the soil report. The BCSR portion of the soil test interpretation is a little more objective. When balancing cations we look for Base Saturation Ratios of 60-70% calcium, 10-20% magnesium, 2-5% potassium, .5-3% sodium (although we never want to have the sodium percentage higher than that of potassium), 10-15% exchangeable hydrogen, and our other bases such as Iron are variable. When this general balance is achieved our soil pH will usually show a reading of 6.2-6.8 which is ideal for most crops, including most turfgrasses.

In summary, a soil report is only as good as the way in which it was obtained. Once the targeted areas have been sampled, a complete soil report, with proper interpretation, will help in determining the required nutrients and quantities of nutrients needed in order to balance soil fertility, and supply adequate nutrient levels in order to provide optimum plant growth while maximizing fertilizer dollars.

TANK MIXING PESTICIDES[1]

Paul Sartoretto and William J. Johnston[2]

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[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
[2] Technical Director, W.A. Cleary Chemical Corporation, Somerset, New Jersey and Assistant Professor, Department of Agronomy and Soils, Washington State University, Pullman, Washington, respectively.

The following presentation is based on an article "Compatibility in the spray tank" by Dr. Paul Sartoretto and has been edited by Dr. W.J. Johnston for presentation at the 44th Northwest Turfgrass Conference.

There is a great economic and performance benefit in being able to spray a mixture of chemicals at the same time. The beneficial results have at times been astounding, and once the art has been mastered the chemical operator will never go back to the old-fashioned notion that chemicals must be sprayed one at a time.

Pesticide chemicals can be divided into two categories: *solubles* and *insolubles.* Of course, water is the substrate. *Insolubles cannot burn grass.* If they are insoluble in water, how can they possibly diffuse into the plant in toxic concentration? Or, how can they possibly be so concentrated as to produce reverse osmosis and have water move out of the plant and cause dessiccation?

Admittedly, there are insoluble pre-emergent weed killers that could be sprayed on fine turfgrass and could, over a period of time, release a soluble chemical that could be toxic to a particular species of grass. But these precautions are clearly outlined on the label.

Taking this exception into consideration, and following the rule of not exceeding the recommended application rate, one can mix any number of insoluble chemicals in the spray tank without incurring phytotoxicity.

Fortunately, the majority of pesticides are insolubles. This allows the pest control operator considerable latitude on what can be mixed in the spray tank. On the other hand, *soluble* chemicals must be handled intelligently to avoid phytotoxicity. One must carefully follow the rules and guidelines that are about to be proposed in order to avoid burning.

Soluble chemicals can be divided into two general classes: *ionic* and *nonionic.* The ionic solubles are usually referred to as salts, and can be further subdivided into cations and anions. The cation, which is positively charged, is always accompanied by an anion, negatively charged. They are always found together, neutralizing each other. But it is customary to single out the nature of the active ingredient and ignore the ionic charge of the inert ingredient.

Incompatibility results when an active cation is tank mixed with an active anion. An example of such incompatibility would be the tank mixing of Caddy (cationic) fungicide with 2,4-D (anionic) herbicide. This is clearly visible when a little 2,4-D and Caddy are added to water in a glass jar. Instead of being a clear solution, the water will become milky, followed by the precipitation of a gum of the cadmium salt of 2,4-D.

Fortunately for the pest control operator, all the soluble post-emergent herbicides on the market are anionic. Therefore, they are compatible and can be tank mixed without incurring precipitation. When trying new soluble pesticides for possible tank mixiiing, simply test them in a glass jar as previously described. If they can be mixed with water and still result in a clear solution, they can be safely tank mixed.

It has been previously stated that all soluble post-emergent herbicides are anionic and compatible. However, there are a few cationic pesticides on the market at the present time. We can forget about two of them, Diquat and Paraquat, because they are general grass and weedkillers and are never tank mixed with other pesticides. The other six are all fungicides: PMAS and Calo-Clor, two mercuries; Caddy and Cadminate, two cadmiums; and Subdue and Previcure (propamocarb), two *Pythium*-control chemicals. Again, recall that if two or more soluble pesticides are tank mixed, test them in a glass jar of water to assure yourself of their compatibility. Once you are satisfied that they are compatible, you can add any number of insolubles to that mixture without incurring phytotoxicity.

EPA uses signal letters to inform applicators whether or not a product is soluble or insoluble. *S, SP* and *EC* are classified as solubles; *WP* and *F* are insolubles.

It is possible to encounter all three forms of a single pesticide: *EC, WP* and *F*. Wettable powders and flowables are safer to use but slower acting emulsifiable concentrates. Because the aromatic solvents used in preparing *EC*s are notoriously phytotoxic, *EC*s used with low gallonage spray invite phytotoxicity.

Never tank mix emulsifiable insecticide concentrates with other chemicals, but insecticides can be tank mixed with each other for better control.

Phytotoxicity will occur when aromatic solvent sits on the grass blade. In addition, the insecticides, according to the labels, must be sprayed with large volumes of water (10 to 30 gallons), sometimes followed by heavy watering. Wettable powder and flowable formulations will not burn but still require watering in control.

All insolubles can be tank mixed without incurring phytotoxicity, provided the products are sprayed at recommended rates.

This permits the tank mixing of a tremendous variety of chemicals and it allows the applicator to spray four or more chemicals simultaneously.

Where money is no object, broad spectrum control is a must. The applicator should not rely on only one chemical to control a target disease. Note how pathologists at the various agricultural colleges are mixing different pesticides in an attempt to achieve better control in their experimental plots.

With the advent of systemic fungicides, the broad spectrummixture has assumed more importance because of the longer residual control attainable with the addition of a systemic to one or two contact fungicides in the spray tank.

Before the development of systemics, it was accepted that contact fungicides did their job on the grass blade and in the thatch and were dissipated within 2 to 3 days. A good contact fungicide, which will kill germinating spores at a few parts per million, is usually sprayed on the grass blade at about 5,000 parts per million. With current irrigation and mowing practices, it doesn't take more than 3 days to get down to a dilution below the effective 5 parts per million.

In hot, humid weather accompanied by sporadic showers, an applicator had to spray twice a week or the grass would go unprotected the latter part of the week. Systemics have changed all this because they hydrolyze in the soil to knock down the fungus population. They act not only in the soil but also within the grass blade by diffusion through the root system, thereby giving extended protection.

Only one soluble chemical can be tank mixed with one or more insolubles. If two soluble chemicals are tank mixed with or without insolubles, avoid phytotoxicity by cutting the rate of each soluble in half.

Dr. Sartoretto maintains that the ideal fungicide tank mix is a three-way combination of soluble contact/insoluble contact/insoluble systemic chemicals. For years he has recommended mixing two soluble contacts, each at half rate, to get braoder coverage than the single soluble at full rate.

All the insolubles can be tank mixed, and they can be tank mixed with one of the solubles. If the solubles are tank mixed, cut the dosage with proportion to the number of chemicals added. If three solubles are tank mixed, cut the dosages to one-third of the recommended rate of each soluble component.

Soluble fertilizers and trace elements can be added individually or mixed, provided the amount will not exceed 2 ounce solid per gallon of tank spray mix in hot weather, or 4 ounces per gallon in warm weather. Six ounces per gallon can be used in cool weather.

Hot weather is considered to be temperatures in the 90s, warm weather as temperatures in the 80s and cool weather as temperatures in the 70s. Some soluble fertilizers have a greater burn potential than others. The nitrates, sulfates and phosphates are truly inorganix soluble salts, whereas urea is truly an organic soluble. It must hydrolyze and oxidize before it is available to the plant. It has less burn potential than the soluble salts. Formolene is a solution of urea and methylol urea processing less burn potential than straight urea. Finally, two ureaform polymers are categorized as insolubles. They are Fluf and Nitroform, which contain a mixture of soluble methylene ureas and insoluble methylene urea polymers. They are considered very safe and can be used at rates higher than the rates referred to previously.

Iron and magnesium, elements necessary for cholorophyll production, can be sprayed as sulfate salts, but due to their ease of hydrolysis they are not as effective as they are in chelated forms. It goes without saying that N, P and K are also necessary for chlorophyll production. Of these three, too much reliance is placed on the semiannual granular feedings to provide adequate amounts of slow-release N and K. Nitrogen and potassium deficiencies are real. In an attempt to supply adequate amounts of nitrogen, the tendency is to add large amounts at infrequent intervals, which results in lush growth, particularly in the absence of potassium (which provides turgidity or hard growth).

What a great opportunity the chemical spray operator has to add nitrogen, potassium, iron and magnesium to the spray tank in small increments every time he sprays.

Dr. Sartoretto has witnessed better disease control when these elements are added to a fungicide program because they help the grass grow out of stress. The same result is witnessed when post-emergent herbicides are used that have a narrow safety factor and have a tendency to slow down the metabolism of desirable grasses.

The accompanying chart (Table 2) of alternative spray progams, entitled "Some fungicide combinations," illustrates the diversity of chemicals used. An excellent article written by Dr. Patricia Sanders of Penn State, explains very clearly the proper use of various systemic fungicides ...

"The broad spectrum of systemic fungicides that control other turf disease fall into three groups according to their mode of action; the benzimidazoles (Tersan 1991, Fungo 50, CL3336), the dicarboxymides (Chipco 26019, Vorlan), and the sterol inbibitors (Banner, Bayleton, Rubigan). Any fungus that is resistant to oneof the benzimidazole fungicides will be resistant to them all. The same is true within the dicarboxymide and sterol inhibitor groups of fungicides. Therefore, for resistance management, broad-spectrum systemic fungicides must be mixed or alternated BETWEEN but not WITHIN groups. Systemic fungicides may also be mixed or alternated with any contact fungicide that will give the disease control desired."

Dr. Sander's article was reprinted in its entirety in the fall issue of Turf Topics (Vol. 34, No 1).

TABLE 1. Solubility and formulation

Solubles: EC, S, SP		Insolubles: WP, F		Soluble-Insoluble combinations (Treat as solubles)
FUNGICIDES				
PMAS		Tersan 75	Bayleton	Calo-Clor
Caddy		Tersan LSR	Fore	
Subdue		Tersan SP	Maneb	
BANOL		Spotrete	Zineb	
ALLIETTE		Bromosan	Captain	
BANNER		Spectrol	Daconill 2787	
RUBIGAN EC		3336	Dyrene	
		1991	Fungo	
		RUBIGAN WP	RP26019	
		SCOTTS FUNGICIDES I, II, III		
INSECTICIDES				
Dursban	Malathion	Oftanol		
Diazinon	Proxol	Diazinon		
Chlordane	Dylox	Dursban		
Sevin	Triumph	Sevin		
		Malathion		
HERBICIDES				
2,4-D	MCPA	Dacthal		
MCPP	DSMA	Tupersan		
Dicamba	MSMA	Balan		
ACCLAIM	AMA	SURFLAN		
	Betasan-EC			
FERTILIZERS				
urea		Nitroform (Powder Blue)		
ammonium nitrate		IBDU		
ammonium phosphate		Fluf (flowable ureaform)		
ammonium sulfate				
potassium nitrate				
muriate of potash				
Formolene				
Cleary's Water Soluble N-P-K's				

TABLE 2. **Some fungicide combinations**

	Soluble contact		Insoluble contact		Insoluble systemic
	1 oz. Caddy	+	3 oz. Spotrete-F	+	1 oz. 3336-F
or	1 oz. Caddy	+	3 oz. Daconil	+	1 oz. RP26019
or	1 oz. Caddy	+	2 oz. Dyrene	+	1 oz. Bayleton
or	½ oz. Caddy	+	1 oz. Tersan SP 2 oz. Daconil	+	½ oz. 1991 ½ oz. Bayleton
or	½ oz. Caddy	+	1.5 oz. Daconil 1.5 oz. Spotrete	+	1/3 oz. Bayleton 2/3 oz. 3336-F

Suggested fertilizer combinations added with fungicides:

1 oz. urea + ½oz. chelated iron + ½ oz. chelated magnesium + 1 oz. potassium sulfate
6 oz. Cleary's (N-P-K) + 4 oz. Trugreen (Mg + Iron + Potash)
8 oz. Fluf (ureaform) + 1 oz. potassium sulfate + 1 oz. chelated iron + 1 oz. epsom salts (magnesium)

CROWD CONTROL-MINIMIZING TURF DAMAGE AT WATERFRONT PARKS[1]

James Carr[2]

[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
[2] Turf Manager, Bureau of Parks and Recreation, Portland, Oregon.

The City of Portland's Tom McCall Waterfront Park is often referred to as the flagship of the city's park system. This 26-acre park is located on the banks of the Willamette River in downtown Portland and is Portland's highest use park, with major events scheduled throughout the summer drawing thousands of people.

The park is easily accessible for those who visit, live, or work in the downtown area. Views of high-rises to the west, and the river and distant mountains to the east, provide an exciting setting which blends urban and pastoral scenery.

From Cinco de Mayo in early May, to the Neighborfair and the Bite in July and August, to weekly symphonies in August and September, Waterfront Park is host to hundreds of thousands of Portlanders and visitors alike. In fact, there are ten major events which draw between fifty and one hundred thousand participants each, from May through September, plus many smaller events,

The Portland Park Bureau's Maintenance and Operations crews are continually striving to keep up with usage demands. Sometimes, the Popularity of Waterfront Park seems to be too much of a good thing.

Over the last few years, the Park Bureau has developed a variety of methods for dealing with this heavy use. These include establishing new user's fees, breaking the park up into more manageable areas, constantly updating maintenance procedures and focusing greater emphasis on communicating with event organizers.

The event that draws the largest crowds and wreaks the greatest amount of devastation on the turf is unquestionably the Portland Rose Festival and its Fun Center. The fun center carnival, which includes rides, games and food booths, is a fund raiser which pays for many of the other Rose Festival activities, this runs from Memorial Day through Mid-June.

Using more than 3/4 of the total park acreage, the Fun Center operates for two full weeks and requires several days before and after the event for set up and tear down. During these three weeks all irrigation is shut down.

June is near the end of Portland's rainy season, so rain is almost always a factor. Over a million feet and innumerable wheels from baby strollers to semi-trucks can turn the turf into a sea of mud— an oozing quagmire. If, on the other hand, there is no rain, the lack of irrigation for three weeks, results in a hard, compacted, dry, burned out turf—a fairway of dust.

When the last of the carnival is hauled away, the Park Bureau often has only a couple of weeks to repair the irrigation and turf before the next major event. In the meantime, hundreds of people continue to use the park each day and smaller weekend events draw thousands.

The first major part of the renovation process involves a six-foot magnet. The Parks maintenance crew drags the magnet over the turf to find bolts, nails, bottle caps, wire and other metal that might damage turf equipment or injure park users. This 2-3 day project takes time, but is a key function in our operation. This is followed by the removal of soil contaminated by oil, grease, or hydraulic fluids which kills the grass. These areas are then back- filled and the entire area is aerated, topdressed, and overseeded as needed.

Who pays for the repairs? Until very recently, park users paid a single permit fee (five dollars) for which they could use any or all of the 26 acres. They were responsible for cleaning up their mess, although there was no commitment required on their part and no way to force the issue. Therefore, the taxpayers picked up the bill for most of the renovation.

In January, 1989, all of that changed. The park was divided into seven sections and a new fee structure was instituted. Now (depending on the area used, the number expected and the activity planned) fees range from $25 per day per section for a public event Where no sales or profit are involved, to $500 per day per section where products will be sold or admission charged. The new fee structure may by itself relieve some of the burden on the park.

Under these new regulations, the Park Bureau can now bill event organizers for any destruction of park property, such as the cost for turf renovation and irrigation repairs.

COMMUNICATIONS, this is perhaps the single most important function that the Portland Park Bureau has been able to perform when dealing with high use, high demand turf areas. It has proven to be an essential part toward minimizing turf damage, not only at Waterfront Park, but throughout our park system.

As the Turf Manager, I have found it extremely helpful to schedule a before and after walk through of the areas to be used, with each event organizer. This provides the users and the Turf Manager up- to-date information on the condition of the site before the event. It also gives both the user group and the Turf Manager the ability to asses damages after the scheduled event.

During the walk through (which should not take place more than a few days before or after a scheduled event) the parks representative has the opportunity to point out possible problem areas such as wet spots, or not so obvious obstructions in the parka It also is the perfect time to point out irrigation and valve-box locations so they can be marked and avoided when equipment and vehicles are driving in the park. It also provides an opportunity to inform the organizer of the importance of obtaining irrigation and electrical line locations before driving fence post or stakes into the ground.

The Portland Park Bureau has learned from experience that you can not give out to much information and advice when dealing with first time events or new organizers. The information and advice you provide may save you and the organizer time and money and perhaps more importantly it may save your turf from long term damage. It's communicating the simple things like: placing plywood under drop-box wheels and legs as they are placed in the park, providing gray water and grease disposal sites, requiring blotter pads and drop cloths under power equipment, or placing heat shields under barbecues and other cooking equipment, that is as much a part of turf management as mowing.

Because event organizers know they will be accountable for damages, it is in their best interests to ensure that vendors and event participants reduce damaging practices where ever possible. To assist the user groups the Park Bureau provides a copy of the Waterfront Park User's Manual to the person or party applying for the park permit. The manual provides information on the site plan, green space policy, utilities that are available, and maps showing utility locations. It also provides information on sewer and waste water disposal sites and instruction on proper grease disposal, emergency telephone numbers, billing information and restoration cost per hour.

Breaking up the park into seven sperate sections also allows the Bureau to schedule individual areas for maintenance and to assign events to areas best suited to a particular need. The Operations Division works closely with the Park Permit Center to schedule open times for maintenance and repair activities.

For example, one area has been designated high use. This area receives minimum restoration efforts during the summer, but is shut down in mid-September for complete restoration. This complete turf renovation involves any necessary regrading, total aeration, top dressing, overseeding, fertilization and total rest of the turf area for the fall.

Each year we see the demand for well groomed open spaces such as those provided by our park systems become greater, whether it is for organized sports or special events such as those at Waterfront Park. Unquestionably, the end result remains the same—stress and over-use. It is for this reason that today's Turf Managers must have the ability to perform good turf cultural practices and the ability to communicate with user groups to assist them in reducing destructive practices and minimizing turf damage.

Unfortunately the general public understands that artificial turf wears out in time, but feels that because natural turf is alive and possesses regenerative potential, it should never wear out. Of course, it does and thus turf maintenance and renovation must he seen to on a regular basis.

In summary, today's turf manager must recognize the need to communicate with user groups and with the scheduling and permit office to insure that all necessary precautions are taken to minimize turf damage. Many interrelated conditions contribute to long-term turf damage which are not readily identifiable until after the event. The watchful eye of the grounds superintendent is a highly valuable asset.

JC/sb/NTA9O

BEFORE MOVE IN

1. CONDUCT A WALK THROUGH OF SITE BEFORE EVENT

2. PROVIDE A USERS MANUAL LISTING DO'S AND DON'TS

3. IDENTIFY POSSIBLE PROBLEM AREAS

4. MARK IRRIGATION & VALVE BOXES

5. IDENTIFY APPROX. LOCATION OF IRR. & ELECT. LINES

6. REQUIRE & PROVIDE BLOTTER PADS & DROP CLOTH

7. IDENTIFY WASTE WATER & GREASE DISPOSAL SITES

8. IDENTIFY DROP-BOX LOCATIONS / "PLYWOOD REQUIRED"'

9 . EMPHASIZE RESTORATION COST ($) AND WHO PAYS

10. PROVIDE EMERGENCY PHONE NUMBERS AND NAMES

11. DOCUMENT CONDITIONS BY TAKING DATED PHOTOS.

AFTER THE EVENT

1. CONDUCT WALK THROUGH WITH EVENT ORGANIZER
2. RUN AND DO VISUAL CHECK OF IRR. & ELECT. SYSTEMS
3. CHECK FOR AND IDENTIFY HEAVY COMPACTED TURF AREAS
4. CHECK FOR AND IDENTIFY GREASE AND OIL SPILLS
5. CHECK FOR AND IDENTIFY EXCESS LITTER & GARBAGE
6. CHECK FOR AND IDENTIFY NEEDED HARD-SURFACE CLEANING
7. GIVE A VERBAL ASSESSMENT OR EVALUATION OF CONDITIONS

WHAT YOUR PROFESSIONAL ORGANIZATION CAN DO FOR YOU[1]

Blair Patrick[2]

[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
[2] Certified Association Executive (CAE) and Owner, Association Management, Inc., Olympia, Washington

It is no secret that associations have a profound impact on American society. But, even through associations are intimately woven into the fabric of American life, until just recently little has been know about the breadth and depth of their contributions. What most Americans know about the unique roles of associations in our nation has been limited to their personal experience. It's almost as if associations as a whole are an invisible part of the private and government sectors.

Before we go any further, let's define our terms. Webster defines an association as "an organized body of people who have some interest, activity or purpose in common." The IRS, for purposes of tax-exemptions, defines an association as a group with common business interests. There is an association for almost every interest, purpose or group imaginable. There are associations for manufacturers, lawyers, dentists, home builders, architects, broadcasters, hunters, fisherman, golfers (as you well know) etc., etc. There is even an association for association executives such now, in my opening remarks I made the statement that associations have a profound impact on our society, let me illustrate what I mean.

How would you like to be working with an enterprise employing more than 500,000 people?

How would you like to be a part of an enterprise spending $14.5 billion annually setting and achieving standards that protect consumers' health and ensure the quality of products and services? Or, how would you like to be a part of an enterprise devoting $8.5 billion annually to continuing education to benefit its personnel?

Well, you are—very likely because of one or more of your current national association memberships. A recent survey, conducted by a prestigious "think tank" in Indianapolis- the Hudson Institute, of 5500 national trade and professional associations determined that those associations were making the contributions I just outlined to the national economy. When you consider that the figures I sighted reflect the activities of only 5500 tax—exempt associations, it is mind-boggling to consider what those figures translate into when you consider that it is conservatively estimated by the IRS that there are over 960,000 tax—exempt organizations in the U.S. Obviously, the figures reported in the survey are only the tip of the Iceberg.

Clearly, associations play a major role in our nation and are indeed a community resource. In this role, I think it also is note worthy that associations, particularly in recent years, have come to realize that a major function is to serve the public interest. By enhancing the economic, social and political climate of this nation—and even the world—they create a more desirable atmosphere within which their members (individuals and companies) can function efficiently and effectively.

Professional and trade associations are founded on voluntarism. Voluntarism is defined in the dictionary as "the principle or system of doing something by voluntary action." Thus, professional and trade associations, as they have evolved and grown in our country, are logical extension of our system of private enterprise—a way of doing things for oneself rather than relying on the government to do it for (or) to us.

Even though an underlying principle of the association structure is the desire to do something for oneself, associations also provide a coherent, effective voice and vital information to opinion leaders, government and the general public. The voice of one individual or company cannot match the collective influence of a strong association.

Other examples of association activities that benefit society are community services such as:

The California Trucking Association, within hours of the 1989 San Francisco area earthquake, set up lines of communication between their trucker members, their association headquarters and various emergency agencies to provide information on serviceable roads. They also were instrumental in trucking in potable water for devastated areas.

The National truck stop operators association uses a network of truck stops to locate and identify missing children.

The American Association of Advertising Agencies have formed a three-year media campaign called media advertising partnership for a drug-free America featuring $500 million annually of free media time and space aimed at changing attitudes about illegal drug use.

Associations are an active, essential component in the area of research and statistics too.

Many health care related associations support or conduct extensive research compiling life-saving statistics on various potential illness cures and treatments.

The Northwest Turfgrass Association itself has provided over 34,000 dollars to turfgrass related research this year alone and probably well over 100,000 over the last 3-5 years.

Associations are a major source for product and safety standards; political education; ethics and professional standards; as well as, economic and education information.

Membership in regional turfgrass associations offers individuals and companies a void in a host of research, educational and extension activities that significantly affect the entire green industry. As one superintendent in an article I recently read put it, "Our role is to promote turfgrass in general and represent turfgrass, if you would." Government doesn't consider turfgrass a "cash-producing crop." That means that despite the fact that we're a billion-dollar-a-year industry, federal research money is limited. Stepping into the breach are the various non-profit turfgrass research and scholarship foundations such as ours.

Turfgrass associations represent the entire green industry. A typical association membership profile would include golf course superintendents, lawn-care professionals, landscaping contractors, grounds and park maintenance professionals and green industry suppliers. Golf course superintendents play an essential role in the leadership of turfgrass associations; however, they don't always constitute the majority of the members. The northwest membership profile of our association bears this rule of thumb out. The 400 NTA members include approximately the following, membership-wise.

39% Golf Course Superintendents
27% Green Industry Suppliers
22% Grounds and Park Maintenance Professionals
5% Lawn-Care and landscape professionals
4% Honorary Members
3% Students

I see professional organizations, in particular, taking a greater role in establishing industry standards, as well as maintaining satisfactory levels of performance, ethics and conduct. Here, the important self-regulating function of organizations comes into play. It is always preferable for an industry to develop its own set of standards than to have one arbitrarily imposed by government. Through established standards, industry groups can assure the public of the professional quality of work performed and goods provided, as well as supervise the maintenance of legal and ethical levels of conduct.

As our society becomes more technically complex, an increasingly important role of professional organizations will be the sharing of information. No one company or individual has a corner on know-how or expertise. Industry looks to trade associations to provide the medium through which specialists in many fields share their experience and knowledge for benefit of society.

In conclusion, you will note that I have taken a lot of latitude with my assigned presentation topic – what your professional association can do for you. I hope it is obvious that I did so because, after over 20 years in the business of working with professional and trade associations, the one lesson I have learned is that an association members only gets out of their association what ever they put into it. Association membership should not be evaluated on the basis of what I am going to get out of it solely. What you can contribute through your membership and the resulting collective efforts is in many instances as important or more important a consideration.

Thank you for your patience and kind attention.

THE USE OF COMPUTERS IN TURFGRASS MANAGEMENT-A FORUM DISCUSSION[1]

William B. Griffith[2]

[1] Presented at the 44th Northwest Turfgrass Conference, Rippling River Resort, Welches, Oregon, September 17-20, 1990.
[2] Golf Course Superintendent, Veterans Memorial Golf Course, Walla Walla, Washington.

FOLLOWING IS AN OVERVIEW OF THE FORUM DISCUSSION ON THE USE OF COMPUTERS IN TURFGRASS MANAGEMENT, RIPPLING RIVER RESORT, NTA CONFERENCE 1990.

After a introduction of the topic and proposed agenda for the days session the meeting was turned over to Mr. John Link III of THE TECHNOLOGY GROUP who gave a presentation on the various categories of software that a person should consider using. These software categories were, word processing, database programs, and spread sheet programs. Specific brands were not really discussed as there are so many different possibilities and different price ranges of material available.

The two main areas of interest to the group seemed to be record keeping, and budget tracking. Many record keeping in ideas were shared including, time keeping, equipment maint & repair, pesticide records, etc. In the area of budget tracking, several things were talked about. The focus seemed to be less in the area of time saving, but rather in the area of keeping more complete records and records of things not now being kept,

Several comments on the subject of computer hardware were voiced and we were reminded that if we are using this system in conjunction with an irrigation controller system we need to be sure and have adequate storage and memory for not only the irrigation program we are using, but the other software programs we might care to use also.

This type of educational session makes it impossible to list everything that was said but the session lasted approxiamatly 1 and 3/4 hours and was attended by about 125 people who expressed an interest in continuing afternoon sessions

EDITOR'S NOTE:

The following Proceedings papers that were presented at the conference were not submitted for publication:

Pesticide Spill Response What You Need to Know	John Peterson Riedel Environmental Services
Aquatic Weed Control	Mike Vandecoevering Wilbur-Ellis Company
Sprayer Selection and Calibration	Steve R. Eisele R.W. Falkenberg and Associates
Herbicide Update – Characteristics of Confront	Tom Cook Oregon State University
Integrated Pest Management	Tim Rhay City of Eugene

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