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Water Stress Index Measurement

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Traditional methods of estimating plant water stress include soil water status through tensiometers, neutron probe, gamma ray attenuation, and time delay refractiometry. Plant water stress estimates have also been by measurement of diffusive resistance, and leaf water potential through pressure bombs and thermocouple psychrometers. These plant water stress estimates and measurements are in general good. However, these methods are slow, cumbersome, and only measure a point source of plant water stress and soil water status. There is not a good area average and integration the large number of interacting factors which influence plant water stress.

Refinements in micrometeorological measurements have opened the way for new technologies and concepts in water use management. There has been a recent rise in the active use of infrared thermometery for measurement of plant water status. Several plant water stress index models have been created to estimate plant water stress. These models define crop water stress indices (CWSI) based on estimation of the ratio of actual to potential evapotranspiration (ETa/ET/p).

The energy balance based CWSI requires two crop parameters, one being aerodynamic resistance (ra, sm-1) and canopy resistance (rc,sm-1), and an additional meteorological component, which is net radiation (Rn). These crop based parameters are the basis of different "baselines" derived from aerodynamic components (ra,rc) for different plant species. There is also an empirical method which utilizes only plant canopy temperature, air temperature, and relative humidity. Several scientists have combined these temperatures, and relative humidity. Several scientists have combined these different methods and calculated average rap and rcp (aerodynamic and canopy resistance at potential evapotranspiration) values which appear to be species specific.

It appears then for CWSI to be accurate and useful, species specific parameters (ie. rap, rcp) will need to be determined, along with theoretically sound estimates for the dynamic parameters ra and rc. Parameters such as rcp, may be associated with plant physiological parameters as well as canopy energy balance. These techniques may then yield potentially useful methods of estimating turfgrass water stress.

Turf Irrigation Requirements and Water Management

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Only a few years ago there was little information available on actual water requirements for producing turf. Water supplies (both quantity and quality) have concerned turf researchers in arid and semiarid parts of the U.S. for over ten years. Recently, severe droughts in more humid areas have prompted concerns there, and resulted in increased work on turf water requirements and management. Presently there is a gerat need to get available knowledge on turf water use implemented into management programs.

WATER REQUIREMENTS

Turf irrigation practices often cause a serious waste of a renewable, but limited resource. Mismanagement of water is major contributor to the production of poor quality turf. The efficiency of an irrigation system, climate, soil characteristics, topography, shade, grass species, and management practices (such as mowing and fertilization) are important considerations for proper water management. It is, of course, not possible to delve deeply into turf water management here. For an in-depth treatment of the subject the reader is referred to the publication "Turfgrass Water Conservation" published by the University of California. Below some of the more important aspects of turf water management will be briefly discussed.

Determining water requirements. Various methods are used to determine water needs of a turf. Although any method will have inherent problems these are minor, especially when compared to the common practice of guessing at how much water to apply. One method used to determine evapotranspiration (ET) from a turf is direct measurement. This is often done using weighing (bucket) lysimeters. Determining water loss by weighing the lysimeters after a period of time can give a fairly accurate idea of water loss; consequently, the proper amount of water to apply to the turf can be determined. Although this method is fairly easy, it does require that the lysimeters match site conditions as much as possible.

In addition to the use of lysimeters, turf water applications can be based on open pan evaporation. Work on this aspect of determining turf water needs has been done at the University of California - Riverside. An open pan can be easily maintained on a site, and by closely checking losses from the pan verses actual turf performance, with different watering schedules, a fairly close correlation can be achieved.

Several different formulas are available to calculate ET. These rely upon utilization of weather data. Reported ET requirements, as given in newspapers and on radio and TV in Colorado, are typically accumulations of calculated water loss over the past few days. Application of the calculated amount of water will resupply water to the soil in amounts sufficient to meet turf needs for a few days. Evapotranspiration data can be employed in fairly large geographical areas (Denver Metropolitan Area) for considerable water savings. Research with turf indicates that there is a fairly close correlation to calculated turf water use and that measured by lysimeters.

Another method of determining turf water needs is to measure (available) soil moisture. Tensiometers and soil moisture blocks have been used extensively, especially in research, to measure soil water content. Other simple probes are available for determining soil moisture. Such equipment can be very helpful in managing water. In fact, some of this equipment can be tied directly into irrigation controllers to help implement better water management.

Water management. In spite of the effort put into determining the amount of water to apply to a turf, this information is of little value if the irrigation system or its use is not efficient. Efficiency of application needs to be constantly monitored by turf water managers. Continually, over irrigation of most of a turf installation to grow grass in the driest place causes serious drainage problems, and poor quality turf. Continuous effort to improve turf water application is needed on any irrigated site.

Significant amounts of water can be saved by not giving turf as much water as it can potentially use. For most cool season turfs there is little return in quality when more than 75-80% of the amount of water that a turf can use is applied. Large amounts of water can be saved by using deficit irrigation. In some cases, irrigation at 50% of potential ET during extended drought may produce a usable turf, and one that can be rapidly returned to high quality after the drought has ended.

Research in Colorado has indicated that the potential ET rates of warm season turf (buffalograss) is around 80% that of Kentucky bluegrass. Also, when water is not limited tall fescue uses quite a lot more water than Kentucky bluegrass, which uses more than fine fescue. This is not to say, however, that tall fescue could not be managed to use a lot less water, and still produce acceptable turf.

Frequency of irrigation to achieve water savings has been discussed, but investigated very little. A study at Colorado State University on watering amounts and frequencies indicated that better quality Kentucky bluegrass could be produced when irrigated at 100% of potential ET frequently (2 and 4 days) vs. infrequently (7 and 14 days).

Water conservation and improved turf quality are the responsibility of turfgrass managers. In order to do the best job possible, turf management professionals need to cintinually evaluate their practices, and implement existing technology as appropriate.

Irrigation of Athletic Fields

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It would be extremely difficult to maintain an athletic field without irrigation. In fact, it could be considered to be impossible to have a safe playing field without irrigation. Many athletic fields are constructed on soils that contain high amounts of a clay that shrinks when it is dry and expands when it is wet. During dry periods, many of these fields may develop soil cracks that are several inches across and many inches deep. These non-irrigated fields may not be safe for play.

The frequency and duration of irrigation is dependent on many environmental factors as well as those limitations imposed by design of the irrigation system. Ideally the system should be able to provide enough water over a reasonable time period to wet the soil to a depth of 4-6 inches. The soil should then be allowed to become nearly dry before the next irrigation. Since many fields are constructed from high clay soils, it may not be possible to get on enough water in one irrigation to wet the soil that deep before water begins to run off the fields. When runoff occurs, stop irrigating cycle several times before irrigation is complete. There is a mechanical process called aerification that will help move water deeper into the soil. The use of a wetting agent (surfactant) at the manufacturers recommended rate will also help water movement into the soil.

It is very important to allow the surface of the field to dry out between irrigations and not to irrigate until it is absolutely necessary. The first visual sign that turf needs water is what is commonly called "footprinting". When the turf plant has a low water content, it does not tend to bounce back after it has been stepped on or driven over. In other words, after you walk or drive across it, you can easily see where you have been. That's the time to irrigate.

If a turf is irrigated too frequently and the surface stays wet for an extended period, it tends to be more susceptible to disease, accumulate thatch and the turf tends to become more shallow-rooted.

Some irrigation systems are designed to use a very few heads which spray water over a great distance. These designs may look good on paper and usually work well as long as the wind doesn't blow. The systems using smaller more numerous heads usually do a better job. If at all possible, don't play on wet fields, it only adds to the soil compaction.

LANDSCAPE ARCHITECTURE IN TURF GRASS AREAS
SOME NEW STRATEGIES

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The City of Las Cruces delivers annually five billion gallons of water to more than 15,000 households. Residents use about 20,000 a minute per day. This means the average daily water used is 13,000,000 gallons. It's estimated that a large amount of that goes to the landscape especially during the summer.

Although Las Cruces is fortunate in having an adequate supply of water to satisfy its current needs, there are limits to the amount of water that can be treated and distributed.

When water supplies become critical the landscpae is the obvious chioce for rationing. Landscape architects practicing in the southwest are circumventing the situation by adopting water-conserving landscape stategies.

Xeriscape is a concept that was originally developed for Denver, Colorado. it has since spread to Texas, California and Arizona. New Mexico is the only southwest state that has not adopted a Xeriscape program.

Xeriscape is the conservation of water and energy through creative landscaping. The concept is to provide tips and giudelines for conserving water while maintaining an attractive landscape.

Seven principles form the basis for a Xeriscape design they are:

Start with a good design
Improve the soil
Use mulch
Choose low-water use plants
Water efficiently
Practice good maintenance
Limit lawn areas

Start with a good design.

This is the starting point for all successful landscapes. A good design starts with a plan of existing conditions drawn to scale. In addition to the plan an idea of a budget is essential. A realistic figure for estimating the cost of a landscape is $1.15 a sq. ft. and up for residential and between $1.00 and $1.20 a sq. ft. for commercial.

Improve the soil

While some variations occur for the most part the soils in this area are low inorganic materials. To conserve water add organic matter to flower and shurb beds. For trees and grass it is not economically feasible or necessary to perform soil preparation.

Use mulch

Mulching is a gardening practice that for the most part has been ignored in the desert. Mulch should be applied in a layer three - four inches deep around shrubs, flowers and trees. Mulches inhibit weed growth and reduce evaporation of moisture in the soil which saves water.

Mulch can also be used as a design feature. Areas of mulch can become part of the landscape in the same way as beds of flowers. Using beds of mulch saves water because planting areas are reduced.

Choose low water use plants

The use of native or water efficient plants is the single contributing factor that can effect water consumption in the landscape. Native plants are becoming increasingly available in local nurseries and also more popular.

Under natural conditions native plants thrive on the existing rainfall however under man made conditions these plants need additional watering. Native plants require deep watering the first two years after being planted. After their deep roots get established most plants will be able to survive without additional water except under extreme drought conditions.

Grouping plants with similar watering needs together is a strategy used by landscape architects. Each plant receives the proper amount of water needed for survival.

Native and low water use plants can be substituted for any exotic plant. There are native and low water use plants suited for both formal and more natural landscapes. Native and low water use plants can provide year round color, they need less maintenance and most take no pruning or fertilizing.

A Xeriscape tag has been developed for Texas, Arizona and Colorado nurseries. The Xeriscape tag is your assurance that these plants are true low water users.

Water efficiently

Knowing the age, size and type of plant, type of soil, time of year and the weather is essential to determine water needs. Learn how plants signal for H2O. Grass tends to lie flat after being walked on when moisture is low. It also becomes dull in

color. Many plants lose their gloss and start to droop before wilting. Others will drop buds, leaves or flowers. Observation is the best way to learn when it's time to water. Water harvesting is another stategy that can be designed into your Xeriscape.

Practice good maintenance

Proper maintenance must be practiced to have an efficient system. The major maintenance considerations are as follows.

-Fertilize in moderation
-Remove weeds as soon as possible
-Build catch basins around plants
-Aerate lawns for better water penetration
-Raise the height of the lawn mower to its highest setting
-Cut only 1/3 of total grass height at a time
-consider chemicals such as anti-transpirants and growth retardants

Limit lawn areas

Turf concepts have evolved more than any other landscape material. The trend used to be turf from property line to property line. Today turf areas are limited because of maintenance or water constraints.

Turf areas cannot be eliminated from the landscape even in a Xeriscape. They are necessary relief from the desert. However, maintained lawn areas require one inch or more water per week in the summer to stay attractive.

One concept that has been voiced is eliminate private turf areas (back and front yard lawns, etc.) and the relief will occur in the public parks and turf intensive recreational fields.

More realistically the concept of mini-oasis is becoming more popular. As you are grouping your plants according to their water need for your design, those with high water requirements can be concentrated as close to the building as possible. This is where the needed amount of turf area will exist. The essence of mini-oasis is water budgeting spending water where it will be enjoyed most.

By incorporating Xeriscape in the landscape, water waste can be limited and New Mexico an intensify the regional commitment to wise use of our limited water supply.

Landscaping with Native Plants

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The native New Mexico landscape is as varied as the topography it covers. There are many "native" plants that have adaptation potential for use as ornamental plants in home, commercial and community landscape designs.

Research continues in identifying plants, in making selections and in understanding cultural requirements of New Mexico natives.

Landscaping with native plants generally brings anticipation of low maintenance, low water requirement gardening. However each plant will have its own limitations depending on a wide variety of factors. Landscaping, using natives requires an understanding of the plant, its habitat and the expectations in a landscape.

Many plants can be transplanted from native stands, although most reports of success indicate container grown stock performs best.

Native plants require supplimental water for at least one season to encourage good root development and vigorous top growth. Generally, deep irrigation is recommended during establishment. Once established, a gradual transition to minimal care can be made. Keep in mind that a plant, like Blue Spruce, is native to New Mexico, however it's normal habitat is in mountain elevation from 6,000 to 11,000 feet. The temperatures at these altitudes is cooler and normal precipation occurs both summer and winter at substancial higher rates than lower elevations. This tree may not survive unless given adequate water, in both summer and winter.

Refer to NMSU Circular 513, Native Plants for New Mexico Landscape, for information on specific plants.

Controlling Diseases of Ornamental Plants

by

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There are numerous plant diseases that affect the beauty of our ornamentals around the golf course and around our homes. Because of limited time, my discussion will involve three major diseases: (1) limb die-back problems in shrubs and trees, (2) yellow leaves and (3) powdery mildew. These diseases account for most of our ornamental problems.

Numerous situations or problems can account for limb die-back problems in shrubs and trees. They include: (1) poor care, (2) inadequate fertilization, (3) changes in grade, (4) construction around trees, (5) salt, (6) mechanical injury, and (7) freeze injury.

Freeze injury is responsible for most of our die-back problems in New Mexico. Injury can result from (1) early winter freezes such as the one that occurred in November 1976, (2) extreme mid-winter freezes (January 1978) and (3) late spring freezes. Severe tree losses resulted from the November 1976 freeze, which occurred before trees had properly hardened off during that fall period. Trees most severely affected by freeze include ash, pecan, poplars, russian olive, sycamore, mulberry, stone fruits and willow.

Symptoms - General die-back of limbs is the most noticeable symptom of freeze injury. Splits, cracks, cankers and entry of various borers into the bark are often observed. Young trees may not leaf out in the spring, but produce an abundance of sucker growth from below the ground level. Young trees injured in the spring may bleed severely when sap starts to flow. Damage on the trunk and larger branches may be much more severe on the southwest (sunny) side of the tree where sap started to flow during winter warm periods.

A year or so after a severe freeze has occurred, light colored bark can often be seen, particularly around bud scars and below branches. Cut into these off-colored areas with a sharp knife. If the bark and tissue below (cambium and xylem) is dead, this is a good evidence that severe injury has occurred.

Injury from freeze may not be evident until two, three, or even four years after a severe freeze has occurred. This type injury is referred to as "subtle injury."

Occasionally numerous fruiting structures of the fungus Cytopsora sp. will grow on the bark of trees affected by freeze

injury. The fungus appears as pin head sized pimples that produce masses of spores resembling orange colored hair following wet, humid periods. No special controls are needed for this fungus. Gumming may also be commonly seen in stone fruits and Russian olive. Also, shot hole borers may appear after injury.

Prevention of Freeze Injury

Selection of freeze resistant varieties of trees is the easiest way to prevent freeze injury. Stay away from "wichita" pecan varieties and if ash trees are planted use resistant ones such as the "Green" Ash. Expect problems if you plant most varieties of willow and poplars.

Avoid planting highly freeze susceptible trees such as "Wichita". Stimulate rapid spring growth by providing adequate nutrients (especailly nitrogen) and water, but do not stimulate late fall growth. Apply nitrogen fertilizers before July 1.

It is essential to water and fertilize cool season grasses in the fall; however, apply only enough for the turf so that trees will not be stimulated.

Paint the southwest side of trunks and larger limbs of young trees with white, latex paint or whitewash if it does not severely distract from the overall appearance.

Other measures include wrapping trunks with burlap strips, aluminum foil or other commercial products. It is important to keep bark tissue in a dormant condition during the winter and early spring. If these protective means are not taken, sap will start to flow on the southwest side of the tree where the sun has heated the trunk. Severe freeze injury can then result.

Care of Winter Injured Trees

Prune all sprouts, except one, on young trees that have been killed to the ground. This sprout can be used later for re-budding. Severely prune trees that have extensive injury. Where subtle injury has been experienced, prune out dead and weak limbs as they appear. This may take a period of two or more years. Water and fertilize to stimulate new growth.

Several situations can cause yellow leaves in shrubs and trees. They include: excessive salt; lack of nitrogen, zinc or iron; freeze injury; etc. Diagnosis of the problem is essential before you can correct a "yellow leaf problem" in trees.

Powdery mildew is the most common fungus problem of ornamental shrubs and trees in New Mexico. It is commonly found on Euonymus, rose, Photinia, crepe myrtle, zinnia, and phlox. It won't kill plants but can make them very unsightly.

Powdery mildew appears as gray, moldy or powdery patches on

leaves, stems, and buds. The mildew spots may enlarge until they cover the whole leaf. Leaves and flower buds may curl and become distorted. The disease is spread by wind-borne spores. Mildew is common when days are warm and nights are cool, especially during periods of high humidity. Poor air circulation and damp, shaded locations also contribute to disease incidence.

Control - Apply a dormant spray containing lime sulfur (example - Orthorix Spray), another product containing sulfur, or benomyl just as leaf buds start to open in the spring. Spray or dust with a fungicide recommended for powdery mildew when the disease is first noticed, and repeat every 7 to 14 days until the disease is under control. Funginex, Systemic Fungicide with benomyl, Benlate, Pipron, Rubigan, Actidione PM, Karathane, sulfure, and Phaltan. Karathane and sulfur should not be used when temperatures are above 90 degrees F, as they may burn the foliage. Do not crowd plants, and avoid damp shady locations. Powdery mildew can be largely avoided in roses by using resistant varieties.

IRRIGATION NEEDS AND PRIORITIES AS SEEN BY THE GOLF COURSE SUPERINTENDENT

AL KLINE

SUPERINTENDENT

UNIVERSITY OF NEW MEXICO GOLF COURSES, ALBUQUERQUE, NEW MEXICO

For a starter in this discussion, let's concentrate on "NEEDS", as relates to all of use; MANAGERS of water, by the operation of a TOOL, commonly referred to as an Irrigation System.

Stop already! How can I have the audacity to reduce the glamorous description - Irrigation System - to the lowly status of TOOL? Because - I just did and propose that we can better identify our "NEEDS" by taking this approach.

O.K. you're thinking, what's the big deal, as relates to "NEEDS" about the TOOL we use to apply water? Well, I think the big deal is, that as managers, you would and should ask the same relative and basic questions about your "NEEDS" from this Irrigation TOOL as you would about any of the other tools you purchase; such as:

1. Initial Cost
2. Long Term Maintenance Cost
3. Operational Cost
4. Guarantee
   a. Mechanical
   b. Performance
   c. Efficiency - expressed in terms of a percentage for all nozzle and pressure combinations.
5. Flexibility of Operation
6. Man-hours to Operate
7. Built-in Protection
8. Service
9. Susceptability to Vandalism
10. Independent Test Results and Certification of

Equipment

11. Etc.

As managers, let's stop for a minute on #4 above. I think most of us have seen the mechanical guarantee, and most of us think we have seen the performance guarantee (very questionable); please raise your hands if you have seen an efficiency guarantee; and, I believe for all of us - WHY NOT?

Now, please look at #10 - test results and certification - the key word here might be independent. Without meaningful information, how can we expect, from ourselves, effective management decisions when purchasing these tools?

Hopefully, what we have established here is that in order to effectively and efficiently manage water, there is not only a requirement to analyze our "NEEDS" for use of this tool; but, a great "NEED To Know" MORE about this tool!

Now to PRIORITIES, and assuming you agree that water is a precious and, in too many areas, a diminishing commodity; AND you cannot afford excessive energy bills, premature leaching of nutrients, wet spots/dry spots and ulcers: then, MAKE IT A PRIORITY TO -

1. Join - "CENTER FOR IRRIGATION TECHNOLOGY". (See Handout).
2. Request specific data from manufacturers as relates to efficiency expressed as a percentage; by nozzle combinations, at listed pressures, at specific spacings.
3. Verify information provided by manufacturers with Center for Irrigation Technology.
4. Request guarantees which not only cover mechanical performance, but accurate distribution of water.
5. DON'T be satisfied with heads that turn and squirt - you need PERFORMANCE.
6. TEST systems you now have - enlist the assistance of manufacturers and C.I.T. for improvement.
7. INSIST that all future purchases of equipment be

tested by C.I.T.

"HOW EFFICIENT ARE PRESENT TURFGRASS IRRIGATION SYSTEMS"?

James A. McPhilomy

That is a very simple question, but, the answer must be based upon the answer to another question. Are you attempting to "wet the grass", or to "uniformly replenish the soil moisture"? Depending upon the method you use to evaluate the equipment performance, all turfgrass irrigation sprinkler head products would be rated as either "highly efficient", or "generally in-efficient" and "wasteful".

If the method of evaluation is based upon the ability of the product to "wet the grass" or the "distance of throw" from the sprinkler head, then almost every available sprinkler head product must be given a very "high" efficiency rating.

Un-official, un-controlled, and non-scientific field testing has proven, with very few exceptions, that the product performance will indeed match or exceed the performance information as furnished by the manufacturer of the product: "X" psi of applied pressure, at the base of the sprinkler head, will generally distribute "X" GPM of water, over "X" feet of "wetted area", with each of the listed nozzle sizes or nozzle combinations.

However, if you evaluate the sprinkler head performance on the uniformity of the distribution pattern, over its affected area of coverage, to uniformly replenish the soil moisture to the root zone reservoir of the plant material, within the ability of the soil structure to "accept" and "efficiently utilize" the application, then the "highly efficient" rating must be changed to "generally in-efficient" and "wasteful". Non-scientific field testing has indicated that approximately 40% to 60% of the applied water is being "wasted" simply because of the non-uniform distribution of the application.

Any applied water below the depth of the root zone of the plant material is lost to "gravitational flow", and thereby "wasted", and, of course, any water applied in "excess" of the ability of the soil structure to "accept" or "infiltrate" the application must also be considered as "wasted".

In general, the non-uniform distribution of the applied water has been from 3 to 1, and 4 to 1, within a combined, multiple head application pattern. The absolute best performance I have been able to obtain, with any product, under field conditions of operation, has been 2 to 1, or .20" to .40" in the average of the combined application pattern.

The continued acceptance of the "wetted area" or "distance of throw" as the primary method to evaluate sprinkler head equipment performance is directly responsible for this situation.

Furthermore, the "implied inferrence" of the manufacturer of the

product, combined with the "erroneous assumption" of the irrigation system design engineer and operator of the equipment, that any product is "efficiently adaptable" to all of the published operating pressure ranges, with all of the listed nozzle combinations, and gallonage of application rates, at any "geographical area" of operation, is not only mis-leading, it is the primary cause of the un-intentional "mis-application of product" so prevalent today.

There are very few, if any, bad or un-acceptable performance turfgrass irrigation sprinkler head products available today. Each and every product has its own, always "limited", range of three operating performance areas. These three areas are: #1-"Optimum", or the absolute best, most efficient "uniformity" of distribution pattern that is possible with that product, #2-"Acceptable", or pattern "alteration" or non-uniform "distortion" of the application pattern, within the ability of the affected area of coverage to accept, and efficiently utilize the application, and #3-"Unacceptable", or non-uniform pattern "distortion" severe enough to create "run-off", non-uniform nutrient release, shallow rooting, etc.....

There are 10 "constants" which "affect", without exception, every turfgrass sprinkler head product. The "alteration" of any one of these "constants" will always result in the "alteration" of the distribution pattern.

However, the "constants" of "applied pressure", and "geographical area of operation", are, in my opinion, the two most "critical factors" which "affect" the "larger capacity" turfgrass sprinkler head distribution patterns.

"Applied pressure" - Without question, the most improtant "Constant" which "affects" the "Uniformity" of the distribution pattern of any sprinkler head product. Without exception, all product distribution patterns are altered or distorted by the increase or decrease of applied pressure. However, not all products are affected in the same way. Some products "uniformity" of application pattern are completely "altered" by the minimal changes of applied pressure of 5 PSI to 10 PSI, whereas, some products will retain "acceptable efficienty" over a wider range of operating pressures of from 10 PSI to 20 PSI pressure "differential".

Therefore, if you "evaluate" sprinkler head performance by the "wetted area" or distance of throw, then the "information" as furnished by the manufacturer of the product; that the listed nozzle combinations will distribute "X" feet of radius, at each of the listed applied pressures, must be "accepted" as "accurate".

The in-disputable fact is that NO product available today would be considered as "efficiently adaptable" to the "extremes" of published operating pressure range, (of 40 PSI to 80 PSI, or 50 PSI to 100 PSI), with the same nozzle combination IF the

performance "evaluation" were based on the "efficient and uniform replenishing of soil moisture".

"Georgraphical area of operation" - This basi ally "un-known" factor is probably directly responsible for more of the un-intentional "mis-application" of product than any other single factor. "Geographical area of operation" includes a number of un-controllable factors, each of which influence the "uniformity" of distribution pattern of ANY product. The simple fact is that NO product available today will retain the same "uniformity" of the distribution pattern, at differing "air density" or "geographical areas" of operation. Therefore, a product which distributes water with "acceptable efficiency" at Houston, Texas, at an elevation of 15', MAY NOT perform with "acceptable efficiency" at Las Cruces, New Mexico, elev. approximately 3900, at Albuquerque, New Mexico, elev. approximately 5,000 or at Los Alamos, New Mexico, at an elev. of approximately 7,000'.

SLIDES:

Is there any reasonable way to "obtain" and "evaluate" the information necessary to determine the efficiency of your distribution system equipment? Yes, there is. How?

The first step is to determine the "extremes" of dynamic or operating pressure, and defining the operating pressure areas. For example, 50 PSI to 70 PSI area, the 60 PSI to 80 PSI area, the 70 PSI to 90 PSI area, and the 80 PSI to 100 PSI area, etc.. This is very important, and should be determined during the normal operation of the irrigation system.

Step #2 - With the utilization of in-expensive, non-scientific plastic cups or catchment containers, "catch", and "measure", (using a calibrated measuring device such as a "rain gauge"), the "percentage" of water in each container placed along the "pre-determined" catchment pattern, to "cross section" the combined distribution pattern, at each of the differing "pressure areas" you wish to check. You may establish 3 or 4 catchment patterns at the same time, at different operating pressure areas. This would allow you to "average" the total of the "combined application pattern".

By experimenting with different nozzle "sets" or nozzle "combinations", you will be able to determine the most efficiently acceptable "combined" distribution pattern for your product, head spacing, spacing "pattern", and pressure area. Regardless of brand name, there is a nozzle combination most efficiently adaptable to all of these operating conditions.

There are some preliminary steps which must be taken to insure the reasonable accuracy of the catchment test results. First, all sprinkler heads affecting the catchment test pattern must be installed to grade and levelled, within the average of the uniform spacing pattern of the area. Second, catchment tests should be taken at each of the 20 PSI pressure differential

areas. Finally, all catchment test readings will only reflect the percentage of the applied water in each area of the "combined" application pattern, and NOT the actual precipitation rate of the application.

The length of the catchment test "run-time" is not important as long as it is of sufficient duration to provide a reasonable amount of measurable time for all field testing except when we are checking the normal nighttime irrigation applications of the distribution system. Remember, you are only checking the percentage of applied water in each container, unless you are using all "calibrated containers" for the test.

In conclusion, there are only two methods presently available which may be used to evaluate the "efficiency" of the distribution pattern of sprinkler head equipment: The presently acceptable "wetted area" or "distance of throw", or the radically different, highly contentious, and yet perhaps more accurate "evaluation" based on the "uniformity" of the "distribution" of the "applied water".

The 10 constants which affect distribution patterns are:

#1 - Applied pressure

#2 - Air density or geographical area of operation

#3 - Nozzle design

#4 - Angle-of-discharge

#5 - GPM volume of applied water

#6 - Distance of throw or radius of coverage

#7 - Speed of rotation

#8 - Drive mechanism (ball drive, cam drive, gear drive, rotary impact)

#9 - Installation (all products must be installed absolutely level)

#10 - Consistantly uniform spacing (distance between sprinklers) and uniform spacing patterns (triangular, square, rectangular, etc.)

GLOBAL TRENDS IN TURFGRASS RESEARCH

[1]
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Worldwide, there is an increasing amount of leisure time available to an ever-increasing population. Much of that leisure time is devoted to outdoor recreation, primarily sports activities. Thus, the need for low cost, wear tolerant; yet aesthetically appealing turfgrass facilities - parks, playing fields, and sports fields is greater than at any time in the past.

This need comes at a time when supplies of natural resources, especially water and energy are diminishing throughout the globe. Too, global economic pressures affect the ability to provide adequate, well-maintained turf facilities. Ironically, just as is the case in the U.S., public funding of the research needed to solve turfgrass problems is decreasing; or, was never available. Nevertheless, turfgrass research is expanding and is providing answers to the more pressing problems that confront turf managers.

A comparison of the types of papers presented at the international turfgrass research conferences in 1981 and in 1985 will serve to illustrate global trends in research.

First however, let me point out that turfgrass research conducted at US Land Grant colleges and universities represents, by far, the greater effort worldwide. Too, in most cases, the work conducted in the U.S. is more basic than applied. Not so, of course, 20 to 25 years ago.

Global research efforts may be placed in six major categories. Namely:

1. Turfgrass breeding and establishment
2. Soils, nutrition and irrigation
3. Establishment and maintenance
4. Plant protection - pest control
5. Physiology
6. Growth regulators

A review of papers presented at the 1981 and 1985 international conferences shows:

Category	Number of Papers			
	U.S.	Others	U.S.	Others
I. Breeding	9	2	9	8
II. Soil Nutrition	12	8	17	5
III. Establishment-maintenance	7	2	6	4
IV. Plant protection	13	0	12	0
V. Physiology	10	0	7	0
VI. Growth Regulators	-	-	10	-

The search for new species and cultivars is a global effort. Many believe that improved grasses with better resistance to pests, drought, heat, cold and salinity including brackish water, provides the best opportunity to reduce maintenance costs and to lower water use. In this respect, it should be noted that the USGA-GCSAA research program devotes major resources and effort to grass breeding including the development of a polycross seeded bermudagrass by Dr. Arden Baltensberger. Other species are zoysia, bentgrass-creeping and colonial types, Poa annua and "native" grasses - buffalo, saltgrass, alkali grass and crested wheatgrass.

For the future, bio-engineering techniques will provide greatly superior grasses; but, these are still some time away.

Soils and nutrition studies represent another global effort. In the U.S. the greatest amount of research effort in this category has been directed toward improvement of golf greens. Much of the basic information has been transferred to sports fields and other heavily trafficed areas. Elsewhere in the world, soils research has been directed toward, primarily, sports fields - soccer, rugby, cricket, grounds and pitches bowling greens and race tracks (turfed). Germany, Holland, New Zealand and Great Britain among others have studied ways to stabilize surface areas of sports fields, improve drainage and reduce compaction. In the U.S. Daniel and associates at Purdue have done similar work.

Establishment and maintenance studies have received much attention globally. These applied studies for the most part, have dealt with cultural practices and their direct and interacting effects on turfgrass! Bowling green maintenance received major attention in Great Britain, Australia, New Zealand and South Africa among others. Methods to prevent freezing of soccer fields, by use of covers and electric heating cables have been studied in Sweden.

Turfgrass Fertilization Needs with Emphasis on Iron

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Fertilization of turfgrasses grown in arid and semi-arid regions often requires special consideration. Because soils in low rainfall areas are often alkaline, availability of certain nutrients such as iron can greatly influence fertilizer selection and use.

In drier areas, potassium is frequently available in adequate amounts to meet plant needs; consequently, fertilizers developed for use in more humid areas may contain more potassium than is actually needed. Other factors also need to be considered in a broad way when discussing turf fertilizer needs. In areas with little rainfall, limited leaching of nitrate nitrogen tends to keep this important nutrient in the rootzone for a fairly long period, reducing amounts and extending frequencies that soluble nitrogen fertilizers should be applied.

The above generalizations, of course, have limitations because soils may be coarse textured or heavily watered; therefore, leaching of nitrates can be quite rapid. Soils may be quite alkaline, yet adequate iron may be available to maintain a healthy, attractive turf.

It is evident that, in order to properly manage turf, close attention to visual characteristics of the turf is necessary. If a turf has poor density and is yellow, there is a strong possibility turf would benefit from nitrogen fertilization. However, if during the summer the turf is dense, but yellow, then there is a strong possibility that the turf needs iron. Nitrogen application alone at this time could cause the turf to become more chlorotic and sickly. In addition to visual indicators, soil tests are a very valuable tool for turf growers in arid and semi-arid regions. Soil tests are quite valuable in detecting low levels of more important macro-and micronutrients. They are also quite helpful in detecting salt problems. A few of the research findings and observations with turf nutrition that we have experienced will be mentioned.

Nitrogen - Frequently, significant amounts of nitrates will occur in irrigation water, whether from well or effluent water. In fact, nitrates in water from one well has been adequate to keep good density of Kentucky bluegrass, and other cool season turfgrasses for more than a dozen years.

Sources of nitrogen can influence soil pH; thus, they may influence turf quality by making iron more available, or by supplying needed nutrients, such as sulfur. In arid and semi-

Jim Beard in one of his reviews of turfgrass research since the early 1950s has summarized the scope of projects studied as follows:

1950-60	Development of specialized equipment for care and maintenance of turfgrass. Studies dealing with mowing practices, compaction, cultivation, watering and other cultural practices.
1955-65	Development of specialized fertilizers and weed control through use of selective herbicides.
1960-70	Studies of root zone modifications (which led to development of USGA Green Section specifications and incidentally modified root zones for sports fields). Also, during this period, roadside establishment procedures were evaluated.
1965-75	Intensive breeding of cool season grasses, especially Poa prantensis and Lollium. Development and evaluation of sod production procedures.
1970-80	Turfgrass diseases and allied fungicide programs and new turfgrass nutritional practices.
1975 to -	Growth and physiology of turf grasses in relation to environmental stress tolerance and conservation of water and energy resources.

It is valid to assume that global trends in turfgrass research will continue in this same pattern. New techniques in cell culture and in bio-engineering, especially the genetical aspects, will bring new technology to turfgrass research. Private funding, as opposed to public, will, no doubt, provide the necessary financial resources to support research in this all important area.

arid regions, ammonium sulfate routinely performs quite well as a fertilizer.

Phosphorus and potassium - A long term study of creeping bentgrass (grown on sand) responses to various applied nutrient elements has demonstrated that over the short term only nitrogen seemed to be deficient. But, after a couple of years both P and K deficiencies occurred. In hydroponic systems, as are being developed on many greens, close attention to more than nitrogen or nitrogen and potassium is needed.

Sulfur - Sulfur is being increasingly used to fertilize turf. In a few instances the S may be applied to remedy deficiencies in the turf. In more dry areas one of the primary benefits from S seems to be to lower soil pH; thus, increasing iron availability to green the turf. Results of improved turf greening with S applications have not been as consistent as they might; however, on alkaline soils normally deficient in iron positive results have occurred (after only a few months). Sulfur, like most nutrients, needs to be handled with respect in order to minimize phytotoxicity problems.

Iron - Above, the effects of acidification of the soil on iron availability were mentioned. There are two othe approaches to growing good quality, green turf on soils low in available iron. One of these is to grow varieties that maintain good color at low available (DTPA extractable) iron levels. Adelphi, Ram I and Merion Kentucky bluegrass have maintained good color; whereas, Park and Delta have become very chlorotic when grown on soils with low levels of available iron. Iron containing turf fertilizers have long been used in drier parts of the U.S. There are several different forms of iron which may be used alone, or included in commercial fertilizers along with nitrogen and other nutrient elements.

Iron has become a staple in the commercial lawn care industry in Colorado. There has been a trend to reducing the amount of nitrogen put on home lawns while increasing the amount of iron. This allows growth of an attractive, green turf that is not succulent and water demanding and so prone to disease.

Ferrous sulfate is often used in turf fertilizers. It is sometimes used as a liquid, but more often as a granule. It stains sidewalks, and can cause serious burning of turf, especially bentgrass. Ferrous ammonium sulfate and treated mine tailings are other inorganic sources of iron that have performed well in greening iron deficient turf. Organic sources of iron, including iron chelate, are also used to green turf.

One of the more surprising happenings with iron fertilizers has been the long term greening possible with a single application. Use of ferrous sulfate and other inorganic sources have resulted in acceptable greening that lasted for more than a year.

Fertilizer is one of the turf managers important maintenance tools, perhaps the most important one. It is important that a turf professional use his experience as well as soil tests in developing workable fertilizer programs. In addition, turf managers need to keep up to date on technical developments happening in the fertilizer industry and research on how to put the latest information to use.

Effective Use of Sewage Sludge for Turf Grass

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Quality turfgrass production and playing surface appearance is generally associated with large amounts of nitrogen (N), phosphorus (P), and potassium (K). Managing the time and rates of application of these nutrients to give quality turf is essential. Managing the three major nutrients efficiently, obviously becomes much more complicated when one is dealing with problem soils. Problem soils may be simply those that are very sandy and allow easy leaching of the highly soluble mobil major nutrient forms. Problem soils in New Mexico can also be those that easily become deficient in one of the other 10 nutrients that are essential (Calcium, magnesium, sulfur, zinc, iron, copper, manganese, chlorine, boron and molybdenum).

There is a renewed interest in the use of sewage sludge in the production of high quality turf across the United States. Federal laws concerning the dumping of potentially toxic materials into sewage systems has made it possible to market products that are consistently safe to use on turf. Also laws to help increase the supply of materials on the market. More metropolitan areas are seeing an advantage to producing products that can be used agriculturally including turf and ornamentals. Recent research at New Mexico State University adds support to the renewed interest in sewage sludge products especially for New Mexico.

Two three year experiments have been done. One of the experiments was on bermudagrass (common) at Las Cruces and the other in Albuquerque. With the City park mix (k-31 35%, red fescue 35%, Kentucky blue 30%) at Bullhead Park. These studies are soon to be published.

The results indicate that sewage sludge can be used as a complete fertilizer alone or with an existing fertilizer program with a reduction in nitrogen and phosphorus rates from the mineral sources. The unique properties of sludge other than use for nitrogen, is to use it as a soil applied micronutrient source.

Experiments have shown sludge to be a good micronutrient source especially for zinc and iron which are perhaps the most common trace element dificiencies in New Mexico. The experiments have shown sludge-iron to be exceptionally effective. Sludge can especially be used to good advantage in areas where it is hard to foliar apply iron. It could be used to even supplement foilar applications.

Sludges' slow release nutrients give it a long lasting residual fertility characteristic. Add the fact that it has been shown an excellent micronutrient source even soil applied, make it another option in good soil fertility management schemes. Miloganite and other sludge products are now available in New Mexico.

Tucson Parks and Recreation Department

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1. Status of the current use of effluent water on ourgolf courses and reclaimed water on City parks.

2. The use of reclaimed water on private golf courses and the plan and delivery system for reclaimed water to the Parks and golf courses in the Tucson basin.

3. Problems in separation of pottable system and reclaimed water system in existing parks.

4. Irrigation systems used on existing golf courses including valves, sprinkler heads and the reasoning behind their use.

5. An analysis of sewage effluent as well as the reclaimed water and the nutrients provided by the water to turf areas.

6. Fertilizer and chemical applications required to keep soils balanced and controlling nitrogen release to turf.

7. The state rules and regulations on the use of reclaimed water in golf courses including sign postings, water timing, etc.

OVERSEEDING

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If they haven't already, very soon now most southern golf courses will be involved with a ritual that has taken place every fall for a number of years, that of overseeding their putting greens with one of the coolseason turfgrasses.

The overseeding of bermudagrass greens serves at least two purposes, the most obvious being purely aesthetic. The visual effect of a green target at the end of a long fairway set against seas of dormant brown bermudagrass is very impressive. Just this effect may make overseeding worthwhile.

The other purpose that overseeding serves is more functional. We are well aware that a golf course putting green receives a great deal of traffic, especially foot traffic. Actively growing turfgrasses are able to withstand the abrasive action associated with traffic, in part, because they constantly renew the leaf surface area and leaves protect the most important part of the plant, the growing point. Without leaf growth, traffic abrasion can soon wear out the leaves and expose the growing point to damage.

When a plant enters dormancy, like the bermudagrass plant, all leaf growth stops and the wear-damaged leaf system can not be replaced. But the leaves of the overseeded coolseason turfgrass serve to protect the growing points of the dormant bermudagrass plant, which would otherwise have been damaged.

In the overseeding of bermudagrass greeens, several trends have begun to develop in the past few years. The basis for most of these changes have been centered on some of the incredible problems some courses have experienced with spring transition. In many cases, the overseeded greens have failed completely to make the transition to bermudagrass. Patches of bermudagrass under the over-seeding have died and the greens have had to be reestablished.

There is a fairly sizable movement away from overseeding greens at all. In this movement, the biggest hurdle to overcome has been getting the golfer to accept brown "greens." At a distance, a green may be hard to distinguish from the surrounding fairway. Many courses have fairly light winter play, and if the flag is moved once in a while, the wear problem has not seemed to be a big issue. The lack of overseeding has helped with the budget and in some respects made winter weed control easier. Materials that control all problem vegetation may be used over the dormant bermudagrass. Check with your local turfgrass

specialist or county extension agent for specific recommendations.

Lighter seeding rates have been used by some as a tool to help spring transition. The feeling is that if you use less seed, then you'll have less to get rid of in the spring. Rates in the past for perennial ryegrass have been as high as 40 lbs per 1000 square feet but now 20 or 30 lbs per 1000 seems to be in the ballpark.

While transition has been a serious problem, an equally serious problem has been the occurrence of Pythium. Many overseeded greens have been lost to Pythium. At the time greens are overseeded, in most parts of the South, days are still fairly warm and, of course, the frequent light waterings necessary to start seed provides ample humidity for the encouragement of Pythium development.

The use of seed treated with a fungicide such as Koban is absolutely necessary. Beginning seven to 10 days after overseeding, it might be a good idea to apply Subdue, Banol or Koban at the intervals and rates described on their respective labels for Pythium control. Helminthosporium has also been a problem on overseeded ryegrass. The control of Helminthosporium in overseeding can be achieved by using 1-2 oz. of Chipco 26019. These applications should continue as long as high humidity levels continue. Without high humidities, the disease pressure is greatly lessened.

While the timely use of good fungicides has greatly lessened the disease problems associated with overseeding, the bitter memories of poor transition still haunts many superintendents. We certainly need research that will help us understand more about transition and give us the tools to get through it smoothly.

COMMON PROBLEMS ON SOUTHWESTERN GOLF COURSES

James F. Moore

USGA Greens Section Agronomist

The problems of Southwestern Golf Course can be divided into two distinct categories. These are:

1. Problems caused by people such as superintendents, professionals, managers, and green committees.

The relationship between the superintendent and his co-professionals has never been more critical to the success of the golf operation. Unfortunately, there continues to be a great deal of friction between these individuals - especially in the South. Superintendents can do much to make this situation better - or make it worse. Common problems seen at courses throughout the Mid-continent region will be discussed as well as possible solutions.

2. Problems caused by or aggravated by Nature such as black layers, turfgrass diseases, and poor construction techniques.

Slides and narrative will discuss a few of the most serious agronomic challenges to good turf noticed across the region this season. Some of these challenges can be met with alternate agronomic strategies while others will require re-construction. If time permits, common failings in the green construction process will be discussed.

You'ns We'uns and Us'uns
Building a Shared Vision of Excellence

by:
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Relationship between professional organizations provide each an opportunity to expand services to the publics they serve. Service, the focal point of any profession needs to be nutured and fostered in a state such as New Mexico.

The Southwest Turfgrass Conference has long been a recognized professional organization whose primary purpose has been to aid communities and organizations in the development and promotion of grass and soils for lawns, parks, golf courses and nature resource areas.

The New Mexico Recreation and Park Association, established in the 1950's also has the same responsibility as one of their goals.

The NMRPA is a professional organization affiliated with the National Recreation and Park Association. The major goals of the Association are:

1. To unite all those intersted in the recreation and park movement in New Mexico.

2. To foster and maintain high standards of professional qualifications, training and ethics.

3. To organize all levels of recreation and park personnel for the purpose of promoting, broadening, and improving recreational services in New Mexico.

4. To study existing recreation and park legislation and additions and improvements to existing legislation affecting all fields of recreation and parks in New Mexico.

5. To assist in the dissemination of information affecting the field of recreation and parks in New Mexico.

To effectively meet the goals of the organization the NMRPA publishes an official organ, Inroads. This publication now has a full time editor and a review board composed of qualified individuals from throughout the State. This has been planned to ensure a vital quality publication. The editor is interested in receiving articles from all sources relevant to the park and recreation profession and to have individuals from organizations such as the Southwest Turfgrass Conference sit on the review board.

In the past, representatives of the S.W. Turfgrass Conference have sent selected papers from the Conference for publication consideration. I am pleased to say several have appeared in past issues. Hopefully, some of you will consider Inroads as a vehicle for publishing not only papers presented at Conferences but any others you deem appropriate for park and recreation personnel.

Another principal objective of the NMRPA is to foster training for professionals in an effort to broaden and improve the human resources so vital to this profession.

The organization periodically conducts workshops for segments of the total population such as Therapeutics, small communities, Aquatic Personnel and administrators. In each case sessions as devoted to planning, designing, implementing, and maintaining programs and resources. You as specialists, can assist in the latter area through agreeing to serve as presenters, demonstrators or as participants through cooperative planning in such activities. In this manner both organization will better meet the needs of their publics. Such an arrangement is beneficial for both organizations. A park and Outdoor Recreation Branch has recently been established in the NMRPA and the objectives of this organization are:

1. Provide better representation and recognition of the fields of park and recreation resources planning, design, development and management.

2. Unit in one organization all personnel interested in park resources planning, design, development and management in the State of New Mexico.

3. Provide for the exchange of ideas, information, and programs of mutual interest to park resources oriented individuals and organizations.

4. Promote standards, ethics, and training for park

resources professionals.

5. Make the services of the New Mexico Recreation Park Association more readily available to Branch members.

6. Promote a better working relationship between agencies and organizations concerned with providing park resources.

7. Act as an agent for representing park resources practitioners when such representation is desired.

8. Function in such a manner as will further the best utilization of park resources in New Mexico.

9. Uphold the Constitution and By-Laws of the New Mexico Recreation and Park Association.

The Southwest Turfgrass Conference has many of the same objectives and perhaps the two might consider working together through shared conferences, workshops, etc. to allow for greater participation and involvement in the provision of service to our state.

It just might be that You'ns and We'uns working together may be what is needed to make parks recreation and leisure opportunities available to more people in New Mexico.