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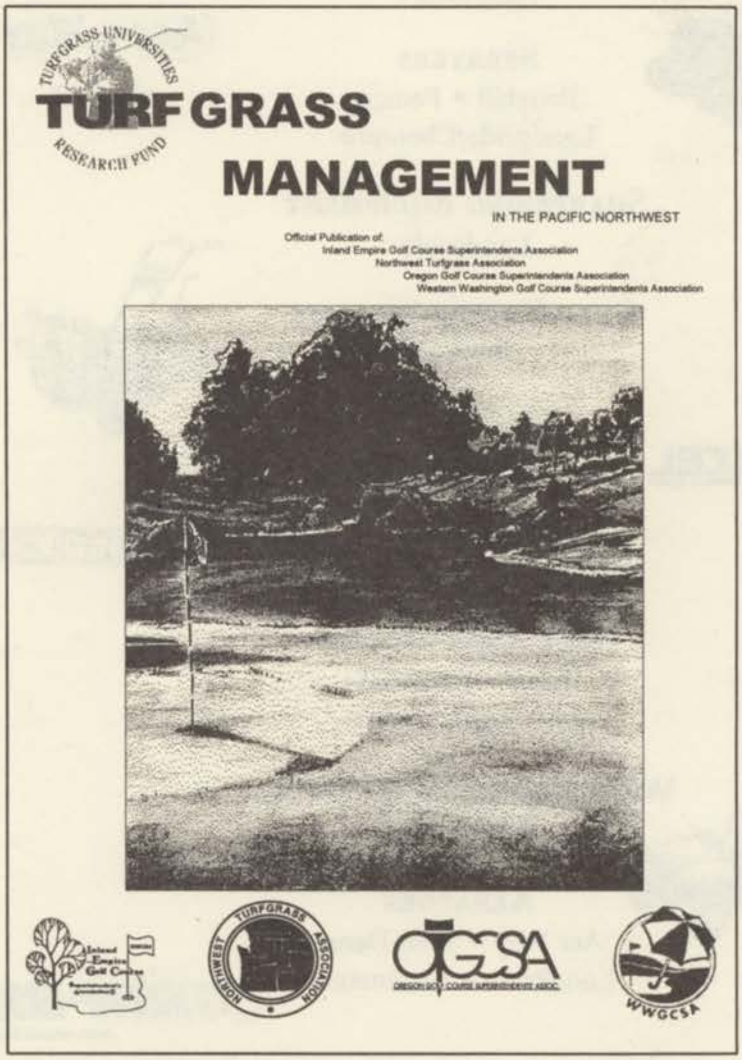
FINAL ISSUE



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PRESIDENT'S MESSAGE

Recently, It was my privilege, on the behalf of the NTA to attend the Washington State University Foundation benefactors recognition and homecoming weekend. This was a weekend in which the University honored individuals and organizations that contributed sizable gifts and moneys toward scholarships, and research. The NTA has pledged over a $100,000 toward research projects and research staff. The University highlighted the ways that our participation makes a difference.

We are helping improve learning by providing cutting edge technology. We are easing student debt through scholarships. We are improving citizens access to higher education. We are attracting top faculty, and we are targeting problem solving research. This is very commendable.

I did not accomplish this. There is no single person who accomplished this. This is a combined effort. From the establishment of the NTA in 1950, to the present there have been many members who have shared their vision and dedicated their time to providing education and information to turf managers and the community. They participated in something unique, fulfilling, and worthwhile.

I believe that participation in the NTA is a worthy endeavor, that it represents a high standard of citizenship and commitment to our profession. I believe turf managers must take an active participation in their own learning and give direction to research.

Obviously in the past few years we have built momentum and gained strong support from the Washington State Golf Association, Pacific Northwest Golf Association, and the Washington Junior Golf Association. These are organizations who's members realize the benefits of turfgrass education and research. Their participation helps make Northwest turfgrass research possible. Our members participation gives the research direction. Please, exchange your ideas and experiences, and support the NTA. I am looking forward to serving you as your President.

Sincerely,

Thomas J. McCarthy

Tom McCarthy

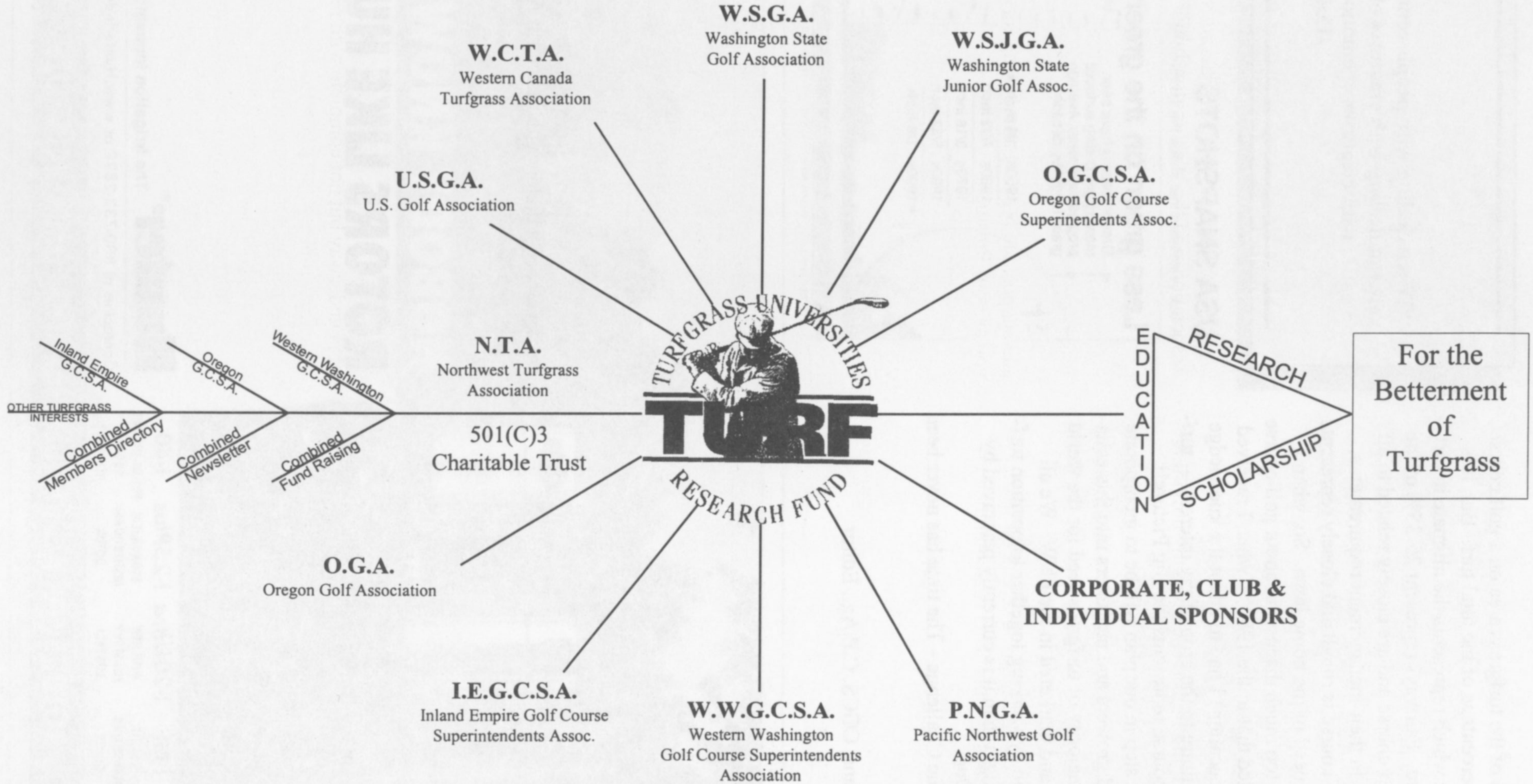
EDITORIAL COMMENT

Final Edition - The *Northwest Turfgrass Topics* has been published since February, 1959. (See page 7 for Volume 1 Number 1.) You will see front and center "Why do We Need Turf Research?" As I mature, I seem to notice more and more that the questions remain the same over time, the answers change. (Another example, in the first issue of *The National Greenkeeper*, July 1926, "Is Poa Annua Good or Bad?" by John Morley)

The Northwest Turfgrass Association was founded for the purposes of improving turfgrass management through Education, Research and Scholarship. Very little has changed! In the 1950's and 60's the focus was the turfgrass professional. As we have progressed toward the end of the 20th century we, too, have been targeted by the environmental movement - a world-wide phenomenon. It has been said, and rightly so, that the turfgrass industry will not survive as we know it by proving scientifically that we are environmentally responsible. There is a need to shift education to include the general population. To accomplish this endeavor, we need your continued support. We have made significant strides in improving communications with the 200,000+ golfers in the Pacific Northwest. These consolidated cooperative efforts are beginning to snowball. There are approximately 1000 turfgrass professionals who are members of the four turf associations in the PNW. We have begun the dialog with the 200,000+ golfers who in turn will be the message bearers to the non-golfing population. During the past four years, we have developed a dialog with the North American Turfgrass Foundation which includes Canada and all the U.S. Turfgrass Associations. This is opening the door to communications with the 25 million+ golfers in America and the general population. Additionally, the North American Turfgrass Foundation monitors turfgrass research world-wide and is cognizant of research that is underway but not complete with reportable results. Our problems and concerns are not just in Oregon or Washington, they are universal. Every sizable industry is global as we enter the 21st century.

On page 5, you will see a diagram which is a working representation of the turfgrass industry. Golf is seen by some to receive too much attention in turfgrass discussions. Historically, golf has been the driving force from which other applications of turfgrass management have been derived. Putting greens repre-

(Continued on page 6)



TURFGRASS MANAGEMENT IN THE PACIFIC NORTHWEST

sent less than 2% of the turfgrass area on a golf course — a minuscule percentage of the total turf. But, it is the green surface which represents the ultimate in turfgrass management. Fairways represent 25-35% of the turfgrass on a golf course and are closely related to all other sports turfs in their management requirements. 65-75% of a golf course is rough and closely represents the management need of the home lawn. So, when I hear that there is too much discussion about golf course turf, I am reminded that in the 1950's (when I received my agronomic education) I had to adapt the knowledge of farming agriculture to the crop of my interest — turfgrass. The golf course represents the Big Picture!!

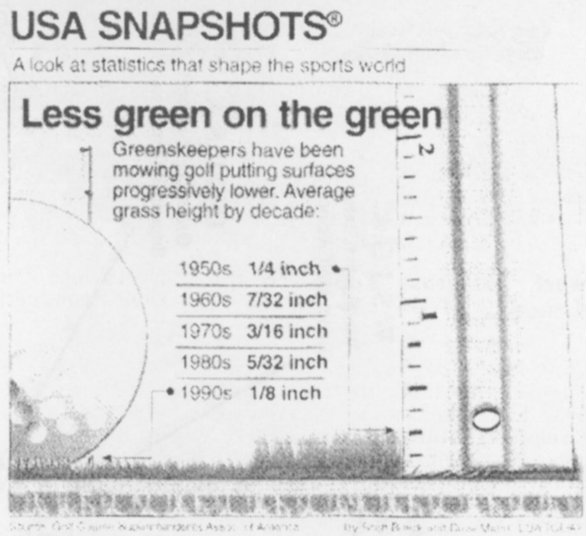
The next step in our plan will be to incorporate the turfgrass seed growers and marketers into this equation. The great majority of turfgrass seed for the world market is grown and marketed in the PNW. We all have much to gain by working together to position turfgrass in a better light than it is currently perceived by John and Mary Doe.

Accept the Challenge - The time has never been better!

Donald A. Clemans, CGCS, C.P.Ag., Editor

"When dealing with people remember you are not dealing with creatures of logic, but with creatures of emotion."

-Dale Carnegie



NORTHWEST TURFGRASS TOPICS

FEB. 1959 VOLUME 1 - NUMBER 1

D. F. ALLMENDINGER

H. M. AUSTENSON

C. J. GOULD

ROY GOSS

Northwest Turfgrass Topic To Be Published 3 Times Per Year

by Roy Goss

Various interested turfgrass organizations and individuals in the Pacific Northwest have expressed a desire to have a regular publication that would be devoted to their specific problems and interest, which is better turf. Research progress and findings in other areas cannot be accepted for par value here in the Pacific Northwest. Our climatic conditions do not permit the same management practices and, therefore, create a somewhat modified assortment of problems for the turf manager.

The ultimate goal of this paper is to bring to you the most up-to-date recommendations and research reports from this and other experiment stations which will benefit all turf workers in dealing with their problems. Since this paper will be coming out only 3 times each year, not all problems can be thoroughly discussed on a current basis, so a column entitled "Looking Ahead" will be employed to remind you of certain things for which to be "en garde".

A Calendar of Coming Events of interest to turf workers will be listed with each printing. This is an item which will be the responsibility of each one of you to bring to the editor's attention so that it is as complete as possible.

Appreciation for research grants and contributions from individuals, companies, and organizations shall be recognized in an appropriate section of this paper.

The editor wishes to encourage all turfgrass workers in the field to send in items which will be of interest to a number of people. These items should include events, new ideas, new machinery, new techniques, and successes.

This publication **NORTHWEST TURFGRASS TOPICS** is sponsored by the NORTHWEST TURF ASSOCIATION and is currently financed through funds obtained from membership dues in the turf association. Persons regularly receiving this paper will be members in good standing of Northwest Turf Association, institutions conducting turf research programs, and editors of the various turfgrass publications and journals. Persons interested in being placed on the mailing list, not included in the above categories, direct your communications to

Henry Land Sr.
Tacoma Country & Golf Club
Tacoma, Washington

Subsequent editions of this publication will be expanded and it is felt that some space could be made available for advertising of products or items by companies or individuals. The revenue from this advertising will be used to defray the costs of publishing. A tentative schedule of charges for advertising is suggested at $3 per inch of 2⅜ inch column per edition, with a maximum allowable space of 6 column inches. If a 2-column width is desired, the length would be limited to 3 inches. The minimum space would be ½ inch long. **The editor will reserve the right to limit advertising due to space limitations and other considerations.**

Why Do We Need Turf Research?

by D. F. Allmendinger

Research is the magic work of today's progress. Our rapidly changing times are based on the findings of a great many scientists, in a great many research institutions developing new ideas, new processes and new tools. Our way of life has radically changed in the past few decades, and is now still rapidly changing as a result of all this new information.

During this change, we find that the solving of one problem leads to others and the demand for, and need for, additional research is increased. Perhaps one of the greatest changes has been that our increased productive capacity has left more time for leisure activities and avocations—golf, gardening, camping, and a multitude of other activities. A large number of new homes, as well as our older homes and grounds, are receiving more attention than ever before. We have a greater interest in our surroundings. Our lawns must be well kept, our golf courses have to be not only attractive but serviceable, and our parks and playgrounds and other public areas must be made as attractive as possible.

The establishment and maintenance of turf has now become "big business." It utilizes an ever increasing portion of our land and provides employment for industry through use of fertilizers, insecticides, fungicides, equipment, and a multitude of other related products and services.

Research, of course, has made many contributions to the establishment and maintenance of turf. But as with other areas of agriculture and industry, there have developed many new problems. We want to know how to do a better job. We want to know how to irrigate, how to control lawn pests, what grasses will do the best job, how to fertilize, and a host of other things.

It is only natural that we look to research for answers to these problems. Our experiment stations with a long record of productive agricultural research are best equipped to do the job and it is to these institutions that requests for work come. Some of these problems can be handled by scientists already on the staff. Some of the information may be already available and needs only to be applied to turf problems. When the problems become too numerous or too complicated to handle in this manner, it then becomes necessary to increase the research effort.

The State College of Washington, recognizing the need for and importance of turf research this past year, agreed to establish a half time position in turf research. Mr. Roy Goss, well qualified to do this research, is now developing a research program at the Western Washington Experiment Station. His work will be augmented by work of other scientists at Puyallup and at Pullman already working on turf problems. It is hoped that a one-half time extension specialist will also be appointed to help disseminate the information as it is developed.

This program has been developed through the cooperation and encouragement of many people interested in the turf program. The financial assistance from several organizations including the Northwest Turf Association, Northwest Association of Golf Course Superintendents, and U.S. Golf Association has helped materially in the turf program and has been an important factor in the recognition of the need for this work.

While we know that the results of research sometimes come slowly, we also know that the research program already under way will provide many answers which will help all of us do a better job in providing more attractive and serviceable grounds and increasing our employment of their use.

Turfgrass Researchers At Western Washington Experiment Station

In the first edition of this paper, it was felt that an introduction on the turf research scientists at the Western Washington Experiment Station would be in order. An introduction of research scientists at Pullman will be made in a forthcoming issue. Even though most of us are acquainted through conferences and other meetings, there are a number of people growing turf who have not met their research staff.

Dr. Charles J. Gould:

Dr. Gould was born and reared in the eastern states and attended Marshall College where he earned his A.B. degree in botany in 1934. He then attended Iowa State College and received his M.S. degree in forest pathology in 1937. He was an instructor in botany at Iowa State College from 1937-1941. He joined the Western Experiment Station staff as an Assistant Plant Pathologist in 1941 and completed his Ph. D. degree in ornamental diseases in 1942. He was appointed Research Plant Pathologist in 1943, Associate Plant Pathologist in 1946, and was promoted to Plant Pathologist in 1952. He was a Fulbright Scholar in Holland for 6 months in 1951.

Dr. Gould has made many outstanding scientific contributions in the field of ornamental diseases, especially narcissus, tulips, iris, gladiolus, and lilies. He is now devoting about 40% of his time to turfgrass diseases, where he has also made outstanding contributions, 40% to diseases of the bulb crops, and the remainder to other ornamentals such as rhododendrons. Much of his work has been in cooperation with V. L. Miller, chemist, in addition to others listed herein.

Dr. Herman M. Austenson:

Dr. Austenson was reared at Viscount, Saskatchewan, Canada, and attended the University of Saskatchewan where he received his B.S.A. in 1946. He was a Saskatchewan Agricultural Research Foundation Scholar from 1948-1950, at the University of Saskatchewan, where he was granted his M. S. degree in agronomy. He was awarded assistanceship at Washington State College and continued on for his Ph. D. degree which was completed in 1951. Dr. Austenson served for 2 years at the Northwestern Washington Experiment Station at Mount Vernon as an assistant research agronomist. He then worked as an extension agronomist at Cornell University, Ithaca, New York, for 1 year and then joined the staff at the Western Washington Experiment Station in 1954.

Austenson has been in charge of hay, pasture and grain crops research programs in western Washington where the results of his work have been of great importance to farmers and ranchers in western Washington. He carried out for 4 years various tests with turfgrasses here at the Station and several cooperative programs with Dr. Gould. He will continue to work with the turfgrasses, in cooperation with Roy Goss, especially in selection, and seed production. His assistance and advice are to be greatly appreciated.

Roy Goss:

He attended East Central College in Oklahoma in 1946 and transferred to Eastern Washington College of Education in 1947 and on to Washington State College in 1948. He earned his B.S. degree in agriculture in 1950 and Bachelor of Education degree in 1951. After teaching high school vocational agriculture for 2 years at Tenino, Washington, he worked with soil, irrigation and orchard cover crop problems with the Soil Conservation Service at Wenatchee until 1955. He returned to W.S.C. to work toward his Ph. D. degree in agronomy (crops management) in September 1955, and plans to complete his degree by September of this year.

Mr. Goss was appointed to the position of Acting Jr. Agronomist at Western Washington Experiment Station in July of 1958. He is currently working as a fulltime researcher on turfgrass problems and is setting up a turfgrass research center and research program. His thesis problem since 1955 has been concerned with factors affecting turfgrass quality.

Gifts And Grants From January 1, 1958

Disease Research	
Northwest Turf Association	$ 500.00
Oregon Turf Managers Association (via N.W. Turf Assn.)	250.00
Northwest Golf Course Superintendents Assn.	718.00
U.S. Golf Association—Greens Section	1,000.00
California Spray-Chemical Corp.	500.00
W. A. Cleary Corp	500.00
American Sisalkraft Corp. (Plastic - value of)	295.00
National Blower & Sheet Metal (Tape - value of)	15.00
E. I. du Pont de Nemours & Co. (Inc.)	Fertilizers
O. M. Scott and Sons Co.	Fertilizer spreader
Agronomic	
Northwest Turf Association (Puyallup and Pullman)	$500.00
Northwest Turf Association (greens mower, Pullman)	180.83
American Cyanamid Co.	400 lbs. cyanamid
E. I. du Pont de Nemours & Co. (Inc.)	10 lbs Neburon
E. I. du Pont de Nemours & Co. (Inc.)	4 bags Uramite
Johnny Harrison (Hayden Lake Golf & Country Club)	Hand greens mower
O. M. Scott & Sons Co.	Herbicides, fungicides, and spreader

Samples of materials not mentioned above which have been contributed to research are hereby gratefully acknowledged.

A New Plastic Greenhouse Aids Turf Disease Research At The Western Washington Experiment Station

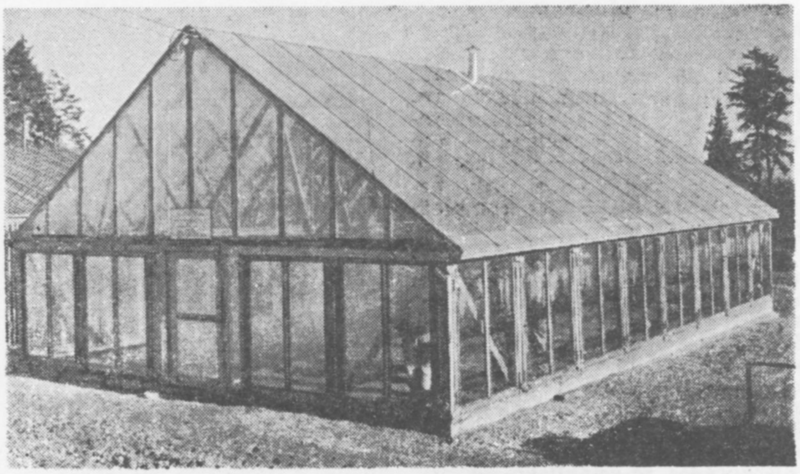
Charles J. Gould

Research on turf diseases is usually 'stymied' during the winter months in western Washington because grass growth is slow and disease development is retarded. In order to study diseases on a year-around basis, a greenhouse was needed, but none were available, nor did it seem likely that one could be built with state funds for several years. It appeared for a while that we might be able to build a plastic greenhouse with a grant from an outside source. However, it was found that this grant, for technical reasons, could not be used for building purposes. Fortunately, at that time two Northwest Turf Associations decided to underwrite the project.

The Northwest Turf Association (under the leadership of Don Hogan and Research Committee Chairman Henry Land) voted to advance $500 from their research fund so that construction could get underway. Subsequently, they contributed an additional $250, which had been donated for the plastic house by the Oregon Turf Managers Association. The Northwest Golf Course Superintendents Assn. (under the leadership of Ken Putnam, President) ran a Research Golf Tournament directed by Dick Haskell and in cooperation with the Rainier Golf and Country Club. This raised $368. Superintendent D. F. Allmendinger of the Western Washington Experiment Station also gave us $132 from his 'reserve fund' to complete certain construction. The American Sisalkraft Company donated $295 worth of Eskaylite plastic for covering. The total cost of this 25′ x 40′ plastic greenhouse with installed equipment will be about $2000, exclusive of the plastic. The total price is higher than estimated, but we have a good, solid structure that should last for many years.

This plastic greenhouse is equipped with automatic controls which enable us to have different day and night temperatures, ventilation whenever the temperature rises to high, and mist-watering at any time needed for good disease development. These controls are much better than anything we have in our regular green houses. However, we have had our growing-pains. Because of reduced light intensity, the grass does not grow quite as well as it does outdoors. Consequently, we now plan to raise the grass outdoors (with Roy Goss' help) and transplant it into the house as needed for each experiment. This procedure will also enable us to run more experiments.

The experiments will be of two types: at first, applied and later on, basic. In other words, first we plan to test new fungicides, new ways of using old ones, and the effect of var-



iou types of nutrition on control of the Fusarium Patch. Later we intend to investigate basic factors, such as the effect of temperature, relative humidity, soil moisture, and soil texture on infection and disease development under controlled conditions.

Two experiments have been run already. One experiment, with V. L. Miller, included new fungicides as well as various mixtures of PMA (phenyl mercuric acetate) plus different nitrogen fertilizers. These fertilizers were added in order to test their relative ability for decreasing the injury that sometimes occurs with PMA. We had discovered in a previous experiment at Broadmoor that one type of nitrogen was very effective for this purpose. Therefore, we were quite surprised to find in this plastic house test that some other types of nitrogen increased the injury instead of decreasing it. This type of study, as well as one on new fungicides, will be expanded in another experiment starting on February 19.

The other completed experiment was a cooperative one with Roy Goss and involved the effect of various organic and inorganic fertilizers on infection by the Fusarium Patch fungus. The fertilizers were applied in two rates at bi-weekly intervals. Unfortunately, grass growth was weak because of deficient light and excessive trampling during installation of equipment. Only meager results were obtained. It appears that for such experiments, which must last for several months, we will have to either add lights or start the turf outdoors.

We expected that it would take some time to learn how to use this plastic house most effectively. Our expectations have been fulfilled. However, we have found that it can be used very productively in preliminary testing work. It should at least double our output so that we can develop better disease control measures much more rapidly than heretofore—not only for golf greens, but for high-cut (lawn-type) turf as well.

In addition to the men and organizations listed at the beginning of the article, we wish to thank the Greens Section of the United States Golf Association for a grant of $1,000 which has enabled us to run the experiments this winter.

Looking Ahead

It is not possible to treat a great many subjects in detail with each printing of this paper, hence the idea for this column presented some favorable aspects. The intent of this column is not to bring to you a host of specific facts and recommendations but to more or less informally mention to you a few problems areas in the turfgrass field for which to be particularly aware within the next few months. — Ed.

WATCH FOR INSECTS THIS SPRING

by A. J. Howitt, Entomology

The Alfalfa Looper

The caterpillars are a dark olive green with a light colored head. There are dark lines down the middle of the back and along each side. They move in a looping fashion. The alfalfa looper is a very general feeder and can cause serious damage to golf greens. The winter is passed in a pupae and adult stages. There are two generation a year. The first generation appears early in the spring, while the second appears sometime in July.

The Variegated Cutworm

These caterpillars are general and destructive feeders and can cause serious damage to turf. The caterpillers seen maturing are usually gray or brown mottled above with gray or darkish lines. They often have oblique gray areas on the sides. This cutworm is the most widely known and important cutworm in Washington. The eggs are laid in rows in large irregular masses on the stems of plants. Like the alfalfa looper, mild winters favor outbreak of the pest.

Frit Flies

Frit flies or grass stem maggots, mine down the stem of grasses killing the central shoot of young plants and stunting older plants. The larvae spend the winter in the growing stems. Pupation occurs early in the spring with the adults emerging in May or June. The adult is a small yellowish-green fly that has three stripes on its back. The eggs are glistening white and are laid in the fall on the stems above or beneath the sheaths of the leaves. The maggot is especially serious to lawn and golf course grasses and greens. Damage often shows in the form of small irregular brownish patches.

Web Worms

Sod web worms of the genus, **Crambus**, are one of the most serious pests of golf course greens and turf. The lawn moths prefer bent and young bluegrass lawns. However, they may infest all varieties of grasses. The most reliable test for sod web worms is to apply a pyrethrum-containing solution to various parts of a lawn in order to bring the larvae wiggling to the surface. Other criteria of infestation that can be used are irregular brownish patches near which the grass is thin and uneven. An abundance of parasites and predators hovering about the turf may also indicate the presence of lawn moths. The sod web worm breeds continuously throughout the late spring, summer, and early fall.

Disease Control Recommendations—

by C. J. Gould, Plant Pathology

Fusarium Patch (Pink Snow Mold)

Apply phenyl mercury acetate (10%) at ¾ ounce in 10 gallons water per 1,000 feet every 2 weeks during "Fusarium" weather. PMAS is the type that we have generally used in our tests. As stated elsewhere, certain types of nitrogen fertilizers will reduce the injury that sometimes occurs from this fungicide. Definite recommendations will be given in the next TURFGRASS TOPICS.

Red Thread

Use nitrogen-type fertilizers. This disease is responsible for the widespread "scorch-like" appearance of lawn-type grasses in western Washington.

Management Precautions for Spring and Early Summer Consideration—

by Roy Goss, Agronomy

Irrigation

It is a fact that soil pore space filled with water has no air. Plants need oxygen the same as we do, hence too frequent and too heavy irrigations will cause this waterlogged effect. In the absence of oxygen, roots will die within a short period of time (a few days). There is good reason to suspect that starting irrigation too early and applying water too frequently has resulted in loss of roots in all turfs in the past, especially in the summer of 1958. It is strongly recommended that a critical examination of the turf soil be made (by soil sampler or knife plugs) before irrigating. Over irrigation will also result in leaching of nutrients, especially nitrates, and purging the soil with cold water, which will interfere with various metabolic activities.

Avoid Overfertilization

Some of our turfs have made a "poverty adjustment" while some are in the range of "super luxury consumption." It is known that excessive nitrogen will cause a decrease in root production which becomes apparent during the first hot spell. A balance of nutrients is the goal for which we strive, which doesn't imply that a complete analysis fertilizer must be applied each time. Soil tests and actual turf response jointly considered should be the best guide. Putting green turfs are often the overfed or "out of balance" turfs, whole home lawns and other high-cut turf are usually the underfed.

Topdressing

Topdressing mixtures high in sand (75% or more) should be ready soon for applying. Avoid the use of material that is too coarse or too fine. Unless putting greens are extremely heavy or light, the topdressing material should be as similar in composition as possible as the putting green soil in order to avoid the formation of layers. If the topdressing material to be used is sterilized (with cyanamid or methyl bromide types of sterilants), be sure to wait until the action is completed before spreading or a burn may result.

Verticutting

Remember what happened last year? Get the verticutting done early in the growing season and avoid verticutting in the hot part of the summer. "Puffy" spots appeared in many greens in May and June of last year and verticutting scalped the spots badly. Several (3 or 4) light verticuttings are always better than 1 or 2 severe treatments.

Summary Of Uses Of Neburon (Kloben), 50% Formulation, For Turf Purposes In The Northwest

by Roy Goss

The chemical Neburon, now being marketed under the name Kloben, is manufactured by the du Pont Co. Chemically, it is 3-(3, 4-dichlorophenyl) 1-methyl-1-n-butyl urea and belongs to a group of the substituted urea herbicides.

Some of the favorable aspects of Neburon are:

1. Persisists for some time in the soil (somewhat less than a year).

2. Has a high affinity for organic matter; therefore, the higher the soil organic matter, the less the injury to the grass. (Putting green soils and old lawn soils are usually high in organic matter.)

3. Residual effect in soil is not permanent, since decomposition occurs.

Some unfavorable aspects:

1. It is nonselective if the rates used are high; therefore it must be used with care as is true of most herbicides.

2. It does not dissolve in water but forms a suspension which must be agitated constantly while being used.

Chickweed, both common **(Stellaria media)** and mouse-ear **(Cerastium vulgatum).**

Apply Neburon to the chickweed any time during the season of rapid growth (May-August) or warm (not hot), sunny days (temperature 85° F. or lower). Make the applications at the rate of 4 pounds of 50% active ingredient material per acre, or 1.4 ounces per 1,000 square feet in 5 gallons of water, or 4.1 grams per 100 square feet in 1 gallon of water. (See table of measures below.)

Since spot spraying is usually all that is needed, mix just enough material to wet the leaves of the chickweed. The kill should be complete within a week if weather conditions are good.

Pearlwort, Sagina procumbens

Apply Neburon in the same manner and rate as for chickweed and observe the same weather conditions.

Individual plants of pearlwort are so small that they easily escape detection until they have multiplied into many. Therefore, it is important to extend the sprayed area slightly beyond the observed spot for complete kill.

Black algae

Algae conditions usually occur in the coastal areas of the Pacific Northwest during the wet winter months and cause a considerable thinning of the turf and promote a scummy appearing surface condition. When the immediate ground surface dries, algae residues form a thin, tough crust which discourages re-establishment of grass in these places until this crust is broken.

A complete control of algae has been achieved on the Inglewood Golf & Country Club in Seattle (Jack Spalding, superintendent), by applying Neburon at the rate of 1 pound of 50% material per acre, or 10 grams per 1,000 square feet in 5 gallons of water. Treatments were made in November and control was complete in December. One application should do the job; however, if a second treatment is necessary, it should be apparent within 3 weeks. This rate of application is very low, hence the toxicity to grass is also very low.

Table of measures for Neburon (Kloben) (50%)

1 teaspoon (level) Neburon	1.2 grams
8 tablespoons (level) Neburon	1 ounce
28.3 grams	1 ounce
455 grams	1 pound
3 teaspoons	1 tablespoon

This material is not being recommended by the company for some of these uses, hence they are not liable. Therefore, do not go beyond the rates recommended here unless you are interested in some experimentation on your own.

I am told this material is available in the 50% formulation from Van Waters & Rogers in Seattle and Spokane, under the name "Kloben".

You will find that by spraying chickweed or pearlwort when the spots are very small some grass is still present and the spots will heal rapidly, but older, large spots have eliminated the grass. Small spots will not have to be plugged out when dead, since the grass will fill in. Kill the large spots with chemical, then plug them out if necessary. This way, you are sure of getting all the weed.

Since these uses have been found for Neburon on turf, it is desirable to make this information available to interested persons in order to lick the three weed problems listed and to insure some degree of safety and accuracy in the use of the material.

Officers Of The Northwest Turf Association

Mr. Don Hogan -------- President
Mr. Glen Proctor --- Vice President
Mr. Henry Land Sr. ----- Treasurer
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NORTHWEST TURFGRASS TOPICS is sponsored by the Northwest Turf Association and financed through funds of this organization. Any communications concerning distribution of this paper or association business should be directed to Henry Land Sr., Tacoma County & Golf Club, Gravelly Lake Drive Southwest, Tacoma, Washington, or Dr. J. K. Patterson, Agronomy Department, Washington State College, Pullman, Washington.

Communications concerning **content** of this paper should be directed to Roy Goss, Editor, Western Washington Experiment Station, Puyallup, Washington.

Calendar Of Coming Events

Northwest Golf Course Superintendents Association, April (Date not announced)
Annual meeting with presidents, pros, and greens chairmen

British Columbia Sports Turfgrass Conference, April 27-28
Univesrity of Brit. Col., Vancouver, B. C. Conference theme: Irrigation Methods and Practices

Oregon Turf Managers Assn., March 2, 1959. Corvellis Country Club — 10:30 a.m.

Your Turfgrass Programs At Washington State University

Turfgrass research and extension programs were significantly increased beginning July 1, 1958, when Roy Goss was hired and assigned the task of developing the program at the Western Washington Research and Extension Center at Puyallup, Washington.

To those who may be unfamiliar with some of the previous history, a good share of credit goes to some of the early turfgrass advisory committees who help to make our present-day programs possible. People such as Henry Land, Sr., Glen Proctor, Milt Bauman, Dick Haskell and others strongly represented turfgrass interest in western Washington and impressed Washington State University administrators with the need for these programs. Prior to the hiring of Roy Goss, disease control work was being carried out by Dr. Charles J. Gould, retired plant pathologist, who was addressing problems such as fairy ring and Fasarium patch disease. Dr. Jack Meiners, USDA at Pullman, was also working on grey snow mold. Al Law and J.K. Patterson at Pullman were conducting some turfgrass research, mainly directed at eastern Washington problems. Dr. Herman Austensen and Chuck Rasmussen had initiated some research at the Western Washington Experiment Station during the mid-50's directed at putting green management and some varietal investigations.

A great deal of credit for lending strength to our present programs goes to Dr. Rod Bertramson, former chairman of the Department of Agronomy, and to Dr. Louis Madsen, retired dean, College of Agriculture, for implementing the program as it existed in 1958.

Roy Goss initiated the first concentrated research program at Farm 5 in 1958 and 1959. Large areas were developed to putting green turf research as well as lawn investigation areas. The rpincipal thrust at that time was to develop proper fertility management programs which were essentially nonexistent and everyone seemed to have his own ideas of fertilization.

The results of these investigations led to the development of the 3-1-2 ratio requirements of lawn turf for nitrogen, phosphorus and potassium and eventually a 6-1-4 ratio for putting green turf. Local fertilizer industries were very cooperative and helpful and readily accepted the research recommendations, and since that time have provided all turfgrass managers with properly formulated fertilizers for this area.

These original investigations helped to indentify Ophiobolus patch disease and nutritional means for its control through investigations with sulfur. These same investigations revealed that sulfur applications significantly reduced the incidence of Fusarium patch disease, especially when soil potassium levels were maintained at high levels, nitrogen at moderate levels, and phosphorus at low levels. After approximately five years on this type of program it was found that **Poa annua** was significantly reduced and essentially eliminated from plots receiving high levels of sulfur.

Numerous investigations were conducted jointly with Chuck Gould to determine best methods for turfgrass disease control and nutritional interrelationships with these turfgrass diseases.

Literally hundreds of tests were conducted for broadleaf weed control with standard and newly emerging turfgrass herbicides. Our programs have spanned the era from 2, 4-D only to silvex, dicamba (Banvel), MCPP (mecoprop), DCPA bensulide and other pre-emergence herbicides, and finally to endothal for the control of **Poa annua**. Quite by accident it was learned that Dacthal (CPA) served as a very effective selective post-emergence control for creeping veronica. Programs were developed as early as 1961 for the pre-emergence control of **Poa annua** and crabgrass with Dacthal (known in the early days as DAC 893) and bensulide.

Perhaps some of our greatest contribution to quality turfgrasses in the Pacific Northwest has been the adaptation, development and problem solving with respect to the use of sand construction and sand topdressing on putting greens and sports fields. We presently have hundreds of beautiful football fields where the players can play on dry turn conditions without mudholes and putting greens that can be played on exxentially 12 months per year. You don't have to be a very old golf superintendent to remember back to the days when 18 temporary greens were cut on nearly all golf courses in this area early in the season because the regular putting greens were unplayable for extended periods of time. This was due primarily to poor soil conditions with slow water infiltration and extremely poor internal drainage. Sand, although not a panacea, has essentially eliminated this type of problem.

Stan Orton, Research Technician, deserved a great deal of credit through his responsibilities in maintaining most of our turfgrass areas since about 1960. He has served not only the role of maintenance supervisor, but as mechanic and All American Mole Trapper throughout these years.

Dr. Stan Brauen became involved in turfgrass research programs, especially the verietal testing aspects in the early 1970's and has followed the program closely until 1981 when he assumed essentially full responsibility for execution of the research program. Since the demand for both research and extension work had mushroomed since the program inception in 1958, it was literally impossible for one individual to cover both research and extension programs throughout the state; therefore, on January 1, 1981, Roy Goss took over the fulltime Extension Specialist program while Stan Brauen accepted the research program. Stan has performed a super job in developing new areas of research and working closely with the research associate's program into some interesting areas that will bear useful results for many years to come. It is doubtful that anyone has more information on plant growth regulations than Stan Brauen, and he is rapidly developing excellent programs in other areas, most of which can be seen at the Turfgrass Field Days.

The terrific support shown by golf course superintendents, industry and others has allowed us to hire a research associate over 50% of the time since 1975. We now have our fourth research associate, Dr. Jeff Nus, since the inception of the program in 1975 and feel that it has been very fruitful. Our first research associate was Tom Cook, who is not at Oregon State University, followed by Dr. John Roberts, who is the Extension Specialist at the University of New Hampshire, and by Dr. John Law, who is with a major lawn care company.

Dr. Gary Chastagner succeeded Chuck Gould in the Plant Pathology position and has been very productive in continuing work on Fusarium patch control and more recently with identifying and developing controls for Necrotic Ring Spot, formerly called take-all patch-like disease.

Dr. Bill Johnson is a welcome addition to the faculty on the main campus at Pullman and is conducting the teaching program for turfgrass management as well as research for the eastern Washington area. Bill has some very good programs coming and has developed some fine students, some of whom are out in the industry today.

It wouldn't be fair to close without saying that Diane Ritthaler, secretary to our group at Puyallup, has been most cooperative and efficient in helping us with all programs and her contributions toward the Northwest Turfgrass Association. Roy Goss has served as Executive Secretary since 1963, and without

Diane's help and support, the position would have been difficult to say the least.

I feel confident that with your continued support, criticism and encouragement that there will be few places in North America who can demonstrate a stronger research and extension program than we have here in the State of Washington. I would be remiss if I didn't point out that the golf course superintendents, to identify one single group, have been most instrumental in helping to develop the program and its support, and to you we owe our sincere thanks.

Finally, the Northwest Turfgrass Association, with its dedicated officers and directory over these many years, can take a great deal of credit for making your turfgrass research and extension programs what they are today. They really don't get much credit except a self-fulfillment for a job well done. To all of you past and present, our sincere thanks.

Sam Zook: A Professional

By Andy Soden

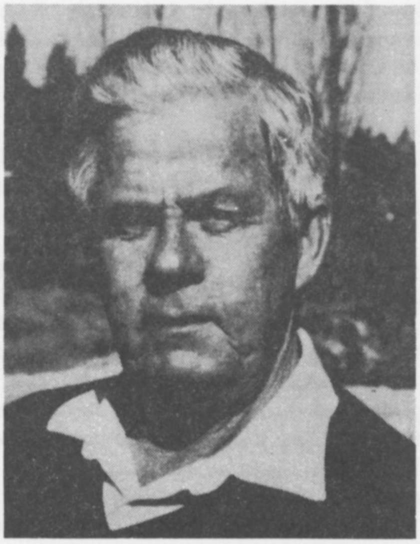
As many of you already know, early next year will mark the close of a career in golf course maintanence for Sam Zook, presently the golf course superintendent at Overlake C.C..

Instead of writing an article at this time of a biographical nature, this author wishes to reflect on an observation of one man's approach towards being respected by his employers and peers as a professional.

In the short time that I have know Sam Zook and been associated with him personally and professionally, I can think of few other men who typify the professionalism necessary in our field. Never once have I observed him out of dress with a situation. Although a job can be done without the attire, a professional always looks good doing it. Never once have I witnessed him critisize a situation without more than enough reason. With the room our profession leaves us for frustration, a professional can leave most of it for behind closed doors. Never once have I seen him treat another man different than he would have liked to be treated himself. Perhaps more than any other trait, an attitude such as this helps the man who wants to be a professional be treated as one.

We know from common knowledge that Sams' career started back when the "greenskeeper" was not regarded as a professional. Many men such as him were regarded as laborers in charge of the green. Through the efforts over the years by Sam and his peers, we who serve as golf course superintendents today have gained the level of recognition that these men have built. We owe them the thanks to continue to build upon their efforts in a continuing direction of professionalism.

I take this opportunity, Sam, to say that I will miss you very much. I count the conversations I have had with you, both personally and professionally, as special times in my career. You have always had a realistic attitude towards the obstacles we face in our profession, and to coin your terminology, "sadly" your career is coming to a conclusion. We will all miss you, but are wishing you and your beautiful wife a long and happy retirement. Best of luck to you both.



Sam Zook Retires

By Milt Bauman

Sam started working on golf courses as a caddy as soon as he was big enough to carry a golf bag. He then went to work on the Greens Crew at Columbia Edgewater in Portland, Ore. in 1938, his beginning in this business.

Sam and Gerry were married in 1938 and had two sons and a daughter. At the present time they have ten grandchildren.

Sam worked at the Columbia Edgewater until he went into the Navy during World War II. After the war, Sam returned to work at Columbia Edgewater. In 1947, Sam became Greenkeeper at Pendleton Country Club. In those days we were called Greenkeepers - the name Golf Course Supts. was introduced in the 1950's.

In 1948, Sam attended the Northwest Turfgrass Association Conference in Pullman, Wash. When the N.T.A. was incorporated, Sam became a charter member. He also belonged to the Oregon Greenkeepers Assoc. In 1951, Sam accepted the job as Supt. at Eugene Country Club and stayed there until 1953, when he became Supt. at Waverly Country Club in Portland, Ore. While at Waverly, Sam joined the GCSAA, attending all of the N.T.A. conferences and most of the GCSAA conferences. Sam remained at Waverly until 1968, leaving to become Supt. at Overlake Golf and Country Club at Medina, Wa. Sam will retire December 31, 1984.

Sam is a true professional, and has served well in many areas. He has been an effective leader, serving as president of local Golf Course Associations as well as the N.T.A. Whether on the local or national level, Sam has stood up to be counted when something was not right.

Sam and Gerry have not been without adversity. Their son, Sam Jr., a career Navy man, passed away several years ago. Also, Sam has had some health problems that he has overcome. Through both good and hard times, Sam has always been cheerfl and very positive in his attitudes.

Sam and Gerry's son, Frank, was a Golf Course Supt. at Green Meadows Golf Course, Willamette Country Club, and Hi Cedars Golf Course. Frank is presently in a firm with Stan Baily and Eric Marston, who sell and service turfgrass and golf course equipment out of Portland.

Sam Zook, we salute you for a job well done! We wish you and Gerry well in your retirement!

Canada Geese Control

Patrick Lucas, Innis Arden Golf Club,
Old Greenwich, CT

The purpose of this article is to discuss some of the problems Canada Geese are causing, and to share some of the lessons I've learned in controlling them. With the onset of fall, migration south of Canada Geese will commence once again. Originally, most Canada Geese were migrators, using corridors or flyways for travel, going south in the winter and coming back north in the summer. We here in the Northeast are located on the Atlantic Flyway, where some one million birds migrate annually.

Today, Canada Geese can be placed in two categories. The first are the migrators, or those Canada Geese which still migrate annually. The second category, our "resident" geese, are those geese who have stopped migrating and stay in one location yearround.

The numerous problems caused by large flocks of Canada Geese include eating fine turf to a stubble, making reseeding necessary; the drippings they leave behind are unhealthy, ruin the grass, pack mowing equipment, and make putting impossible; and, they leave feathers in the water. If the lake or pond they are inhabiting is used for irrigation purposes, eventually, their feathers can clog irrigation suction line strainers.

Why are Canada Geese invading our golf courses and public parks? To answer that, let's look at some of the basic requirements of Canada Geese or what I refer to as their "drawing cards". The first is FOOD and what could be more tasty than our tine turf? The second requirement is WATER, needed for drinking, landing, protection, and sleeping. And the last requirement is PROTECTION, or relative safety from being hunted.

Does your course offer these "drawing cards" to Canada Geese? If the answer is yes, than your course can become a resort . . . for Canada Geese.

Your geese removal program must concentrate on altering these conditions which brought Canada Geese to the area in the first place. The most important factor in your geese removal program will be TIMING. The longer Canada Geese are allowed to inhabit an area, the more comfortable they will become, and the harder it will be to get them to leave.

Let's look at water, remembering what water is necessary to Canada Geese for:

a. Drinking
b. Landing
c. Protection
d. Sleeping

Your goal will be to make your lake or pond look unwelcome from the air. Some of the ways in which this can be achieved are:

WIRE GRIDS: Wires can be strung across the lake a grid-like pattern about 14 to 18 inches above the water level. (see figure I) This will effectively deprive Canada Geese of using the water. If the span is great, use floats as needed for midway support.

ROPE OBSTACLES: Yellow rope can be strung between high trees, across favorite flight paths near the body of water. Keep the ropes somewhat loose to sway in the wind. This will create obstacles in what used to be favorite landing and taking off flight paths.

Consider using the various scarecrow devices:

BLACK FLAGS: The Fish & Wildlife Service reported on the use of a flag-like device made from a black plastic trash bag fixed to a tall pole to deter geese from feeding at their ease. It is said to work especially well in grain fields in the midwest. The Service notes that geese don't like to feed in areas where they sense a treat from overhead, whick is what the fluttering "flag" represents to them. These could be installed in and out of play areas, or even in the pond itself.

SWAN SCARECROWS: Swan families and their babies (or cygnets as they are called) are vicious to Canada Geese and most Canada Geese are aware of this. Consider using replicas of swan families as "floating scarecrows" to deter Canada Geese from landing.

Lastly, consider the aspect of safety and security. Canada Geese are smart, staying close to metropolitan areas to avoid being hunted. This protective "comfort zone" which they enjoy must be removed.

If you have Canada Geese, you can remove thier "comfort zone" and get them to leave at the same time by using what I call the HUNTER AMBUSH APPROACH. Your goal is to make the Canada Geese feel they are genuinely being hunted and that their welfare is being threatened. A point to remember: this is not a form of harassment which probably the geese have had to contend with in the past. This si an entirely different approach which makes them feel their very survival is threatened. Here's how to do it:

You will need a loud blank gun and a trusted member of your crew as your "hunter". Have the hunter stalk the feeding geese either early in the morning, or at dusk, slowly creeping up on them, inch by inch. It may take the hunter 15 or 20 minutes to cover say about 200 yards as he approaches the flock, during which time several things will begin to happen.

The first and most obvious is that the sentinel or lookout geese will begin to look in the direction of the approaching hunterm Next, the majority of the flock will begin to stop feeding and "aim" in one direction. All this time the hunter is getting closer to the geese. As they become more nervous, the geese will begin to squawk and flap their wings, because someone or something is approaching them in a way which is strange and unfamiliar. It is exactly at this point that they are ready to go and the hunter (very close now) should begin firing. Or, at any time during the day that the geese are observed attempting to land, the hunter should begin firing when their wings are lock-in on their approach.

The library of Natural Sounds, Laboratory of Ornithology at Cornell University in Ithaca, New York has available a cassete audio tape of Canada Goose distress call. Consider using it in conjunction with your "HUNTER AMBUSH APPROACH" for greater effect.

Once properly done, you will receive another bonus besides getting the geese to leave. Research has shown that Canada Geese are unlikely to return to a spot where they have been ambushed.

Remember, when Canada Geese fly over they look for "signs", signs below telling them everything is all right, it is okay to land. Other waterfowl (ducks, egrets, kingfishers, etc.) are such signs and must be frightened away. We want our lake or pond to look unwelcome from the air.

Clean out all brush areas which have been favorite nesting grounds in the past. Once the geese have nested in the spring, it is very difficult to get them to leave.

In closing, success can be achieved by a combination of understanding the basic requirements of Canada Geese and implementing a program of action.

Anyone wishing further information, your local library is an excellent source along with your state Fish & Wildlife Bureau.

Assumption: An Attitude

By Andy Soden

It is common knowledge that the word "assumption" defines a thought process that is rarely of value. Defining a loosely held agreement, usually from one's personal point of view, assumption more often than not leads us in the wrong direction. In assuming, we have all hears what it usually makes out of "you and me".

Why, then, is it such a difficult thought process to escape? Why do we time after time fall into assumption's trap?

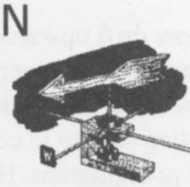
I have personally asked myself the above questions many times during my career. I can remember back to my days as a night waterman when I gave myself the evening off because I assumed it would rain. I can look back to my days as a greenkeeper when I skipped raking the traps on a few holes because I assumed they looked good enough at the time. And I can recall just a few months ago that I neglected to reseed a certain project because I assumed the initial seeding would catch adequately.

For me assumption is the product of attitude. More descriptively, the easier out through self-rationalization that things will work out okay. More simply, occassional laziness.

Involved in an occupation such as ours, the need to perform in an environment dictated by our golf courses' inherant characteristics, our bugetary guidelines and our memberships' needs leaves little room for error. How often has assumption caused you grief in your relationship with your green chairman? How often has mother nature called your bluff?

Let's do away with this dirty word in our vocabulary. As professionals, we can all seek better thought processes as an avenue towards succes.

IS THE WEATHERMAN ALWAYS WRONG?



DR. TERRY GILLESPIE,
UNIVERSITY OF GUELPH

Weathermen are constantly criticized and bear the brunt of numerous jokes because the weather at any given hour in the day is not what the radio or TV said it would be. Are they so off base, or is there a reason for their apparent errors?

In most cases the answer is timing. Weather systems are constantly moving in a generally west to east direction, but their rate of movement is subject to change. They may speed up or slow down, intensify or dissipate. The weatherman is not always able to estimate these underlying factors accurately so rain forecast for this morning may not arrive till late afternoon or light showers may turn into steady drizzle.

Understanding the way weather systems move and how to interpret local signs by observing wind direction, cloud patterns and temperature will enable you to adjust the timing of the forecast for your locale and thus adjust your turf management program. This article describes the basics of weather systems as they affect the local weather.

The "prevailing westerlies" that emerge from a description of global-scale circulations are, in reality, a sequence of traveling pressure cells (see Figure 1). These cells are delineated and tracked by drawing lines called *isobars* which join together locations with equal *(iso)* barometric *(bar)* readings on a *ground level* weather map. The resulting pattern is a series of distorted "bull's eyes" that are labeled as having relatively high (H) or relatively low (L) pressure at their centers. By observing several weather maps in a series, we discover that these cells normally move with a strong west-to-east component. Also, a glance at a home barometer suggests that lower pressures accompany "stormy" weather, while higher pressures suggest the weather will be "fair". To understand why these relationships hold, let's begin by examining individual pressure cells in more detail.

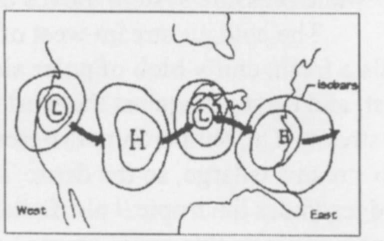


Figure 1: The regular progression of high and low pressure cells from west to east in the prevailing westerlies.

The near-surface pressure cells are mainly a feature of the lowest 4 km of the *troposphere* (from the Greek for "turning sphere"), which is a layer which extends to about 10 km above the earth. In the troposphere the average temperature *decreases* with elevation. "Weather" is confined to the troposphere because more than 90% of the world's water vapor lives in the layer, where it undergoes phase changes from gas to liquid or to solid that we experience as clouds and precipitation.

Our discussion will venture very little into the next layer, the stratosphere, which extends from 10km to 50km above the earth. Surprisingly, this layer warms with elevation. The warming results from absorption of ultra-violet solar radiation by the stratospheric ozone, which protects life near the earth's surface from the damaging effects of this radiation.

Low and High Pressure Cells

Figure 2a shows the wind pattern for a stylized low pressure system. Air moves in a gigantic, counter-clockwise, inward-spiraling pinwheel. Intuition might suggest that air should flow directly into a hub of low pressure like the spokes of a wheel, but this expectation is modified by the spinning of the earth. We must recall that we are observing the weather as we ride on a huge merry-go-round named Planet Earth. If you were to pitch a ball from the center of a merry-go-round directly toward a catcher riding on the outer edge, the catcher would perceive that the ball had traveled a curved path which caused the ball to fly by behind him. In reality, the ball took a straight path and the catcher moved, but an observer stuck to the merry-go-round sees the motion as a curved path. You would also miss your target if you threw a ball from outside of a merry-go-round directly toward the center, or from the outside toward another person sitting on the outside, but one-quarter of the circle ahead of you. Weather observers are stuck to the spinning earth, so we perceive the air motions (the wind) as curved trajectories which always twist to the right when we stand with our back to the wind.

What becomes of the air that makes its way toward lower pressure? It cannot escape through the ground or disappear, so the inward spiraling must have

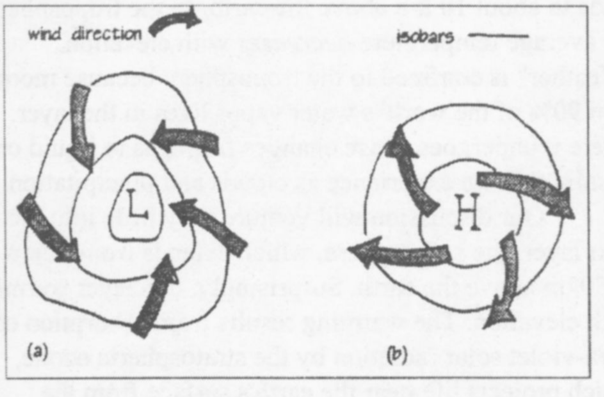


Figure 2: Winds spiralling counter clockwise into a low cell and clockwise out of a high cell.

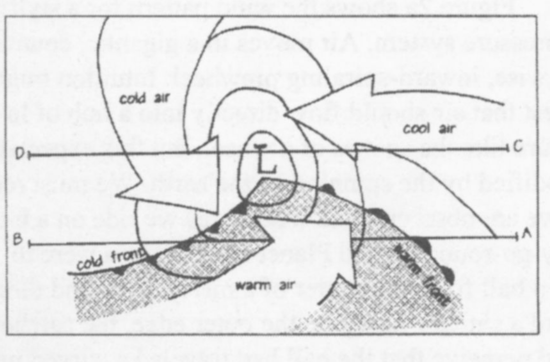


Figure 3: Air streams in a low pressure cell.

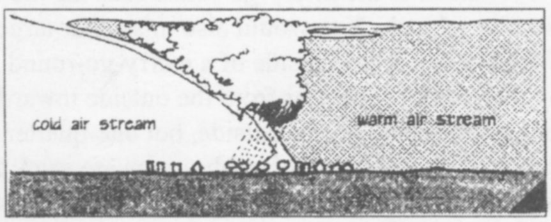


Figure 4: A cross section of a typical cold front that pushes under a warm air mass, forcing the warm and lighter air upward, resulting in condensation, cloudiness and precipitation (often heavy storms) as the air is rapidly cooled.

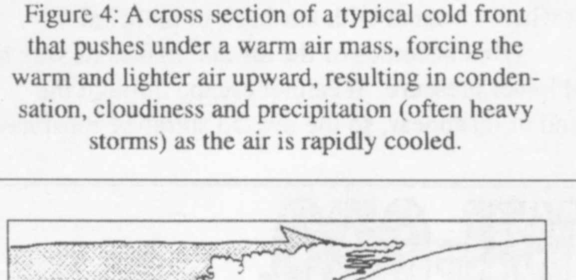


Figure 5: A cross section of a typical warm front overriding cool air resulting in cloudiness and precipitation.

a slow drift upward. Whenever air drifts upward, it encounters ever lowering pressure, and therefore expands. Expansion is a cooling process, and eventually this cooling results in condensation which produces cloud and precipitation. Here we have discovered a fundamental rule of meteorology ... *unsettled weather* is *associated with regions of rising air*.

If air is constantly spiraling out of a region of high pressure near the ground (Figure 2b) where does this air come from? You may have guessed by now that this pressure system must be accompanied by a slow downward drift of air, which results in compression because the pressure increases as the ground is approached. Compression produces slight warming, which discourages condensation and suppresses cloudiness. *Settled weather is associated with regions of sinking air*.

Air Streams and Weather Fronts

The winds near the ground in a typical low pressure cell can be seen as three air streams (Figure 3). A *cool air stream* rides in on the easterlies ahead of the cell's center, accompanied by vigorous pressure (barometric) falls as lower pressure approaches. A *warm air stream* flows up from the south. Moving west of the cell, we find strong rising pressures bursting in from the northwest on the wings of a *cold air stream* as the whole pressure system moves off toward the east.

The cold air stream west of a low pressure cell pulls a fresh, chilly blob of polar air out of the northwest, and drives it against the west flank of the warm air stream. The temperature difference between these two streams is large, so the dense, heavier polar air wedges under the tropical air. Enhanced vertical lifting occurring along this collision zone usually results in a band of aggravated weather. In summer we see showers from heavy *cumulus* (lumpy) clouds, or even thunderstorms from *cumulonimbus* (lumpy and dark) clouds. In winter, precipitation is from less vigorous *nimbostratus* (dark and layered) clouds. Crossing this zone results in a quick wind shift into the cold air stream, so it is called a *cold front* (Figure 3). Figure 4 illustrates the undermining and lifting of the warm air mass as a cold front approaches. The cool air stream typically brings *stratocumulus* cloud (a layer of lumpy cloud). Check any introductory weather text for pictures of cloud types.

The east winds of the cool air stream in advance of a low pressure cell do not tap the depths of the polar air. Therefore, when the warm air stream attacks the south flank of the cool air stream ahead of a low cell, only sometimes is there a sufficient temperature contrast to form a front. If the contrast is strong enough, warm air will slide up over the cool, and this lifting will provide additional cloud and precipitation. The typical cloud sequence starts with wispy *cirrus* (mare's tails) followed by *altostratus* clouds (middle level of troposphere and layered, produces "ground glass sun") and then precipitation begins to fall from nimbostratus clouds. The zone where the flow shifts from the cool to the warm air stream is called a *warm front* (Figure 3). Figure 5 illustrates the rising of the warm air over the cool air mass and the resulting cloudiness and chance for precipitation.

A strong low pressure cell may collide the warm air stream vigorously with both the cold air west of the cell, and the cool air to the east In this case, the enhanced cloud and precipitation caused by both fronts will be clearly visible on satellite images. Sometimes only a cold front is visible because the contrast between the cool and warm air streams is too weak.

High pressure areas, with their *outward spiraling winds,* push air mass borders away from their centers. Thus, fronts do not generally exist in the heart of high cells. A high cell is typically tucked into the burst of polar air behind a strong low. From that location, the eastern half of this cell feeds the cold air stream of the low to the east, while its western half blends into the cool air stream of the next low to the west (Figure 6).

As a cell of low pressure with well developed cold and warm fronts moves by to the north of your location, the resulting sequence of weather events can be seen by following along line A-B in Figure 3

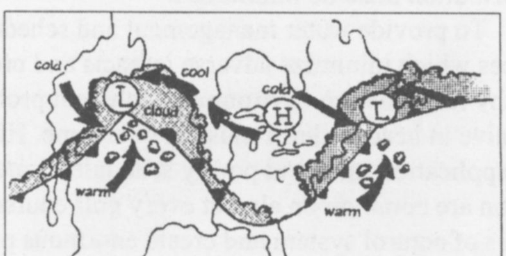


Figure 6: A typical weather map showing the highs and lows, areas of cloudiness and potential precipitation and the wind direction.

(remember you are stationary while point A in the weather mass moves east until point B is over you). Easterly winds of the cool air stream at A will be accompanied by increasing cloud and a falling barometer. Precipitation is likely as the warm front approaches, but this will diminish or cease as the warm front passes and you note a shift to warm southerly winds. After a period in the warm air stream, the cold front will approach with its band of heavy weather. Then the cold air stream will bluster from the northwest and the pressure will rise quickly. As the low cell moves eastward and is replaced by higher pressure, the weather will settle by the time position B is reached.

If the low cell moves by to the south of your location, you will travel along line C - D in Figure 3. Cloud and precipitation will develop in the cool easterly air stream as the system approaches. Gradually the wind will back around to the northwest as you blend into the cold air stream, but you will never enjoy the warm air mass which is confined south of the fronts. Finally, higher pressure will settle the weather again as you approach position D.

Reprinted by permission. Sports Turf Manager, September 1997, Guelph, Ontario, Canada

NEW LAW PROTECTS VOLUNTEERS

GOVERNMENT RELATIONS -Organizations across the country that depend on volunteers are celebrating the passage of the Volunteer Protection Act, which President Clinton signed into law in June. The new federal law allows nonprofit organizations, such as GCSAA, affiliate chapters and other alliances, to reassure individuals that they do not expose themselves to personal liability when they volunteer to serve on boards of directors, committees or in other leadership positions. The law provides that volunteers will not be liable for any harm they cause if they are acting in the scope of their volunteer activity. It does not cover a volunteer whose misconduct is willful, criminal, grossly negligent or reckless, or who causes harm while operating a vehicle. While some states already have laws protecting volunteers, the new federal law will usually apply instead if it provides greater protection.

While the law removes the risk for volunteers, it does not mean that an organization can do without insurance that provides liability protection. The law reduces the likelihood that lawsuits will succeed, but it cannot stop people from suing. Having liability insurance that covers legal fees for defending against lawsuits is still important.

Studies have shown that some people do not volunteer because of the fear of being sued by people who claim they have been injured by the activities of the volunteer organization. Many professional associations and other volunteer organizations worked for 10 years to get this legislation passed to remedy the situation and encour-

Obituaries

Earl Morgan

We have lost a very dear friend. Earl Morgan, Owner and operator of Similk Beach Golf Course, between Mt. Vernon and Anacortes, Washington died in late October. Earl fought a severe heart condition for many years, but you would never know it, if you saw him work on the golf course and club house. The golf course, his wife Betty and daughters were his life.

For many years, Earl and Betty not only ran the golf course, but operated an oyster growing and processing business until recent years. As Earl's health grew worse, Betty and daughters took over more of the responsibilities. Similk Beach Golf Course is a busy and popular course and fun and challenging to play.

Earl was a long term member of the Northwest Turfgrass Association, served on committees, board of directors, and was President 1979-80. Earl and Betty rarely missed a turfgrass conference.

When you visited Similk Beach Golf Course, you were always welcomed with genuine hospitality.

Our sympathy goes out to Betty and family.

Dr. C. Richard Skogley

We were saddened to learn recently of the death of C. R. "Dick" Skogley. Dick was a retired agronomist, University of Rhode Island, birthplace of modern Turfgrass Science. He conducted both teaching and research programs at Kingston, Rhode Island.

Among Dick's many accomplishments was his work in developing the putting green bentgrass cultivars, Kingston Velvet Bent, Exeter and Providence. He was held in high esteem throughout the turfgrass industry including bentgrass seed growing areas in Oregon.

For his 40 years of contributions to turfgrass management, he received the USGA Green Section Award in 1992. A comment made by one of the people nominating him for this award was, "Dr. Skogley is a gentleman, a scholar, and a soft-spoken, compassionate individual who loves the game of golf and the turf on which it is played." He was also honored by golf course Superintendents Associations throughout the northeast for his many contributions.

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CENTRAL CONTROL METHODOLOGY FOR GOLF COURSE IRRIGATION SCHEDULING

By: David B. Beck, P.E., David B. Beck & Associates, Inc., Ann Arbor, Michigan

Over the past 20 to 30 years, irrigation on golf courses has made many strides toward providing an optimum growing environment for turf and landscape ornamentals. Thirty years ago, irrigation was labor intensive, offering little control over distribution or depth of application[1]. Innovations in sprinkler technology, pump and pump control technology, electronics, and now computer applications have transformed golf course irrigation into complex and expensive water management systems which when taken to the extreme, can operate with almost no human input. However, the majority of installed golf course irrigation systems use valve in head technology with non-computerized central control - essentially 70's and early 80's technology. Inherent problems plague these golf course irrigation systems and result in poor growing conditions, drainage problems, wasted water and power, not to mention endless management headaches for superintendents. With all the responsibilities of a superintendent, additional problems caused by improper irrigation scheduling and water distribution must be minimized.

To provide water management and scheduling practices which minimize adverse impacts and promote a healthy turf growing environment, inherent problems with valve in head systems must be overcome. High water application rates and poorly scheduled water application are common on almost every golf course regardless of control system and create enormous problems with turf cultivation and course playability. Typically, sprinkler application rates for golf course systems are in the neighborhood of 0.6 inches of water per hour while soil intake rates are much less, in many cases, as low as 0.10 inches per hour[2]. Symptoms of the high application rates can most readily be seen on courses with mounding and sloped areas. Tops of mounds and side slopes are always dry while low areas are always wet and many times swampy. In most cases, these wet and dry areas are sometimes blamed incorrectly on differences in water use by the turf. In reality, turf water use between tops of mounds and bottoms of mounds is relatively the same instead the applied water moves off the slope before it has a chance to infiltrate and accumulates in the low areas. These low areas can remain marshy for many hours or even days after irrigation and in some extreme cases the low areas may never need irrigation due to irrigation and rainfall runoff moving from higher locations on the golf course.

Due to the nature of the systems and not necessarily the irrigator, problems associated with high application rates are common on most golf courses. The results are problems not generally associated with irrigation including improper drainage, diseases, fertilizer leaching, weeds, etc. Luckily, high application rates are easily overcome by simply and slightly changing water application and scheduling methods. By changing the method of irrigation application and without spending a dime on additional equipment, dramatic improvements can be seen in turf quality. Poor irrigation scheduling is common on golf courses due to lack of water use information. Currently, instruments such as weather stations which measure turfgrass water use are found only on high end course due to their relatively high cost. The majority of superintendents are left to guess on plant water use. If the guess is high, the course gets wet, if the guess is low, the irrigator may have to play catch-up and further complicate the effects of high application rates. Several low cost methods for estimating evapotranspiration (ET) or plant water use are available with instruments such as the ET gage, computer software, and local extension and agricultural services. All golf course superintendents should have a reliable source of daily water use information on which they base all irrigation decisions.

What techniques can be employed to minimize the low intake rates of soils and the high application rates of sprinklers? The most obvious is to reduce application rates so that they either match or are below soil intake rates. Manufactures are developing sprinklers which provide application rates which more closely match soil intake rates[3]. However the new sprinkler technology will only be available for new installations or complete systems replacements, therefore, water management and scheduling techniques must be employed on existing systems. By using a phenomena of the soil wetting curve[4567] , resourceful irrigation management can dramatically improve water distribution efficiency. Soil water intake rates are not constant but are relatively high when a soil is dry and become lower as soil moisture increases. Cycling techniques (the use of multiple start times) take advantage of the higher initial intake rates. Irrigation systems can be set up with cycle times to apply 1/3rd or 1/4th the normal application of water and use multiple start times to provide the required total depth. As an example, if sprinkler run-times for a course are 20 minutes per irrigation, use 5 minutes on the field satellites and use 4 start times on the central controller. Estimate the depth of application for that 5 minute run time. If the sprinkler application rate is .6 inch per hour (typical for a valve in head system), 5 minutes of sprinkler run time translates to approximately .05 inches per cycle. Now daily applications can be regulated through the number of start times at the central controller. If daily water use is .20 inches of water, use four start times to apply that depth of water, if daily water use is .10 inches use two start times. System balancing will be required. Balancing refers to matching water application depths to areas throughout the golf course i.e. south slopes have higher water use rates than north slopes. All adjustments to balance the irrigation system are made at the satellite station level. Adjust the run times at the field satellite to compensate for areas of high water use, and areas for low water use. Simply move individual stations run times up or down as required for the turf conditions being irrigated. Areas such as south slopes will require more water due to a more direct sun angle and sprinklers will require longer run times while areas such as north slopes and drainage swales will require less sprinkler run times. The balancing process may take up to a full season to achieve, but once the system is balanced, very rarely are further adjustments necessary since areas such as south slopes will almost always required more water than north slope areas regardless of daily weather conditions. All daily and seasonal water adjustments will be made by the central timer.

The total time required to irrigate the golf course will be the same or less than with non cycling techniques[8]. Remember, even though 3 or 4 start times are used, station run times are one third or one fourth of previous run times so less time is required to step through the controller. To calculate when to set start times, add all the station times on a field clock, 5 minutes per station times 12 stations per controller is 60 minutes. Since your irrigation system probably will not handle the flow required to operate all controllers at one time start half the controllers at 10:00p.m., they will finish at 11:00p.m., start the second half of the controllers at 11:00p.m., they will finish at 12:00 am, start the first half again at 12:00 a.m. and so on until 6 am when .2 inches of water will be applied. (This is an example only; actual water application may be more or less based on an individual system's location, and water use requirements.) Now look at what has effectively happened to the application rate. If we add .05 inches of water at 10:00, the next .05 inches isn't applied until two hours later. We have now reduced our application rate from .6 inches per hour to .025 inches per hour.

In Pacific Northwest, water use rates vary dramatically from day to day. As mentioned earlier, all daily and seasonal water adjustment will be made by the central timer. Each afternoon during the irrigation season the superintendent needs to make a decision as to how much irrigation will be required for that night: Irrigation is always a replacement of soil water used since the last irrigation or rainfall. There are many instruments and sources of water use data which can help in making the irrigation decision. Once obtained, depth of application can be regulated to match seasonal and daily water use requirements by changing the number of cycles or start times. During a cool period use one or two cycles, during a hot period use three or more cycles. Simply changing number of cycles to regulate depth of application instead of station run times. A second and more preferable method may be to skip one or more nights between irrigations and apply the maximum number of cycles to replace the soil moisture. Remember field station run times remain the same unless an individual area is wetter or dryer than the rest of the course. On a golf course all daily adjustment takes place at the central controller with number of start times or days between irrigation while all differential water use on the course is compensated at the field controller. If the system is unable to keep up with the water use during the peak irrigation season, simply add one additional cycle to the irrigation which will result in an increased water window. By changing the satellite timing and running more sprinklers longer, the irrigation system will over tax the hydraulics resulting in more problems such as low pressure and sprinkler donutting. The proper way to exceed an irrigation system's designed total application of water is by extending the water window. However, with improved irrigation techniques, irrigation efficiency improves and the water window decreases because less water is required and smaller run times are used.

This cycling method of applying water is a powerful tool to the superintendent and basically emulates the control offered in modern computer controllers. It was the concept conceived during the development of the first golf course central controllers in the 1960s[9]. Almost all non-computer centrals have a multiple start feature. Although this technique cannot overcome irrigation problems related to poor system design or installation, implementing this technique will improve many poor coverage problems and wet and dry areas. Another benefit of cyclic irrigation is that the wind seldom stays at a constant speed or direction for an 8 hour irrigation period [10], cycling technique allows water to be pushed around in many different directions resulting in a more uniform sprinkler coverage.

If the symptoms of high application rates and

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improper management of daily water application are prevalent on your golf course, try this simple technique, it works! It may require one irrigation season to properly balance all the stations on the golf course but immediate results will be seen upon its implementation. Divide current station times by three, use the new time as your station time and set 3 start times on the central controller. Start cutting back on the water you apply, in most cases you will find that overall depth of application will be significantly less resulting in lower water costs, lower power costs and an improved growing environment for the turf[11]. Try this technique on one central clock, convert all satellites to the cycling, once you feel comfortable with the technique and you see the improved turf and playing conditions convert the rest of the clocks.

1. Hunter Industries. Innovations in Irrigation. Product Literature 1992

2. Pair, C.N. 1983. Editor in Chief, Chapter 4 Soil-Water-Plant Relations, Irrigation, The Irrigation Association.

3. Beck D.B. "Future Developments in Golf Course Irrigation". *Golf Inc.,* March 1993 Volume 2 Number 3.

4. Duble, R.L. "Water Management on Turfgrasses". Plant answers Web Site, Texas A&M University URL: http://aggiehorticulture.tamu.edu/plantanswers/turf/publications/water.html

5. Corey,A.T. "Mechanics of Immiscible Fluids in Porous Media". Water Resource Publications 1986. Chapter 2.3 Dependence of Saturation Upon Capillary Pressure. Page 35

6. Schwab, GO. ,Frevert, R. K., Edminster,T.W. ,Barns, K. K. "Soil and Water Conservation Engineering" John Wiley & Sons 1981. Chapter 3.5 Predicting Infiltration. Page 53

7. Jensen, M.E. "Design and Operation of Farm Irrigation Systems" American Society of Agricultural Engineers 1983. Chapter 12.3.4 Soil Infiltration Characteristics. Page 454

8. Beck D.B. "ET Scheduling Simplified: Stepping up Runtimes". *Irrigation Business and Technology,* October 1996. Volume 4 Number 5, p.14

9. Bean EL. Economical Use of Water, Proceedings of the 36th Northwest Turfgrass Conference. 1982

10. Midwest Plan Service Structures and Environment Handbook. Eleventh Edition 1983 Wind Speed Data p.901.5

11.Snyder, Richard L. Schwanki, L.J. Shaw, D.A. Kabashima, J. N. Harivandi, M.A. "Turfgrass Irrigation Scheduling" Monograph, Cooperative Extension, U.C. Berkeley.

Calcium Usage by Turfgrasses: The Nutrient Forgotten by Turf Managers

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Of the six macronutrient elements required by all vascular plants, calcium (Ca) is probably the most forgotten by turf managers and horticulturists. Calcium is a major component of most liming materials. Therefore, if soil pH is adjusted through the use of lime, Ca is automatically applied and will be present in relatively large amounts. Where soils are already neutral or alkaline, Ca is frequently part of the soils parent mineral matter and thus present in abundance. Consequently, during the normal management of landscaped sites, Ca will be present naturally or applied as lime. So, you might ask, is Ca availability ever a problem that requires attention? In most soil-based cultural systems, the answer is no.

However, increasingly plants are being maintained in the landscape on synthetic media. On the golf course, USGA specification greens are essentially a sand culture which provides almost no Ca. Because such media are largely silicon based and have a low cation exchange capacity, little exchangeable aluminum or manganese will be present and exchange acidity rarely becomes a problem. Even if the pH is low, it will rarely negatively affect plant growth. Plants maintained in containers or in deep mulch may contact little if any soil and thus have a limited supply of calcium. In urban settings, roof-top gardens or landscapes are maintained in artificial media from which soil is excluded because of its weight. Here again, no natural supply of Ca may be available.

Greenhouse managers also use soil-less mixes but they are familiar with potential Ca deficiency problems and often add lime while preparing their mix. The complex fertilizer blends used for greenhouse crops also normally contain Ca since it, along with most other nutrients, might not be present in the synthetic culture medium.

Turf managers increasingly are required to grow turf on reclaimed or drastically modified land where the Ca content might be very low. Turf nutrition problems on greens and tees can be aggravated by the low height of cut which discourages deep rooting and makes the grass plants dependent on a limited medium volume. It is not unusual for turf managers to operate in situations where plant nutrition must be considered beyond the traditional use of nitrogen, phosphorus and potassium.

Tissue Content and Supply

Leaves of most turfgrasses contain sufficient amounts of Ca when it is present at between 5.0 and 12.5 g/kg (0.5 to 1.25%) of dried tissue. This is about the same concentration as that of phosphorus (P) which was earlier reviewed in this series on turfgrass nutrition. Like P and most mineral nutrients, the concentration of Ca can change significantly during the growing season. Hall and Miller observed the Ca content of field-grown Kentucky bluegrass clippings to vary between 0.82 and 1.47% on a dry weight basis. Calcium levels appeared to be highest when rapid root growth was likely, in early summer and mid-late fall. When shoot growth is rapid, leaf Ca becomes diluted and the tissue concentration declines.

However, unlike P, Ca is abundant in the solution of most soils. In fertile soils, it is the dominant cation on the cation exchange complex. This results in a soil water Ca concentration of about 1.6 mm (64 ppm) in a normal fertile soil. However, because Ca is absorbed by roots at a rate considerably less than that of the water in which it is dissolved, the Ca tends to be "filtered" out of solution at the root surface and accumulates in the rhizosphere (zone of soil adjacent to a root) to concentrations greater than 70 mm (2800 ppm). Consequently, the uptake of Ca by plant roots occurs as a largely passive process while the uptake of phosphate is strongly active. For a review of the characteristics of Ca in soil and the action of liming materials, please consult an earlier *Turfgrass* TRENDS article (Hull 1995). In this article, I will concentrate on the roles played by Ca in the growth of turfgrass plants and on how this information might be useful to the turf manager.

Ca Deficiency Symptoms Are Linked To Its Role In Cell Wall Synthesis

When most plants experience a Ca deficiency the first visible symptom is a cessation of shoot and root growth. This can occur within a few hours of withholding Ca and becomes most apparent at the growing points. The reason for this is linked to the role of Ca in stabilizing developing cell walls. At growing points (apical meristems) newly formed cells generate a cell wall from complex long-chain carbohydrates (polysaccharides) produced within the cells and excreted into the extracellular space between cells. This material is gel-like and has no structure. However, the very first wall materials produced contain large numbers of organic acid groups (polyglacturonic acid = pectates) which carry negative charges. These charges attract positively charged cations and give to the cell wall a large cation exchange capacity. Because of its abundance in most soils, Ca^{+2} ions normally balance many of these cell wall negative charges. Because of its double charge, Ca^{+2} ions have the capacity to link two pectate chains together which gives some organization and rigidity to the new cell walls. It is likely that when later cell wall polysaccharides (hemicelluloses, cellulose) are released from the cells, they utilize these initial pectin chains to establish the structure of the primary cell wall. It is clear that if Ca is not present, normal cell wall structure is not established and an organized tissue cannot develop.

The amount of Ca bound to cation exchange sites in cell walls depends on the number of exchange sites present and the availability of Ca to the root. Thick walled cells contain more exchange sites and will bind more Ca. This is typical of many broad leafed plants (dicotyledons) which normally have thick roots and contain more Ca than the fine rooted grass-like plants (monocotyledons) which generally contain less Ca. These differences in cell wall structure and volume partially explain why monocotyledons normally require less Ca than do dicotyledons.

This binding of Ca within cell walls results in a high concentration of Ca adjacent to the plasma membrane which encloses the protoplast of living cells (Figure 1). When plants are growing in a medium that contains only a moderate amount of Ca, more than 50% of the plant's total Ca will likely be present within the cell walls. As we will see later, it is important that Ca be the dominant cation in cell walls because both cell wall and plasma membrane functions depend on the presence and properties of Ca.

One obvious such function is the controlled displacement of Ca^{+2} by H+ during cell growth. Because Ca binding contributes to the rigidity of cell walls, these bonds must be relaxed when cells grow and the walls expand. This comes about by the discharge of H+ ions into the walls from the cells through stimulation by auxin of the plasma membrane bound H+-transporting ATPase (Figure 2). The excess H+s exchange for some of the bound Ca^2s breaking the Ca linkages between pectin chains and allowing the chains to slide apart and the walls to expand. After wall expansion, the excess H+s are dissipated and Ca bonds become reestablished again helping to stabilize and strengthen the wall. There is more involved than what is described here but this interaction between wall acidification and Ca-bond breaking is reasonably well established.

Ca Stabilizes Plasma Membrane Structure

As indicated above, the presence of relatively high Ca levels within plant cell walls is critical for proper plasma membrane function. All biological membranes consist of a phospholipid core in which numerous pro-

teins are inserted. These protein globs can float around laterally in the membrane, which is of a liquid consistency, and make contact with each other. In order for these membrane proteins to function as an ion transporter or provide a pore for water conduction into the cell, the component parts must come together and function as a unit. Since these component proteins are free to move about, there interactive structure must be stabilized for them to carry out a physiological function.
This stabilization again comes about through the binding properties of Ca^{+2}. Membrane proteins and phospholipids contain negative charges which can bind with $Ca+^2$ in specific ways linking them together and thereby stabilizing a functional complex structure. Membrane proteins can be stabilized by $Ca+^2$s into groups that can function as a H+-transporting ATPase, an ion channel, a membrane-bound enzyme or other functional protein assemblages.
The uniqueness of Ca to carry out this membrane function has been demonstrated by altering the Na/Ca ratio available to plant roots. Whenever Ca is allowed to drop below a critical concentration relative to other cations, transmembrane uptake of nutrient ions is inhibited, surface proteins become dislodged from the plasma membrane and cells become leaky. The membrane stabilization by Ca also contributes to the plant's ability to tolerate high salt concentrations.
LaHaye and Epstein found that bean plants grown in the presence of abundant Ca were protected from injury by salt levels (5OmM NaCl) that would seriously inhibit the growth of low Ca plants. It is a general practice in irrigated agriculture to protect crops from injury due to poor quality irrigation water by increasing the Ca content of the root zone. Adequate Ca levels in the soil make plants more tolerant of many physical and biological stresses.

Calcium as a Signal Messenger

For a little more than ten years, it has been recognized that Ca plays a critical role in a process that has baffled biologists for many years. It has long been known that plants can respond to environmental stimuli or signals such as day length, low temperature, pathogen attack, toxic metals, etc. The plant response is often a reaction which enables the plant to increase its tolerance to a stress condition or to respond in a manner which favors its survival. What has not been clear is exactly how the perception of a stimulus is transmitted into an appropriate response. How does the presence of a pathogenic fungus tell the plant to take defensive measures? How is an elevated auxin level translated into accelerated stem growth?
The answer to these and many other questions concerning the mechanism of plant responses to various stimuli appears to center around changes in the internal $Ca+^2$ concentration of cells. Normally, there are great differences in the $Ca+^2$ content of cell compartments (Figure 1). As was pointed out earlier, the cell wall normally has a high Ca content and this is also true for several compartments inside the cell. While much of the Ca within cell walls is bound to cation exchange sites on pectin and on the surface of the plasma membrane, free ionic $Ca+^2$ levels are between 0.1 and 1.0 mM (4-40 ppm). The large central vacuole within mature plant cells also contains $Ca+^2$ levels of about 1.0 mM and the endomembrane system within cells may contain as much as 50 mM (2 ppm) Ca with free $Ca+^2$ present at 3-4 mM. The $Ca+^2$ content of cytoplasmic organelles, chloroplasts and mitochondria; is quite variable but also is in the low mM range.
By comparison, the cytosol (fluid matrix of the cell's cytoplasm) contains very low concentrations of free $Ca+^2$ ions; typically 0.1 mM or 0.004 ppm although values as low as 0.03 mM have also been reported. This very low $Ca+^2$ concentration in the cytosol compared to that of the cells exterior and the central vacuole creates a huge $Ca+^2$ gradient of three to four orders of magnitude. The natural tendency is for $Ca+^2$ to move from those sites of high concentration into the cytosol. This movement is blocked or overcome by active $Ca+^2$ transporters that operate in the plasma membrane, the tonoplast (vacuolar membrane), the endomembrane system and probably other subcellular organelles (Figure 2). These transporters directly utilize the energy in ATP to pump $Ca+^2$ across the plasma membrane into the cell wall or across the tonoplast into the vacuole etc. The effect of these transporters is to maintain a very low cytosolic $Ca+^2$ concentration by pumping out any Ca that might leak across a membrane or enter via inwardly directed transporters. It is only through the expenditure of much energy that this very low $Ca+^2$ concentration in the cytosol is maintained.
Why is maintaining a low cytosolic $Ca+^2$ content important? One reason is to prevent Ca from precipitating phosphate which is essential for just about every metabolic pathway. Remember it is in the cytosol that many basic metabolic processes occur in total or in part and free phosphate (Pi) is needed for most of them. Also free magnesium ions ($Mg+^2$) are required for most reactions involving ATP and Pi and most metabolic pathways contain several such reactions. $Calcium+^2$ can compete with $Mg+^2$ for enzyme binding sites rendering the enzyme inactive. Consequently it is not healthy to have high concentrations of $Ca+^2$ around where reactions involving ATP Pi or $Mg+^2$ are supposed to be occurring.

Once having established this sharp difference in Ca^{+2} concentration between the cytosol and its surroundings, signal transduction mechanisms have evolved which utilize the partial collapse of this Ca^{+2} gradient. Signal transduction involves the conversion of a stimulus (signal) to a chemical reaction in the cell which can directly or indirectly initiate a metabolic change or response to that stimulus. Such a signal transduction system must be rapid and require the expenditure of no energy. Otherwise a cellular response might be too late or it might be too easily blocked by degrading the energy source. If a stimulus causes a rapid influx of Ca^{+2} into the cytosol, it can trigger a series of new reactions which in turn could cause a shift in metabolism that would be an appropriate response to the stimulus.

An example might make this idea more meaningful. Suppose a turfgrass plant is being attacked by a pathogenic fungus. The fungus in contact with the grass plant releases an enzyme, polygalacturonase, which can degrade the pectin of cell walls causing the tissue to weaken, provide a route for infection and supply an interim food source for the fungus. However, the product of this enzyme's action, short carbohydrate chains, can bind to special proteins on the surface of the cell's plasma membrane causing Ca channels in the membrane to open (Figure 3). Because the Ca^{+2} concentration within the cell wall is many times greater than that of the cell's cytosol, Ca^{+2} rushes into the cell.

The elevated Ca^{+2} content of the cytosol triggers certain specific reactions. Calcium can bind with an existing protein kinase enzyme which is then activated to add a phosphate from ATP to other enzymes thereby either activating or inactivating them. This change in enzyme activity will shift metabolism along different pathways from where it had been proceeding earlier. In this case, metabolism may be shifted to produce phenolic compounds which are toxic to fungi and thereby prevent infection. Alternatively, the higher cytosolic Ca^{+2} level may cause four Ca ions to bind with a regulator protein such as calmodulin which in turn binds with specific enzymes either activating or inhibiting their function (Figure 3). Calmodulin-Ca_4 can bind with the enzyme NAD kinase activating it to phosphorylate NAD to form NADP NADP is required in the pathway that produces phenolic compounds so it complements and reinforces the effect of the protein kinase described earlier.

Calmodulin-Ca_4 may also bind with the plasma membrane Ca-translocating ATPase activating it to pump more Ca^{+2} out of the cytosol into the cell wall and restoring the cytosol to its original low $Ca{\sim}^{2}$ level.

In this example, the elevated Ca+ in the cytosol served as a second messenger (short chain carbohydrates generated by the fungus in the cell wall being the primary messenger) which linked the primary signal received by the plant to a metabolic response. Influx of Ca^{+2} can be localized to one end of a cell resulting in localized growth at that end. Pollen tubes grow in response to such a signal. There are several second messengers known which promote a cellular response to an external stimulus but by far Ca^{+2} is the most common. It may be no exaggeration to conclude that Ca's role in signal transduction is its most important physiological function.

Calcium in Turfgrass Management

By now you may be asking if all this information on Ca and its functions is of any value to the turf-grass manager. I believe it might be useful. It is hard to be too positive on this point because very little of what was described above has been studied on turfgrasses. There is so little basic physiologic or metabolic research conducted on turfgrasses that we have little choice but to extrapolate from research involving other plants. However, the above story has been established for several very different plants so its validity for turfgrasses is likely.

As mentioned at the outset, Ca is never deficient to plants growing on a well limed or naturally calcareous soil. Consequently insufficient Ca is unlikely to be a problem on roughs, fairways, lawns, athletic fields or utility turfs where mostly native soils are utilized. However, turf managed on synthetic media which contain no soil or on very sandy soil which has not been limed may suffer from low Ca. No field turf will be growing in the complete absence of Ca so classical deficiency symptoms are not likely to be observed. Instead, plants may be inefficient in acquiring nutrients (require high fertility levels) or fail to respond effectively to environmental signals (suffer greater stress injury). These will be subtle effects which only the most perceptive manager will detect. If a sand green requires more fertilizer than normal or if it tends to sustain drought or heat injury when others do not, you might be well advised to check the exchangeable Ca content of the growth medium or have leaf tissue analyzed for total Ca.

A complicating factor may be that turfgrasses differ in their utilization of Ca. Nittler and Kenny found Kentucky bluegrass cultivars to differ widely in their tolerance to low Ca. Thus, a low Ca problem might be unevenly expressed on a site if more than one turfgrass is being grown. A Ca insufficiency would not be my initial diagnosis of a turf problem but you might want to keep it in mind if other more likely solutions fail to provide an answer. Lime is cheap and you are not likely to cause harm by making a judicious application.

One effect of Ca which has been documented on a turfgrass is its impact on disease susceptibility. Colonial bentgrass grown in a nutrient solution deficient in Ca was shown by Moore et al. to suffer greater injury from pythium blight. Plant pathogens frequently initiate infection by producing hydrolytic enzymes that degrade the plant cell wall. The pectin degrading enzyme polygalacturonase is produced by several pathogens as an initial step in the infection sequence. However, calcium pectate is highly resistant to polygalacturonase and when plants are adequately supplied with Ca their walls are largely resistant to pathogen attack. Moore and Couch observed greater activity of pectolytic enzymes (polygalacturonase) in pythium blight infected leaves of bentgrass grown under low Ca nutrition than under adequate Ca.

Adequate Ca nutrition should not be a major concern for the turf manager, however, there are circumstances when a lack of sufficient Ca may detract from turf performance. If a manager is aware of this potential problem, preventive measures can easily be taken. Recognizing that Ca is an essential plant nutrient and not just a component of lime can help minimize some turf management problems that may never be diagnosed as related to insufficient Ca.

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References

Bush, D.S. 1995. Calcium regulation in plant cells and its role in signaling. Annu. Rev. Plant Physiol. & Plant Mol. Biol. 46:95-122.

Hall, J.R. and R.W. Miller. 1974. Effect of phosphorus, season and method of sampling on foliar analysis of Kentucky bluegrass. pp.155-171. IN E.C. Roberts (ed.). Proc. 2nd Int. Turf. Res. Cont., Blacksburg, VA. 19-21 June 1973. Am. Soc. Agron., Madison, WI.

Hull, R.J. 1995. The value of lime in turfgrass management. TurfGrass TRENDS 4(4): 1-5.

Hull, R.J. 1997. Phosphorus usage by turfgrasses. TurfGrass TRENDS 6(5):1-12.

Jones, J.R., Jr. 1980. Turf analysis. Golf Course Management 48(1):29-32.

LaHaye, RA. and E. Epstein. 1971. Calcium and salt tolerance by bean plants. Plant Physiol. 25:213-218.

Marschner, H. 1995. Mineral Nutrition of Higher Plants. 2nd Edition. Academic Press Inc., San Diego, CA.

Moore, L.D. and H.B. Couch. 1968. Influence of calcium nutrition on pectolytic and cellulolytic enzyme activity of extracts of Highland bentgrass foliage blighted by Pythium ultimum. Phytopathology 58:833-838.

Moore, L.D.; H.B. Couch and J.R. Bloom. 1961. Influence of nutrition, pH, soil temperature and soil moisture on pythium blight of Highland bentgrass. Phytopathology 51:578.

Nittler, L.W. and W.J. Kenny. 1971. Cultivar differences among calcium deficient Kentucky bluegrass seedlings. Agron. Jour. 64:73-75.

Pineros, M. and M. Tester. 1997. Calcium channels in higher plant cells: selectivity, regulation and pharmacology. Jour. Exp. Botany 48:551-577

Trewavas, A.J. and R. Mal ho. 1997. Signal perception and transduction: The origin of the phenotype. The Plant Cell 9:1181-1195.

Turner, T.R. and N.W. Hummel, Jr. 1992.~Nutritional requirements and fertilization. pp.385-439 IN Turfgrasses, D.V Waddington, R.N. Carrow and R.C. Shearman (eds.). Agronomy Monograph No.32, Amer. Soc. Agron., Madison, WI.

Youssef, R.A. and M. Chino. 1987. Studies on the behavior of nutrients in the rhizosphere. I. Establishment of a new rhizobox system to study nutrient status in the rhizosphere. Jour. Plant Nutrition 10:1185-1195.

FIELD TIPS

While calcium nutrition is rarely a concern for the turfgrass manager, there are circumstances where Ca additions may be beneficial. The following points might be worth considering.

1. If the substrate on which turf is grown contains no Ca, it must be added to insure a quality turf. Very sandy soils, reclaimed or synthesized soils, sand-based greens are situations where Ca additions might be considered.

2. Under field conditions, acute Ca deficiency is unlikely. You will not observe growing points collapsing or distorted leaves emerging. More likely you will notice sluggish responses to fertilizer, excessive disease incidence, a tendency for greater stress injury (drought, heat) and a generally weak stand that does not recover well from damage.

3. Calcium is most likely to be deficient in well fertilized grass because its need for Ca will be greater. Stimulated growth and clipping removal will aggravate a chronic Ca insufficiency.

4. Calcium can be added as liming materials (calcium carbonate) and on sandy sites, application should be repeated when shown by soil analysis to be needed, perhaps every two to three years because Ca will leach if there is no cation exchange capacity to retain it in the soil.

5. Foliar spray applications usually are unnecessary and might even cause leaf burn. A Ca source such as lime or gypsum ($CaSO_4$) added to fertilizer or incorporated into topdressing should satisfy grass needs. Calcium nitrate or sulfate are good soluble sources of Ca.

UPCOMING EDUCATIONAL OPPORTUNITIES IN THE PACIFIC NORTHWEST

WASHINGTON TURF AND LANDSCAPE SEMINAR

The Washington Turf and Landscape Seminar Program (Formerly PCTL) is taking shape. The December 2nd and 3rd conference will be held at the Maydenbauer Center in downtown Bellevue. The WWGCSA has been working with the Washington Association of Landscape Professionals, Washington State University, and the Washington State Department of Agriculture to put together a program which will serve the needs of many in our industries. This year, participants can receive twelve pesticide recertification credits, attend the pre-licensing training seminars, or take any of the license exams. So, if you need pesticide credits, or need to retake your test, this is the place to be. Confirmed speakers so far include Dr. Gwen Stahnke, WSU; Dr. Bill Johnston, WSU; Dr. Nick Christians, Iowa State University; Cisco Morris, Ed Hume, and others from the turf and landscape industry. Hope to see you there!

-Jeff Gullikson, Program Chairman

O.G.C.S.A. HOLDS ANNUAL PESTICIDE APPLICATORS SEMINAR AND EQUIPMENT SHOW

The Oregon Golf Course Superintendents Association will hold it's annual Pesticide Applicators Seminar at the Oregon Convention Center on December 9-10, 1997. Speakers from OSU, WSU, Clark College, Walla Walla Community College as well as the Oregon Department of Agriculture and others have been lined up for the program. The Department of Agriculture will be administering testing for those who need them. The fee for attendance without taking test is $80.00; with testing the fee is $90.00. Students are admitted for $40.00.

On Wednesday, December 10, 1997, the 1997 Turf and Grounds Equipment Show will be held at the Convention Center from 9:00 AM to 4:30 PM. The show will then close for 1/2 hour and re-open by invitation only to superintendents and their guests (people from their companies who help them in purchase decisions from their clubs or companies or municipalities).

The Oregon GCSA and GCSAA present

The Microbiology of Turfgrass Soils

Monday, January 5, 1998
8:00 AM - 5:00 PM
Columbia Edgewater Country Club
Portland, Oregon

Member Fee: $110; Non-Member Fee: $165

Continuing Education Units: 0.7

For More Information or
To register, contact
1-800-472-7878

GCSAA EDUCATIONAL SEMINARS
in partnership with RANSOMES CUSHMAN RYAN

1997 MECHANICS SEMINAR

Presented by the
Oregon Golf Course
Superintendents Association

Wednesday, December 10, 1997
Oregon Convention Center
8:30 AM - 3:00 PM

Maximum Attendance - 80

Speakers from USGA, colleges, and industry.

Registration deadline:
December 1, 1997
Call OGCSA office for more info:
541/549-1960

GOLFERS GET GOING

Although the game of golf continues to flourish, it has, in fact, been standing still for the past six years with regard to two important measures of growth: 1) the number of golfers and 2) course visits.

On the other hand, new facilities are being developed at a record rate and golfers are spending more than ever each year for equipment and playing fees.

Golf facility supply

In the U.S., over the past five years, growth in golf facility supply has significantly outstripped demand for golf as measured by course visits, or "rounds of golf." However, in the five-year period prior to that, the reverse was true.

The number of golf courses in the U.S. stands at 15,703, an increase of 2,350 courses over the past10 years. While this sounds like a lot, it actually represents only a 1.6 percent compound annual growth rate in supply. Nonetheless, this is a large number of golf courses and conservatively represents an investment of about 10 billion over the 10-year period.

And the outlook for this segment remains bright. There are 850 new courses under construction, and another 800 new courses far enough along in the planning process to be considered "likely to go forward."

Golfer demand

Over the past 10 years the number of golfers and course visits have both increased. The number of golfers has increased from about 20 million to 25 million, and the number of course visits from about 400 million to 500 million. All of this growth occurred between 1985 and 1990. Since 1990 the number of both golfers and rounds played have remained essentially level.

Prospects for growth

The single most important trend affecting golfs future is not related to the game itself, but rather with America's changing demographics. Our population is aging at an unprecedented rate. Research shows that golfers play more and spend more as they age. All things being equal, we expect golf demand to increase steadily as a direct result of the aging of the baby boomers.

To ensure golf's future, we must see to it that the full spectrum of cost alternatives remains available so that golf can justify its claim that it's not a game for the privileged few, but rather a game for all.

Excerpted from remarks by *Mr. Beditz* at the *1997* International *Golf conference, St. Andrews, Scotland.. Reprinted by permission.*

(Continued from page 18) Obituaries

GLEN PROCTOR

We have lost another good friend and one of the Founding Fathers of the Northwest Turfgrass Association. Glen Proctor passed away in early November at the age of 87 and left behind many memories and a record of excellence in the turfgrass industry in the Pacific Northwest.

He was one of the five men who organized the Northwest Turfgrass Association, beginning in 1947. He served as President for the first two conferences in 1948 and again in 1961. Glen served numerous times on the Board of Directors and on the Advisory Committee to Washington State University. He served an important role in creating the Research, Extension and teaching programs that exist at WSU today. He was an active member of the Inland Empire GCSA and the Western Washington GCSA his entire career. Glen, along with two partners, Milt Bauman and Roy Goss, designed and built eleven golf courses in Washington and remodeled portions of several others. He also assisted his son, Larry, in building the second nine holes at Northshore Golf & Country Club.

Glen was an avid hunter and fisherman and taught Roy Goss the art of catching salmon and they spent numerous days together chasing salmon.

His two sons, Larry and Ron, followed in his footsteps very successfully as golf course superintendents. Glen spent most of his working career at two golf courses, Manitou Golf & Country Club and Rainier Golf & Country Club. He is survived by his wife, Hazel, a wonderful and dedicated wife and mother, and his sons. Thank you, Glen, for all you've done.

-Roy L. Goss, Ph.D.

"THE RULES FOR BEING A HUMAN"

* **YOU WILL RECEIVE A BODY**

You may like it or hate it, but it will be yours for the entire period this time around.

* **YOU WILL LEARN LESSONS**

You are enrolled in a full time informal school called life. Each day in this school you will have the opportunity to learn lessons. You may like the lessons or think them irrelevant and stupid.

* **THERE ARE NO MISTAKES, ONLY LESSONS**

Growth is a process of trial and error: Experimentation. The "failed" experiments are as much a part of the process as the experiment that ultimately "works."

* **A LESSON IS REPEATED UNTIL LEARNED**

A lesson will be presented to you in various forms until you have learned it. When you have learned it, you can then go on to the next lesson.

* **LEARNING LESSONS DOES NOT END**

There is no part of life that does not contain its lessons. If you are alive, there are lessons to be learned.

* **"THERE" IS NO BETTER THAN "HERE"**

When your "there" has become a "here", you will simply obtain another, "there" that will, again look better than "here."

* **OTHERS ARE MERELY MIRRORS OF YOU**

You cannot love, or hate something about another person unless it reflects to you something you love or hate about yourself.

* **WHAT YOU MAKE OF YOUR LIFE IS UP TO YOU**

You have all the tools and resources you need. What you do with them is up to you. The choice is always yours.

* **YOUR ANSWERS LIE INSIDE YOU**

The answers to life's questions lie inside you. All you need do is look, listen, and trust.

Editor's Note: Don't know the author of this list. Just thought it made sense.

TURF MANAGEMENT CLASSES

at Edmonds Community College

WINTER 1998

Winter Quarter starts on January 5

Register early for best class selection and to avoid holiday office closures.

Turf Physiology (Hort 151. 3cr.) This class will cover in depth how environmental conditions, cultural practices and physical stresses all affect turfgrass areas. Emphasis on student involvement will be encouraged. Wed. 5:30 PM, Instructor: Becky Michels

Professionalism in the Green and Turf Industry (Hort 158, 3cr.) This class will be geared to presenting a professional image and will cover areas of dealing with difficult people-clients, employers or employees, dress codes, improving skills in management and communication, and profitability. Mon. 5:30 PM. Instructor: Becky Michels.

Pest Management Principles and Horticulture Safety (Hort 110, 3cr.) Common insecticides, fungicides and herbicides: uses and regulations. Topics concerning proper storage, posting. record keeping and safety issues such as eye. and skin protection will be covered. Prerequisite:
Math 080 or equivalent with a grade of 2.0 or higher. Tues. 5:30 PM. Instructor: Laura Strel'lau.

Internships (Hort 191, 1-5cr.) Offered each quarter. Independent training experience at golf courses, parks, landscape businesses, or with professional mentors. Students. are directly involved with planning their projects and objectives. An organizational meeting is held the first week at EdCC; henceforth a flexible schedule depending on students' schedules. Registration permitted first seven weeks as space is available. Variable credit range is shown, departmental advising is needed.

Business Math (Bus 130) or Math for Horticulture (Amath 104). Offered each quarter. Prerequisite:
Math 040 or equivalent with a grade of 2.0 or higher, or appropriate score on Math Placement Test. (3 credits total required in math for the one year Turf Management Certificate.)

Turf classes this quarter eligible for Pesticide recertification credits: *Pest Management Principles and* Safety (Hort *110).*

Call *Edmonds Community College* Admissions (425) 640-1372
Questions? Call EdCC Turf Management 'Hotline' (425) 640-1608

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