

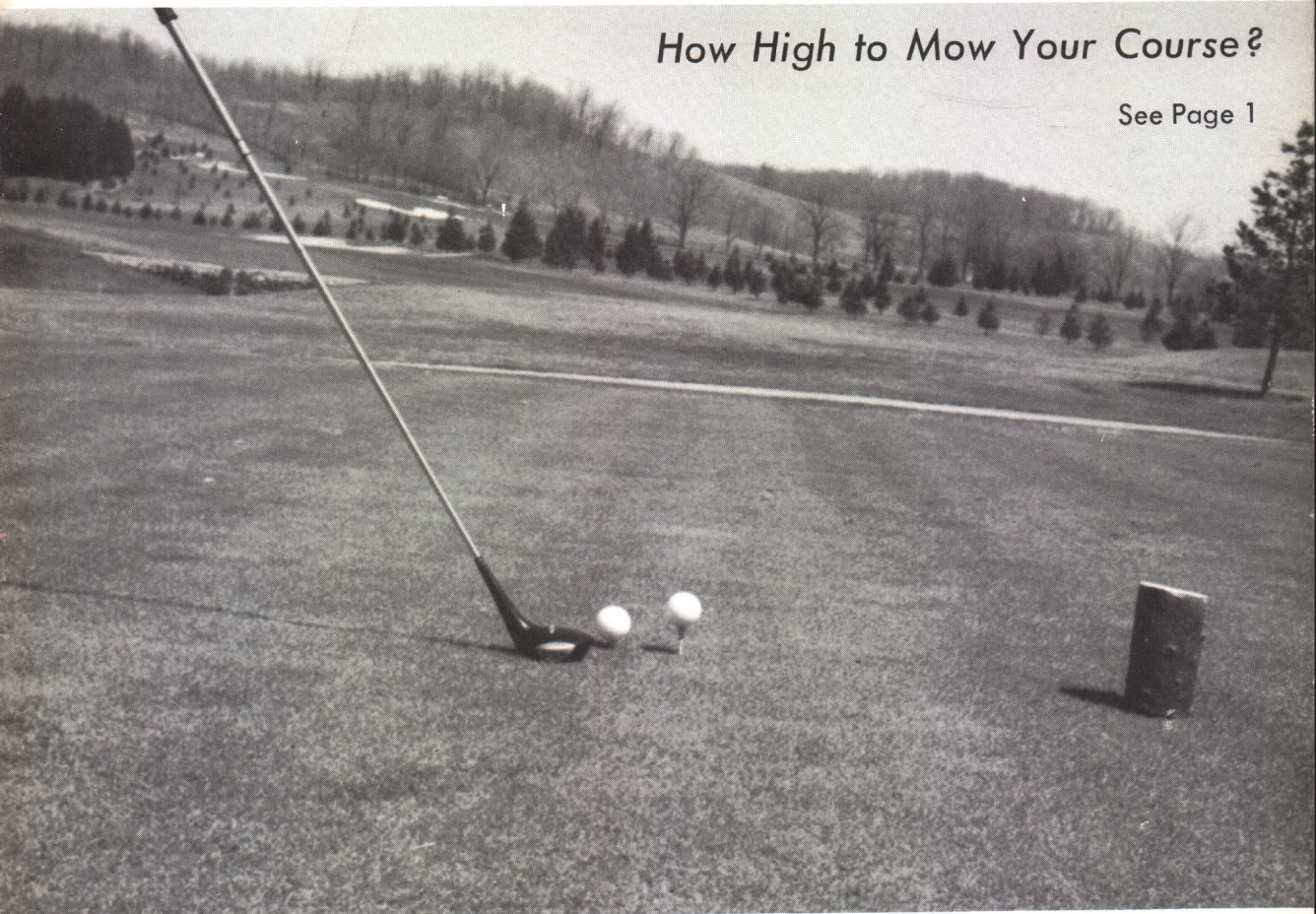
JULY 1968

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

How High to Mow Your Course?

See Page 1





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Cover Photo: Some like them high, some like them low. On a well-groomed tee, the option is yours. Alexander M. Radko's article on turfgrass mowing begins on Page 1.

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Editor: William H. Bengeyfield

Managing Editor: Robert Sommers

THE GREEN SECTION OF THE UNITED STATES GOLF ASSOCIATION

Green Section Committee Chairman: Henry H. Russell, P.O. Box 578, Perrine, Fla. 33157.

Green Section Agronomists and Offices

EASTERN REGION

Northeastern Office: P. O. Box 1237,
Highland Park, N. J. 08904

Alexander M. Radko, Director, Eastern Region
Holman M. Griffin, Northeastern Agronomist
Lee Record, Northeastern Agronomist

Southeastern Office: P. O. Box 4213,
Campus Station, Athens, Ga. 30601
James B. Moncrief, Southeastern Agronomist

MID-CONTINENT REGION


Southwestern Office: Texas A&M University,
College Station, Texas 77843

Dr. Marvin H. Ferguson, Director, Mid-Continent
Region and National Research Coordinator

Mid-Western Office: Room 905,
211 East Chicago Ave., Chicago, Ill. 60611
James L. Holmes, Mid-Western Agronomist

WESTERN REGION

Western Office: P. O. Box 567,
Garden Grove, Calif. 92642
William H. Bengeyfield, Director, Western Region



Grooming Your Golf Course Is Important!

by ALEXANDER M. RADKO, Eastern Director, USGA Green Section

Professional golfers have said that they would rather play from a dirt road than try to control a shot from tall grass. Their explanation is that when the clubhead can make unobstructed contact with the ball from a close, firm lie, they can execute a better shot with greater regularity, and make the ball act in a more predictable way.

Of course, the same golfers would be first to admit that they wouldn't want to play too many shots from a dirt road because it would not only be unpleasant, but also wrist bruising. However, their point is obvious: close-cut turf is required for championship play. No one who knows golf could dispute this statement.

Nevertheless, we have observed courses that have a very fine turfgrass cover, and yet they play badly. Others may have a lesser quality turfgrass cover, and they play beautifully. Why? The answer is grooming!

Know-how in grooming doesn't come from theory alone, it results from experience, trial and error, common sense practices, and a knowledge of golf. One doesn't need to play the game well to be a master at grooming, but it is very important to know what good grooming is and how it affects play.

The late Joseph Valentine, long-time superintendent of Merion Golf Club in Ardmore, Pa., and the first golf course superintendent to receive the USGA Green Section Award, was a master at grooming a course for play.

While I had the pleasure of knowing Mr. Valentine for many years, I never knew whether he played well or played golf at all. However, he knew how the course should play, and it was always groomed to near perfection.

Merion was always ready for tournaments, whether local, State or National. He never had to exert extraordinary measures to shape the course up to championship standards.

QUALITIES OF A "CHAMPIONSHIP GREEN"

What then makes for championship standards for play? When you analyze the situation, it truly resolves itself to the need for a firm, dense, and close-cut turf on greens, tees, and fairways. We expect that greens should always be well-managed because the inferior green manager doesn't survive for long in this day when golf course management is at its highest plane. Also, greatest emphasis is placed on putting green management because approximately 25 per cent of the maintenance budget is allotted to the care of greens. A championship green therefore must:

- 1) Be mowed consistently at $\frac{1}{4}$ inch or less.
- 2) Be firm, but resilient, so that it will hold a shot played from a reasonable distance, when that shot is properly executed.
- 3) Be fast enough so that the ball will roll freely when properly struck with a putter.
- 4) Be free of excess grain and heavy leaf growth.
- 5) Be of such density that the ball will roll smooth and true.



Each ball is teed approximately the same height on bentgrass left, and bluegrass right. Which is your preference?

- 6) Be uniform in texture so that the ball will roll the same from any direction on like terrain.

WHAT ABOUT FAIRWAYS AND TEES?

No one will dispute the importance of the role of the putting green in golf. It is a fact that one-half the strokes allotted for a par round are charged to greens. But what about fairways and tees? They, of course, equally divide the remaining 36 strokes on a 72-par course.

The golfer is allowed to tee the ball 18 times, but seldom does anyone emphasize that this leaves a meager 18 strokes allotted to fairways, where they must be played as they lie. This points up the importance of the fairway program in providing a firm, dense, close-cut turf; turf on which every square millimeter has to be perfect. Why every square millimeter? Because the ball is round and so it comes to rest on a very small area, a few square millimeters, more or less. Grooming every square inch to perfection just isn't good enough.

Fairways comprise the largest fine turf area on any golf course, usually about 50 acres more or less, depending on the pattern of cut. Superintendents strive to keep fairways in perfect condition during all the playing season. However, static perfection with so dynamic an acreage is an almost impossible order. Traffic, weather, disease, insects, and weed competition all take their toll.

Grasses not only have their limitations, but

there are also management and economic limitations that dictate what can be done with fairways. How far can one go in providing conditions that the professional golfer describes as "tight and firm". We have grasses that thrive at a height of cut of 3/16 inch: our putting green grasses are an example, but for obvious reasons it isn't economically feasible to manage fairways exactly like greens. Costs not only would be staggering, but there aren't enough men or machines to do a like job.

Also, if the care of two to three acres of greens turf requires approximately 25 per cent of the budget, imagine how much 50 acres of fairway turf managed similarly would cost? Without a doubt, it's out of the question to expect fairways to be groomed, managed and maintained like greens with the grasses available today.

FAIRWAY GRASSES—BENT, POA ANNUA & BERMUDA

What are the principal fairway grasses and what height of cut limitations does each have? In the northern latitudes the cool season grasses such as the bentgrasses, the Kentucky bluegrasses, and the narrow-leaved fescues (creeping red and chewings) are seeded, *Poa annua* volunteers. In the southern areas the bermudagrasses mainly are used to establish fairways.

Bermudagrasses in general can be mowed as closely as the terrain will permit without suffering any setback. The new, finer-bladed

selections are great improvements over the common types, and they provide an excellent surface from which to play. The density of the newer selections and their greater leaf surface (compared to the stemmy growth of the common types) greatly enhance fairway lies.

It has been said by many that there is no better fairway turf than a tight-mown bermudagrass fairway, when it is right.

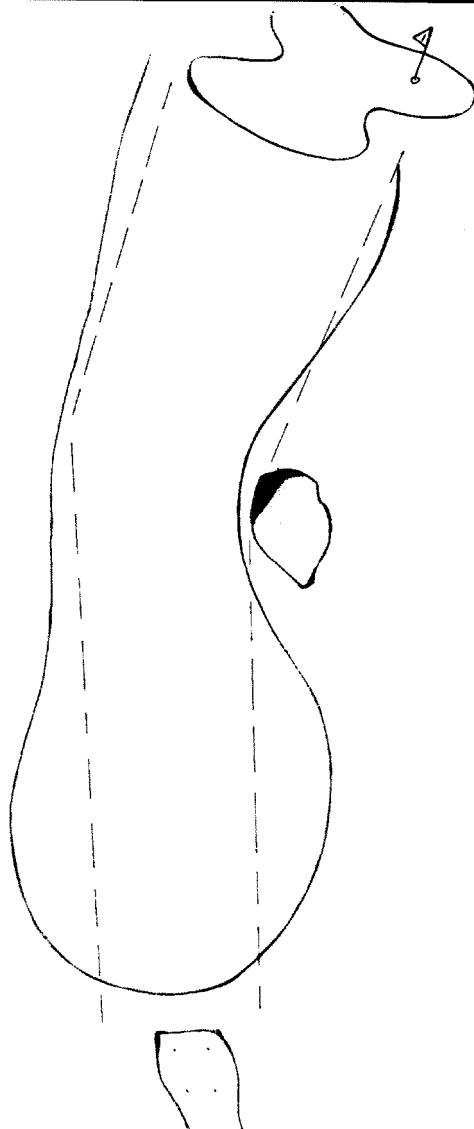
Which cool season grasses offer the same close cut lie that bermudagrass affords? Just two; the bentgrasses and *Poa annua*. Either of these could be mowed just as tight as the terrain allows. *Poa annua* grows upright, the blades are stiff, and the plant count per square foot is high. The colonial type bentgrasses — Astoria, Highland, etc. — also exhibit an upright growth, but their blades are softer. This turf must be mowed closely, otherwise the ball will nestle down into the turf more so than with the *Poa annua*.

The creeping bentgrasses exhibit a less upright growth than either Astoria or *Poa annua*, but the number of blades per square inch is quite extensive. Also, by virtue of its matting growth habit, it makes a carpet-like blanket over the soil. Penncross and Seaside bentgrass principally make up the creepers and have been used in small amounts because of their vigor. Today, up to 25 per cent Penncross bentgrass is being recommended for bentgrass seed mixtures on fairways. This is due to the failure of the Astoria types to perform up to their expectations. It is also due to the fact that we now have far better equipment, safer materials, and improved management techniques for maintaining the more vigorous creeping bentgrasses in fairways.

Bentgrasses will thrive at a cut between $\frac{1}{2}$ to $\frac{3}{4}$'s of an inch. If they are cut higher, the blades will not support the ball as well, and so it will nestle down into the turf causing a less desirable lie. This is true of most turfgrasses; i.e., the height of cut makes a considerable difference as to whether the ball will rest on, or in, the turf.

The amount of water applied also determines whether the blades will be firm or soft. Too much water, unquestionably, softens the plant and contributes to making it lush and soft-bladed, too soft in fact to support the ball.

From what the scratch and professional players say about it, the best lies are those

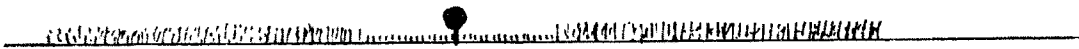


Contour mowing makes fairways more attractive. It breaks the monotony of straight lines from tee to green.

that rest on a tight, firm turf. This could be our goal in fairway maintenance. After all, the game normally goes to the skilled players in any sport: why should it be different in golf? Some might say that this would place the high handicap golfer at a disadvantage, and this may be so for a while. But how else can one ever get to learn to control the ball unless he can practice and play from close lies? If the better golfers are better because they can control the ball, it is only reasonable to assume that the poorer golfers can only improve as they, too, learn more about control.

BLUEGRASSES AND FESCUES

The Kentucky bluegrasses and the fine-leaved fescues make up the other cool-season



Side view of Merion bluegrass tee mowed at $\frac{3}{4}$ inch regularly but at $\frac{1}{2}$ inch between tee markers so golfer can tee ball to height of his liking.

choices presently available. There are a number of different selections of bluegrass. Some are improvements, but most are not adaptable to the close cut required on fairways. In general, the Kentucky bluegrasses must be mowed at not less than $1\frac{1}{4}$ inch. This also holds true of the fine-leaved fescues. Some of the improved selections such as Merion bluegrass and Pennlawn creeping red fescue reportedly could be mowed closer, but few dare to attempt to mow them continuously at closer than $\frac{3}{4}$ to one inch.

FAIRWAY MOWING — FREQUENCY AND PATTERNS

All turfgrasses require frequent mowing. They perform better when mowed regularly and weaken when allowed to grow beyond their normal cutting time. Merion bluegrass is a case in point, it requires a heavy fertilizer program and therefore grows rapidly. Some Merion bluegrass fairways need to be mowed six days a week.

Another point that bears some consideration is that when grasses are cut high, they require more frequent mowing. For example, when mowed at $1\frac{1}{4}$ inch, grasses don't need to make much growth before they reach what some consider to be rough height of cut. This is in the area of $1\frac{1}{2}$ to 2 inches. With favorable weather for growth in spring and fall, such fairways need to be mowed continuously in order to keep them playable as fairway turf.

Another word about mowing fairways — more should be contoured, narrowed, or widened at accent points, rather than mowed in a straight line. Long, sweeping and curving fairway lines are "softer" and far more pleasing to the eye. When coordinated with the degree of difficulty of a hole, contouring can

serve as a hazard to keep the player ever aware of target points, places to aim and places to avoid.

TEE GROOMING

Tees also require a close cut for the principal reason that height of cut affects the height at which the player can tee his ball. If he must tee the ball higher than he normally prefers, chances are he won't meet the ball as squarely or as consistently as he will when he can tee to the height he prefers. Today's trend is to mow tees only slightly higher than greens. This affords the golfer the chance to tee the ball as high or as low as he chooses, and as a result he should be able to hit the ball more consistently.

Most tees in the northern regions are established to bentgrass and *Poa annua*. This presents no problem since these grasses can be mowed closely. On the other hand, bluegrass tees present a problem. Since tees normally are aerated, fertilized and watered on a good schedule, rapid growth is achieved. When bluegrass tees are not mowed frequently, it is sometimes difficult to get a wooden tee long enough to support the ball.

To circumvent this, some superintendents closely mow the turf between markers and hope that this infrequent close mowing will not weaken the turf. If the tee is large enough to allow sufficient changes in teeing area so that the markers are not returned to the same area for three weeks or so, this is a desirable technique.

On a number of occasions it has been said that "golf is played on grass." This statement is only half true. The complete statement should read: "Golf is played on grass managed specifically for controlled play."

Should this not be our objective?

WANTED
Golf Course Superintendent
Experienced Greens Specialist

Must have experience in maintaining a high caliber club golf course, preferably in southwestern desert areas. Experience must include at least 8 to 10 years of full-time responsibility. Prefer family man willing to relocate to Las Vegas, Nevada area; available on reasonably short notice. Salary will be commensurate with your experience. Will be made with present employer, and no competition expressed consent. Starting salary approximately \$24,000.00 commensurate with your ability and experience. Extensive fringe benefits, including medical, dental, life insurance, and a complete resume. Must show family status for employment. This ad.

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Contracts for Golf Course Superintendents

by HARTON S. SEMPLE, General Counsel, USGA Executive Committee

I have been asked many times if a Club should have a written contract with its golf course superintendent and if so, what provisions it should contain.

The superintendent of a golf course is one of the key men in a golf club's organization. I am sure that all golfers will agree that the superintendent "makes or breaks" a golf course. A well conditioned course is a thing of beauty and a joy for every golfer, no matter what his handicap. On the other hand, a course in poor condition leads only to a lot of unfavorable comments from the players, whether justified or not.

Golf is big business today and growing bigger every day. The superintendent is an important and essential part of this business. He is entrusted with the care of the Club's biggest asset and administers one of the largest, if not the largest, budgets with which a Club has to work. Today the superintendent has to have more than just a "green thumb." He has to have specialized, highly technical knowledge to meet the stringent demands of the modern golfer. He goes to school to learn his profession and he is continually learning new methods and techniques by means of educational courses which are made available to him and which he is encouraged to attend.

Therefore, if you agree with me that the golf course superintendent is an important man in your Club organization, it seems logical that the Club should enter into a written contract with him. By doing so, the Club and the

superintendent will have a clear understanding of the many duties of the superintendent and how he is to proceed to carry out these duties. This is a tremendous help to both parties.

The superintendent must know just what the Club requires of him and to whom he must report, not only to receive instructions, but also to pass along any information, suggestions or complaints to the management of the Club and thence to the members. On the other hand, the Club management is helped by the establishment of a definite chain of command to deal with its most valuable asset, the golf course.

A written contract also gives the Club and the superintendent a stability of relationship which is most important to the smooth running of any organization. The superintendent, on his part, will appreciate the fact that he has a definite fixed contract to rely upon before moving his family to the site of his job. The Club also benefits by knowing that this important job will be filled for a definite time and may plan accordingly.

I do not mean to convey the impression that a written contract is absolutely necessary. We all know of some outstanding superintendents who have worked for leading Clubs in the country for many, many years with nothing more than a handshake for a contract. Obviously, these relationships have been eminently satisfactory. However, I am sure that these relationships would have been just as successful if there had been a written contract, and maybe more so.

Furthermore, we do not know how many oral agreements have not been so successful but might have been if a written contract had been entered into. A written contract has the definite advantage of avoiding many of the misunderstandings that are caused when new Club officers are elected who were not present when the oral understanding with the superintendent was made. Finally, a written contract may provide for a term of employment in excess of one year, whereas an oral contract is enforceable for only one year.

There is no particular magic in preparing such a written contract. The most important consideration is to be sure that all of the terms and conditions which will make the term of employment most satisfactory for both parties are embodied in the contract. Naturally, in preparing any such contract the Club's attorney should be consulted and all of the items which the management would like to have included in the contract should be thoroughly discussed with him. He is the most qualified man to draw a contract that will express the best wishes of both parties.

I have taken the liberty of setting forth below some of the provisions that Club management may want to consider including in a written contract. The following suggestions are by no means all inclusive and any contract should be tailored to fit the particular needs or requirements of the individual Club.

1. The first consideration should be given to the term of the contract. As previously stated, it might be well to establish a term longer than one year. However, for the protection of both parties, there should always be included a provision setting forth the circumstances under which employment shall terminate before the completion of the term set forth. An example of this would include death or incapacity to properly and personally perform the duties on the part of the superintendent or in the event the Club ceases to carry on its present business or become bankrupt. Naturally, if both parties agree to a termination there is no problem.

2. The compensation of the superintendent is very important. This should not only include the amount of his salary and how it should be paid, but should also cover all the fringe benefits, such as a bonus, hospitalization insurance, pension rights, life insurance, housing or rent allowance,

automobile expenses (gas) and expenses allowed for attending turf meetings and seminars.

3. A statement of the superintendent's duties and responsibilities for the proper maintenance, care and improvement of the golf course, water system and equipment should be carefully worded. There should be included here any other duties which may be assigned to him, such as care of the grounds around the Clubhouse, a swimming pool or tennis courts. The question of whether or not the superintendent will be allowed to do outside consulting work for other clubs, corporations or individuals (members) should be resolved. In many instances it is well to protect the superintendent from the many requests he receives from members who are anxious for him to help them with their personal turf problems.

4. It is very important to clearly set forth the chain of command which should be used by the superintendent. It is impossible for the superintendent to be responsible to every member. The logical person for him to report to and take his orders from is the Chairman of the Green Committee who, in turn, is responsible to the Board of Directors.

5. The Club may require the superintendent to prepare and submit to the Board of Directors (through the Chairman of the Green Committee) for examination and approval, his plans for each year or season and such budget or budgets of expenses as he may deem necessary to carry out such plans. In most cases this should include all capital improvements and purchases he expects to make.

6. The superintendent's authority to engage and discharge all labor necessary for the proper performance of his duties as outlined above should be set forth, together with his authority to purchase such equipment and supplies as may be necessary therefore; provided, however, that all of the items are included in approved budgets as hereinbefore specified. Any items not included in such a budget should be approved by the Board of Directors.

7. A provision should be included setting forth the amount of annual vacation to which the superintendent is entitled and when he is to take it. For example, in the North it may be desirable to require that

this allotted vacation be taken during the months of December, January or February.

8. The Club may want to encourage the superintendent to attend such regional turf meetings and national conferences as may be helpful to him in the performance of his duties as outlined, but not to interfere with said duties. If so, the approval may be set forth clearly so as to coincide with the expenses allowed in the previous compensation provision or the subject may be left to the discretion of the Board of Directors.

9. In order to facilitate the work of the superintendent, the Club may wish to include a provision that it will inform him in advance of the club's activities affecting his sphere of responsibility in order to allow him adequate time for any special preparations necessary for said activities and to cooperate with him in such manner as will better enable him to perform his duties.

10. Finally, the contract should include a provision providing for the renewal or extension of the contract if this is considered desirable by the parties. The terms and conditions precedent to, and to be included in any such renewal or extension, should be carefully considered and set forth in this provision.

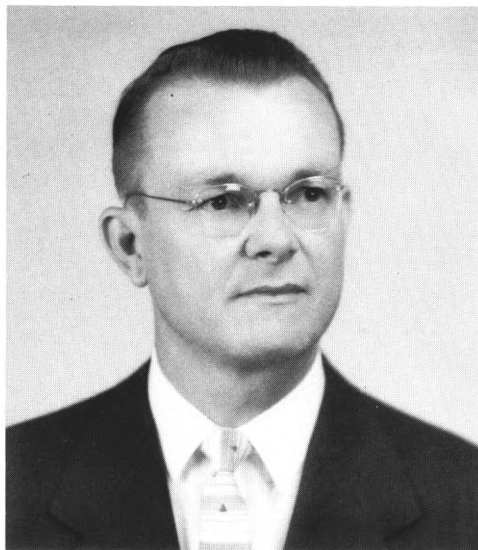
The above suggestions are offered only in the hope that they may be helpful to any clubs or superintendents who are considering entering into such a written contract. I repeat that these provisions are not intended to be all inclusive, but only a guide. If the club and the superintendent decide to enter into a written contract such as outlined herein, your club attorney should by all means be consulted because he is the person best qualified to draft such a contract.

Dr. Marvin H. Ferguson Retires

Edward R. Murrow said it best: "Good Bye and Good Luck!" to Dr. Marvin H. Ferguson, who has resigned from the USGA Green Section after 21 years of service.

In June, 1940, Dr. John Monteith offered the young Texas A&M graduate his first job in turfgrass management. He started his career at the old Arlington Turf Gardens in Arlington, Va. Here the USGA and the United States Department of Agriculture carried on cooperative studies in turfgrass research. Since that time Marvin Ferguson went on to his PhD (University of Maryland, 1950) and to become the USGA Turfgrass Research Coordinator and Mid-Continent Director (1952-1968) of the USGA Green Section.

In 1964, Dr. Ferguson was elected a Fellow in the American Association for the Advancement of Science. He was editor of The Turf Management section of the *USGA Journal* and later, editor of the *Green Section Record*. He was a member of the editorial board of the book *Turf Management* and has written many articles for newspapers and magazines. The programs for all Green Section Educational Conferences were also of his doing. In research, he was the force behind the USGA Specifications for A Method Of Putting Green Construction, and he piloted the study on golf



DR. MARVIN H. FERGUSON

shoe spike damage to greens.

From Seattle to Miami; Boston to San Diego, Marvin H. Ferguson has touched and bettered the lives of many in the world of golfing turf management. On August 31, 1968 he will leave the Green Section ranks and enter private business.

From his nation of friends, "Good Bye and Good Luck." You will be missed here.

Talent Scouting for Committee Members

by EARL D. HOTALING, Director, California Golf Club, San Francisco

Appointive positions are never easy to fill, especially when there is no pay and lots of work. And nowhere in a golf club is the problem so difficult as in appointing a Green and Grounds Committee. The members who want to participate are seldom qualified, and those who are qualified have usually kept their talents fairly well concealed. It takes a strong President to deny the status of the Committee to his friends, and to institute the talent search necessary to find members who will accept the task, and then perform to their capabilities.

Sometimes it takes a crisis, as it did in our case, to forego the current conception of such a committee, and organize one that can accomplish the task of modifying and maintaining a club's most valuable asset—its greens, fairways, traps, lakes and grounds.

Our crisis was simple. We had four new holes to build, a new well to drill and an automated sprinkler system to install. We retained a noted golf course architect and he suggested a contractor—the rest was up to us. We felt confident there was talent enough in

the club to accomplish the job. The problem was to find that talent and organize it for efficient results.

First, we delineated the functions and responsibilities of the committee. We then went on a talent search to fill each position. After some research it became apparent that there were six primary functions to be performed:

1. Agronomy — the course had to be maintained and the new holes brought in as quickly as possible.
2. Equipment and Personnel — we needed new equipment and our old had to be brought up to standard. We would need additional personnel.
3. Wells and Water Distribution — sufficient water had to be furnished to coordinate the programming of the automated sprinkler system.

A par-3 water hole, this is the new Third Green at California Golf Club, as seen from the forward tee.



4. Drainage and Sprinkler Coverage — changing topography would require new drainage and sprinkler head coverage would be the key to effective watering.
5. Budgets and Contracts — nearly half a million dollars had to be contracted and scrupulously accounted for.
6. Aesthetics — the new holes should be as beautiful as they were to be functional. Trees, shrubs and flowers would be most important.

This then pointed to a six-man committee, with each man responsible for a sphere of influence, plus a chairman who could act as the general administrator.

Thus, the talent search began. First, a profile was set up of the ideal man for each of the functions. Second, we searched the files on our member's backgrounds to see who would most likely fit the profile. We were amazed at the amount of talent that can be unearthed with such a search.

For instance, when we looked for the agronomist, we found we had a member who was a graduate agronomist and perhaps the foremost authority in the United States in his chosen field.

We uncovered a retired highway engineer to take care of drainage.

A retired mining engineer with experience in hydraulics was the ideal man to oversee the drilling of our new well and water distribution

system.

A machinery distributor who had helped build two golf courses in the past took over personnel and equipment.

The Vice-President of one of our banks, with excellent experience in working with contractors, became responsible for budgets.

Each of these men was approached on the basis of our need for his services — and the need for enough of his time to fulfill the duties required of him. Without exception they accepted.

With each man assigned his sphere of influence, the problem of where to place authority had to be solved. After serious consideration it was agreed that the authority must rest with the chairman. In this way, everyone knew where to report and where the final decisions must come from. This precluded the confusion that otherwise would have resulted.

In the final analysis, job classification is as important to a committee as it is to a business. Finding talent to fill such job classifications is really easier in a club than it is in industry. Every club has a reservoir of successful men from various professions—and there is no competition from other clubs as there is from other businesses. Best of all, salary is not a consideration. A chairman can always adjust, even double, a committee member's salary—for double nothing is still a mighty small remuneration for the efforts and dedication of a good committee member.

Had we to do it all over again, we certainly would do it the same way.

ABOUT THE AUTHOR

Earl D. Hotaling is a member and Director of California Golf Club of San Francisco as well as Chairman of the Board of the Kaemper & Barrett International Trade Corporation of San Francisco.



Effect of Temperature Stress on *Poa Annua*

by DR. JAMES B. BEARD, Michigan State University

The actual temperature of a turfgrass plant or its individual parts is determined by the surrounding environment. Temperatures of the below ground portions of the plant are usually identical with the adjacent soil temperatures, while above ground plant parts tend to follow the surrounding air temperature. The greatest extremes in temperature commonly occur at the surface of the turf and are moderated with increasing distance above and below the surface. The air and soil temperatures will vary with (a) latitude, (b) altitude, (c) topography, (d) season of the year, and (e) time of day.

OPTIMUM TEMPERATURES

The temperature at which activity of a particular process occurs at the highest rate is referred to as the optimum temperature. The optimum temperature will vary depending upon the (a) age of the plant, (b) stage of development, (c) specific plant organ involved, (d) physiological condition of the plant, (e) duration of the temperature levels and (f) variation in other environmental factors. As a result, the temperature optimum is actually a range rather than a specific fixed temperature.

The optimum of temperature range for shoot growth of annual bluegrass is between 60 and 70 degrees Fahrenheit. In contrast the optimum temperature for root growth of annual bluegrass is between 55 and 65 degrees.

In general, it is more important to maintain an optimum temperature for root growth than for shoot growth. Turfgrasses can maintain growth at relatively high air temperatures so long as the soil temperature remains in a favorable range. Turfgrasses growing in the optimum temperature range will have increased nutrient and water requirements and will also require more frequent mowing.

As temperatures are increased or decreased from this optimum range the various metabolic

processes within the plant are slowed. The net result is a general reduction in growth rate which continues until, at a certain point, growth actually ceases.

HIGH TEMPERATURE STRESS

Turfs are exposed to high temperature stress during summer periods when the degree of use is also the highest. This negative response where growth is slowly reduced and eventually ceases is termed indirect high temperature stress. Growth is impaired at superoptimum temperatures which are not necessarily fatal to the plant. Under these conditions the first visible effect of high temperature observed is a browning and die-back of the root system toward the soil surface. The roots will appear brown, spindly and weak.

High temperature stress actually causes increased maturation and death of the existing root system and also blocks the initiation of any new root system from the meristematic tissues. Loss of the root system is critical because it increases the susceptibility to injury from other adversities such as desiccation, diseases, insects, and nematodes.

The next significant effect of high temperature stress observed is a decline in shoot growth. Specifically, there is a reduction in leaf length, leaf width, leaf area, rate of new leaf appearance and succulence. Quite frequently the leaves will appear dark green to blue. The primary concern of the restricted shoot growth is that it limits the recuperative potential of the turf should injury from other adverse stresses occur.

The cause of high temperature stress is attributed to either (a) a destruction of certain heat sensitive enzymes involved in synthesis or (b) an imbalance between certain metabolic processes. Research at Michigan State University indicates that growth reduction is due to a blockage in either amino acid or protein synthesis.



Former MSU graduate student Tom Duff shows some paper chromatograms which are used to quantitatively analyze for the carbohydrates and amino acid levels of turfgrasses grown at optimum and superoptimum temperatures.

Evidence supporting this phytothesis includes a decline in protein level, an increase in free ammonia and a severe reduction in the amide level, especially glutamine. Michigan State University turfgrass researchers are attempting to describe the specific enzymes involved in high temperature growth stoppage. Once this is achieved it is hoped that the enzyme or enzymes involved can then be used as biochemical markers in a breeding program to select for heat tolerance. Such a technique would greatly accelerate the techniques of heat tolerance selection.

If temperatures are increased to quite high levels, direct high temperature injury may occur. This may be a more common problem than many individuals have previously thought. Direct high temperature kill involves denaturation of the proteins contained in the vital protoplasm of living cells. Studies at Michigan State University indicate that annual bluegrass can be killed at temperatures as low as 100 degrees. This is a surprisingly low temperature for kill to occur. Actually, temperatures of as high as 125 degrees have been measured at the surface of turfs.

Most turfgrasses have a built-in cooling system in the form of transpiration. During transpiration, energy is used to evaporate water from the leaf surface. In this process the leaf is actually cooled, therefore, so long as the leaf has open stomata which are actively transpiring, the temperature may not increase to a lethal level. However, should the stomata be closed due to a stress such as an internal plant water deficit, then transpiration will be impaired and lethal high temperatures may develop.

Detailed observations with annual bluegrass at Michigan State University show that the first signs of direct high temperature stress occur at the junction of the leaf sheaf and the leaf blade of the second and third youngest leaves. The lower portion of the crown, the youngest leaf and the apical stem were more heat tolerant than the older tissues.

TECHNIQUES FOR PROTECTION AGAINST STRESS

The question which is frequently asked by the professional turfman is "How may I protect my turf against high temperature stress?"

First of all, attempts should be made to maintain the plant tissues in a maximum state of hardiness. Specifically, heat hardiness is increased by decreasing the hydration level or water content of the tissue. In other words, judicious irrigation is important. A second factor is the nutrition level of the tissue. In general, excessive nitrogen fertilization should be avoided, because heat hardiness will be reduced, especially when the tissue is in a rapid state of growth.

The other aspect to consider when minimizing the chance of high temperature injury involves various means of cooling the turf or especially minimizing heat build-ups in the soil. Michigan State University research in this area has demonstrated the importance of good air movement in minimizing high temperature stress. Plantings, screens, or buildings which completely surround a turfgrass area and restrict air movement should be avoided. Investigations show that an air movement of

only four miles per hour will cool a turf from 12-14 degrees during mid-day periods when air temperatures exceed 85 degrees.

The second factor to consider is the use of syringing as a technique to moderate peak mid-day temperatures. Although the light application of water may not necessarily lower the temperature, it will restrict heat accumulation for several hours during the mid-day period and, therefore, moderate the extreme soil temperatures which might have occurred had syringing not been practiced.

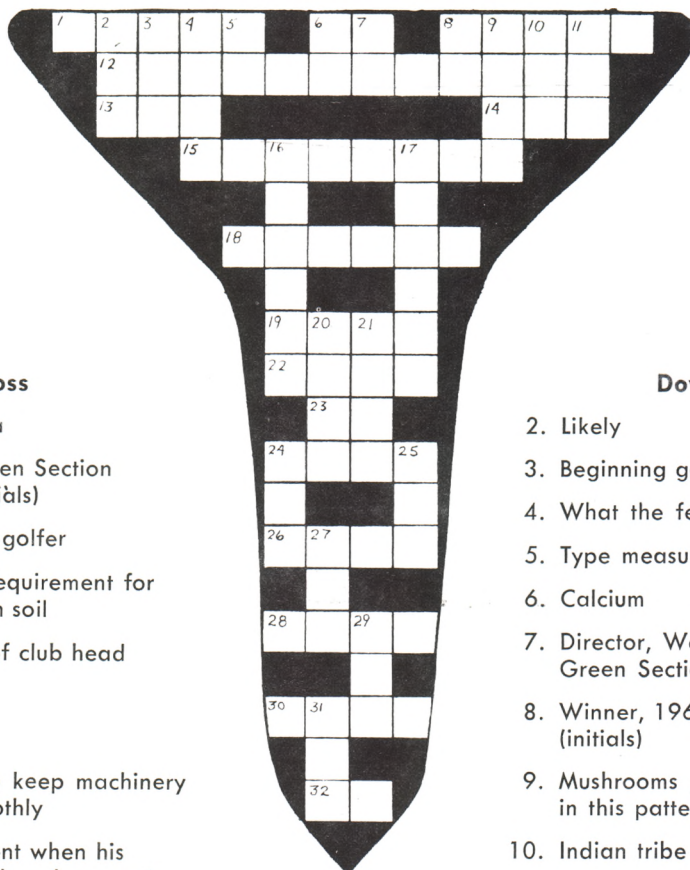
One further point to be made is that syringing should only be used as needed to avoid high temperature stress, and should not be considered a practice to be used day in and day out as a part of the routine maintenance program. This is particularly important on poorly drained turfgrass areas where overwatering can lead to saturated soil conditions, a low oxygen level, and, therefore, a restricted root system and a less vigorous turf.

An experimental arrangement for reproducing a 4 mph (left) and 0 mph (right) air movement over a bentgrass putting green turf.



Crossing the Tee

by KATHERINE CARDWELL, Mid-Western Office, USGA Green Section



Across

1. Practice area
6. Western Green Section Director (initials)
8. Non-refined golfer
12. Paramount requirement for putting green soil
13. Far portion of club head
14. Born
15. Irrigating
18. Necessary to keep machinery running smoothly
19. Superintendent when his greens are played overwet.
22. Mound
23. 3.1416
24. Group of clubs
26. Type of club
28. Type of trench
30. Source of calcium phosphate
32. Director, Eastern Region Green Section

Down

2. Likely
3. Beginning golfer
4. What the fertilized turf did
5. Type measure
6. Calcium
7. Director, Western Region Green Section (initials)
8. Winner, 1967 Women's Open (initials)
9. Mushrooms sometimes grow in this pattern
10. Indian tribe
11. Maddier
16. Distended with water
17. The aced ball is to the cup
20. Used to control galleries
21. Give off
24. Broadcast
25. Sward
27. See 18 across
29. A place to stay while golfing away from home
31. Seeds

Puzzle Solution in next issue.

TURF TWISTERS

HOW MUCH NITROGEN?

Question: There seems to be much confusion concerning the rates of fertilization for a bentgrass green. Why do some clubs apply only 2 pounds of nitrogen per 1000 square feet per year and others apply as much as 14 pounds per 1000 square feet? (West Virginia)

Answer: Fertilization depends on many variables but primarily length of growing season, climate, and soil conditions and to a lesser degree the particular bentgrass species and method of application. For instance, a Penncross bentgrass green with good drainage through a sandy soil might require approximately 8 pounds of nitrogen per 1000 square feet per year if the growing season is long and the weather cool. In general, the lesser amounts of fertilizer are favored provided it is adequate to keep the grass healthy and vigorous with good color. Only in extreme cases i.e., where the growing season is 12 months long, can we conceive of 14 pounds per 1000 square feet being required.

TOO MUCH CALCIUM ARSENATE

Question: Is calcium arsenate effective as a selective control for *Poa annua*? (Wisconsin)

Answer: Yes, calcium arsenate is quite effective as a control for *Poa annua* if used properly. Under no circumstances can calcium arsenate be applied to an area where it is known that free surface water will remain or stand for an extended period of time. If you wish or plan to use calcium arsenate, preparations must be taken to insure that surface drainage is rapid throughout the area to be treated. Slit trenching is currently being used for this purpose. Further, we are finding that light, frequent applications of calcium arsenate are safer and more effective than one heavy application. If calcium arsenate is used and a high per cent of *Poa annua* exists, an overseeding program with desirable grasses is necessary.

ENOUGH EMULSIFIER?

Question: We used a well-known insecticide for controlling cut worms on greens but even applied at less than the manufacturer's recommended rate, we received a moderate turf burn. The formulation was an emulsifiable concentrate and we applied it very carefully. What caused the burn or what did we do wrong? (New York)

Answer: Most emulsifiable concentrates have a petroleum base such as xylene, and this is probably what caused the burning. Although emulsifiable concentrates are good for grub-proofing (where they can be watered in), we prefer the wettable powders of insecticides for cut worm or sod web worm control where the material should remain on the blade or upper portion of the grass plant.