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USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

IRRIGATION

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IRRIGATION

Hand watering the high ground around greens.

A Most Important Key On Your Success Chain

by W.H. BENGEYFIELD, Western Director & Publication Editor

If saccharin is to be banned by the Food and Drug Administration because large doses cause an increase in cancer rates in rats, does it follow that the golf course superintendent should ban summer irrigation because it is the root cause of most summer turf management problems? Some may think this is a strained connection, but the logical conclusion to both propositions is the same: large, excessive doses of anything may cause problems.

America's golf courses have just lived through the coldest winter in the history of the Weather Bureau. Now, summer lies ahead and with it, the irrigation requirement. It is perhaps the most important single key on your summertime chain of success.

The grass plant is comprised of approximately 85 percent water, and although it cannot be grown with water alone, it cannot be grown at all without it. The story of overly wet golf courses is not new. Every dedicated and conscientious golf course superintendent should resolve NOW to do something about it this year! Overwatering leads to trouble. It is not good for golf. It is surely not good for golf course superintendents since it leads to turfgrass disease, soil compaction, shallow root systems, *Poa annua*, nutritional problems, gray hair and high blood pressure.

The Overirrigation Syndrome

Not always should the "overirrigation syndrome" be placed at the door of the golf course superinten-

Small, low delivery sprinklers on a hose help overcome faulty automatic irrigation design.

dent. Too often the general membership complains of hard, fast greens and hard fairways. Somehow they equate "soft and green" with "soft and good." This type of golfer perpetuates the belief that any shot played to a green should hold, whether struck properly or not. When faced with this type of member request, the golf course superintendent needs help. Few members with the soft-and-green syndrome are likely to be persuaded otherwise by statements from the superintendent. He needs the vocal help and support of the Green Committee, the golf professional and all other members (regardless of handicap) familiar with, understanding and knowledgeable of the finer points and true requirements of the game.

In January, 1977, in Atlanta, Ga., at the USGA Green Section Educational Conference, Joseph C. Dey, Jr., told of the Ryder Cup Match at Muirfield, Scotland, one September several years ago. The putting greens were dry, very firm and very true. When he asked James Logan, the superintendent, when he planned to water the greens, he received the unhesitating reply, "Not at all! Last Thursday I locked up the hoses for the winter." Dey reported that it would be difficult to find better putting greens than those at Muirfield.

Roll With The Weather

There are many advantages for the golf course superintendent who will stick to an irrigation schedule of infrequent but deep irrigations. To be most successful, it should be done in the spring or early summer. Better, deeper root systems will result. As the summer progresses, roll with the weather, but strive always to avoid overwetness caused by irrigation.

Base the irrigation schedule on how little water can be applied and still keep the grass generally growing well. To put it another way, irrigate to gain optimum soil moisture levels for the average and low areas—not for the higher and drier ground. The latter can be helped with aerification and low delivery irrigation coverage if necessary. Overall overwettness will thereby be avoided. This may mean some occasional brown areas, but it will also mean a better playing golf course at a lower cost and fewer headaches for the superintendent and Green Committee.

"Rolling with the weather" also means a close check on weather reports including evaporation—transpiration rates throughout the summer. It is much more professional (and meaningful) to plan irrigation on the basis of inches or fraction of inches to be applied each night rather than the "give everything 20 minutes tonight" philosophy. Measured precipitation is **THE** basic requirement. It is not how long sprinkler heads operate, since different sprinkler heads and nozzles have different delivery capacities.

Automatic Irrigation

The importance of knowing measured, uniform precipitation rates over a given area leads one naturally to irrigation design, coverage and management. Indeed, it is the sole reason for an irrigation system. Unfortunately, new automatic irrigation systems are frequently installed with the cost factor determining the type of system and irrigation coverage. The proper approach is to install a system which will insure uniform precipitation, which will permit good turfgrass production and ultimately provide the best possible playing conditions throughout the 18 holes.

Anyone with automatic irrigation experience

knows such systems are not really automatic. They require constant attention, surveillance, repair, adjustment and daily scheduling review if they are to operate properly. This means one man should be assigned to the automatic irrigation system as his prime duty. It is a complex piece of mechanism. It requires maintenance, repair and constant tuning. Too often the system receives little or inadequate care once it has been installed. This approach is not fair to the equipment manufacturer nor to the golf course. A price tag of one-quarter million dollars does not mean one can ignore an automatic irrigation system. Rather, it is an investment in controlled irrigation and, as any investment, it needs constant overseeding.

There are many automatic irrigation systems today with more than 1,200 pop-up heads supported with the necessary backup valves, controllers, pipes, tubing, wires, etc. It stands to reason that malfunctions are going to occur. How does one best monitor such a system?

A few years ago, Superintendent Fred Bove, of Brentwood Country Club, Los Angeles, Calif., solved this problem as neatly as one might imagine. Brentwood was one of the very first golf courses in the world to install automatic irrigation as we know it today. The system has since been updated. On this particular day, as we toured the course, a hose and hand-set sprinkler was seen operating on one of the "automatic" fairways.

Bove explained that he did not hold the day irrigation man totally responsible for wet or dry areas on the golf course. Instead, their presence was primarily the responsibility of the fairway and/or rough mowermen! They covered the entire 18 holes at least three times a week and, if they were paying careful attention, should spot development of any wet or dry areas well before the crisis stage is reached. They then report the fact to the day irrigator and immediate corrective action is taken.

"Under normal operating procedures," Bove said, "the day irrigator replaces or repairs the plugged sprinkler head and that solves the problem. Right?"

"Right!," I quickly replied.

"Wrong!," syas Bove. "The area under the influence of this particular sprinkler head has gone without irrigation for at least several days before the mowerman is able to detect grass stress. In order to catch up with the soil moisture level of the surrounding area, supplemental irrigation is needed and that's why you see the hose and hand-set sprinkler on an automatic fairway."

It was a good lesson in automatic irrigation management.

Testing For Soil Moisture In Greens

Perhaps the most often asked question on irrigation concerns greens. "How can I judge the amount of water to schedule for greens?"

Again, the evapo-transpiration rate is an invaluable aid. So is the soil probe with just a little experience attached to it. Certainly, an irrigation judgment must be made every day for every green during the critical summer months. It seems foolhardy to do otherwise.

The best practical field test for determining the adequacy of soil moisture in greens was published in the Bulletin of the USGA Green Section in August, 1932:

> "The most convenient way to determine the amount of water in the soil is to examine a small plug removed from the putting green. If water can be pressed out of the plug with the fingers several hours after watering, the green has been overwatered. It is better to keep the turf somewhat dry to encourage deep roots and thus avoid a multitude of turf problems."

A simple test but one, that will lead to better irrigation.

Golf Associations Contribute Generously to Green Section Research

During the past several years the U.S.G.A. Green Section Research and Education Fund, Inc. received great impetus from several state and regional golf associations, State Chapters of the Professional Golfers Association, and Golf Course Superintendents' Associations. We are extremely grateful and wish to recognize the following organizations for their generous contribution to turfgrass research geared to golf course management problems. Over the years most of the following have been annual contributors to the program.

Alabama Chapter P.G.A.
Alabama Golf Assn.
Birmingham Golf Assn. Foundation
Carolinas Golf Assn.
Georgia Golf Course Supts. Assn.
Georgia State Golf Assn.
Michigan & Border Cities Golf Course Supts. Assn.
New England Golf Assn.
*Professional Golfers Assn.
Southern Golf Assn.

We wish to encourage all state and regional golf associations to join us in this effort to give further impetus to golf turfgrass research for better golf. Contributions are tax deductible! Contributions in any amount are welcome. Please make checks payable to the U.S.G.A. Green Section Research and Education Fund, Inc.

** Contribution through National Golf Fund—derived from National Golf Day*

Soil Microorganisms and Preventive Fungicide Programs—What are the Interactions?

by A.R. MAZUR, Assistant Professor—Horticulture
Clemson University

Soil is far more influencial in turfgrass management than its most obvious function as a root anchoring medium. Soils often appear to be an inactive mass because the greatest proportion of the inhabiting organisms are too small to be seen with the naked eye. The actual amount of growth that occurs from the vast array of soil organisms (Table 1) is staggering. The greatest portion of the soil organisms are members of the plant kingdom.

Under fertile soil conditions normally associated with the growth of turfgrasses, bacteria may account for one ton or more of live weight in the active root zone. The combined live weight of fungi and actinomycetes is about half that of the bacteria.

More extensive populations of microorganisms are observed in turfgrass soils, than where soil is cultivated for crops. The greater populations have been attributed to the much larger root mass under sod conditions. A strong association and interdependence exists between higher plants and microorganisms. For the most part these organisms are in the immediate vicinity of the plant roots, a zone that is often referred to as the rhizosphere.

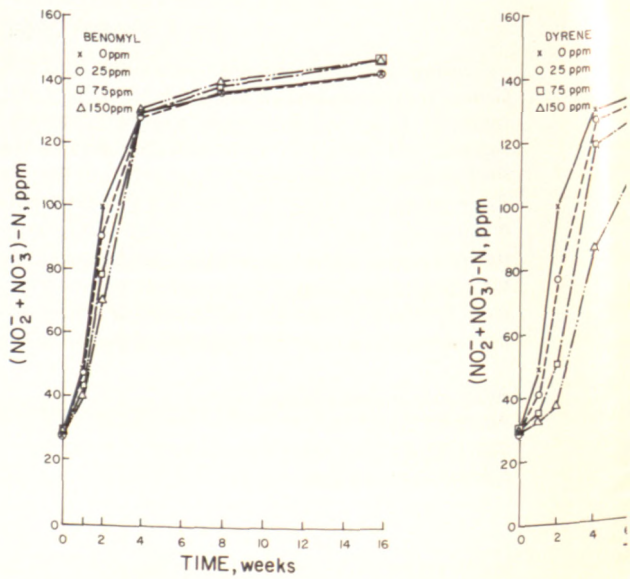
When the word microorganism is used, most think first of the no-see-ums that caused last winter's Hong Kong flu or the *pythium blight* on the ninth green. However, the vast majority of the microorganisms that turf managers deal with are not of the pathogenic or disease-producing type. In general most of these organisms play an important role in decomposition of organic matter residues, improvement of soil physical properties, and increased nutrient availability.

Decomposition of organic residues directly influences soil physical properties and nutrient availability as well as limiting the accumulation of organic debris called thatch. In the undisturbed soil system the breakdown of organic matter often includes the activities of several groups of soil inhabiting plants as well as animals. The rate of decomposition is dependent on the chemical

Table 1. Organisms Commonly Present in Soils.

PLANTS	Bacteria	**ANIMALS**	micro: Protozoa, Rotifers, Nematodes
	Actinomycetes		
	Fungi		macro: Mammals, Insects, Earthworms, Slugs and snails, Mites, Spiders, Millipedes and centipedes
	Algae		
	Roots of higher plants		

Figure 2. Effect of various rates of application of benomyl, Dyrene, and maneb and time on NO_3 concentrations in soil; laboratory application.



nature of the organic substance and climatic factors. Materials which have high percentages of lignin will require primary digestion into smaller sized particles by soil animals such as earthworms. The smaller molecules can then be more rapidly decomposed by actinomycetes, fungi, and bacteria. Where pesticide applications have suppressed or destroyed the activities of one or more of the members of the system, thatch accumulation has often been a persistant problem.

The breakdown products of organic matter decomposition provide the sticky materials and humus that improve aggregation and soil physical properties. These reactions also result in a release of normally unavailable nutrients such as phosphous which is often held in organic combinations or insoluble forms. Organic complexities that form during the decomposition processes also keep metals like iron and manganese available for plant growth.

Controlled release fertilizers which release nitrogen as NH_4^+ rather than NO_3^- are commonly used on turfgrasses. As NO_3^- is the predominate source of nitrogen for turfgrass growth. Any interference in the transformation of NH_4^+ to NO_3^- (Figure 1) has a detrimental effect on turfgrass nutrition. Since the nitrifying organisms have shown a marked sensitivity to several turfgrass fungicides, studies were initiated to investigate the effect of repeated applications of the commonly used fungicides Benomyl, Dyrene and Maneb on these organisms.

Maneb when incubated in soil under laboratory conditions had a pronounced effect on nitrification and essentially blocked the conversion of NH_4^+ to NO_3^- in soil for extended periods particularly at higher concentrations (Figure 2). Dyrene had some inhibitory effects on nitrification that were dissipated almost completely with time (Figure 2). As can be observed in Figure 2, Benomyl had very little influence on the rates at which NO_3^- accumulated in soil samples.

When 14 weekly applications of these fungicides at rates of 3 ounces per 1,000 square feet were applied to Penncross creeping bentgrass field plots, none of the previously observed inhibitory influences were noted (Figure 3). In fact all of the fungicide treated soils generally showed greater accumulations of NO_3^- and an enhancement of mineralization. The greater amounts of mineralized nitrogen observed in treated soils were attributed to the fungicide molecules as Benomyl, Dyrene and Maneb contain 19.3, 20.2 and 10.5% nitrogen respectively. Unlike laboratory incubations, the fungicides were rapidly degraded under field conditions, which accounts for the additional NO_3^- that was observed. The weekly application of fungicides did not accumulate to toxic levels and even appeared to result in an increase in the organisms involved in the degradation of the fungicides. In summary, these fungicides did not appear to have any adverse effect on the soil nitrogen system of golf putting greens when employed for extended periods in preventive spray programs.

Figure 1. Mineralization of Soil Organic Matter

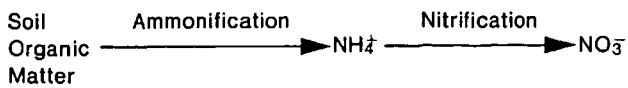
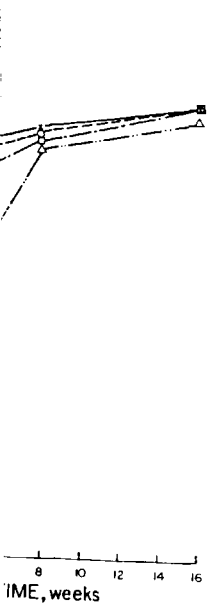
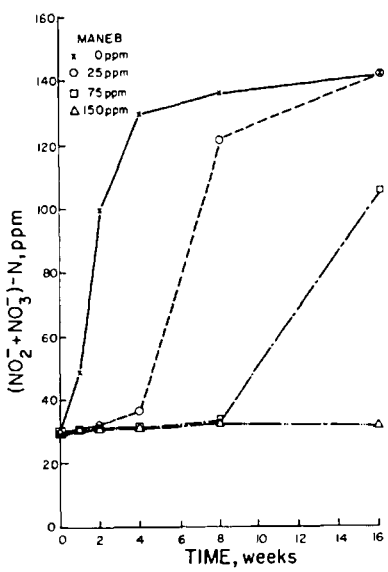
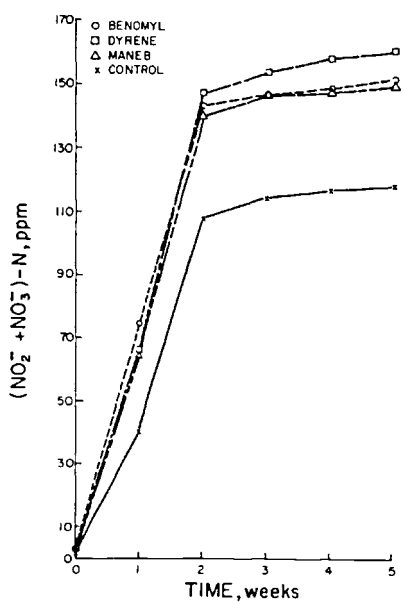


Figure 3. Effect of benomyl, Dyrene, and maneb and time on NO_3 in soil; field application.







One Management System To Check Skyrocketing Costs

by **GREGORY R. DAVIS,** Superintendent
Normanside Country Club, Elmesmere, N.Y.

In the middle of the period of skyrocketing costs, I became the Superintendent of Normanside Country Club, in Elmsmere, N.Y. When developing our management system, we continually looked for inefficiences to eliminate, and areas in which to make cost reductions. I was determined to maintain good golfing conditions and high quality turfgrass to uphold the reputation of the club *and* my own reputation as well.

Since labor is our largest expense, it was dealt with first. A highly qualified assistant was hired and the number of seasonal employees reduced. Each crew member is trained to do all of the regular maintenance jobs on the course. This gives a smaller, more flexible, highly efficient crew requiring less supervision while accomplishing just as much as a larger crew at less cost.

Most of our operations are completely mechanized now, with very little need for hand labor. Three new pieces of equipment were purchased within two years: a triplex greensmower, a large hydraulic spray rig and a utility vehicle with a small hydraulic spray rig.

The new triplex greensmower was much faster than the old because of a higher transport speed and a shorter turning radius. For the same reasons, the old triplex greensmower replaced the tee mower on tees, aprons and approaches, which are all cut at the same height.

Labor savings for both operations were excellent (including reduced weekend overtime). The greens were cut with equal quality, and tees, aprons and approaches were cut better! Time savings allowed us to enlarge some approaches. This improved them by allowing the big fairway mowing unit to make turns farther away from the greens, thereby reducing wear.

The new spray rigs brought about savings in three ways: reduced time to apply pesticides, reduced costs of pesticides (more concentrates and less pre-mixed formulations), and reduced labor to apply pesticides (eliminated most walking applications).

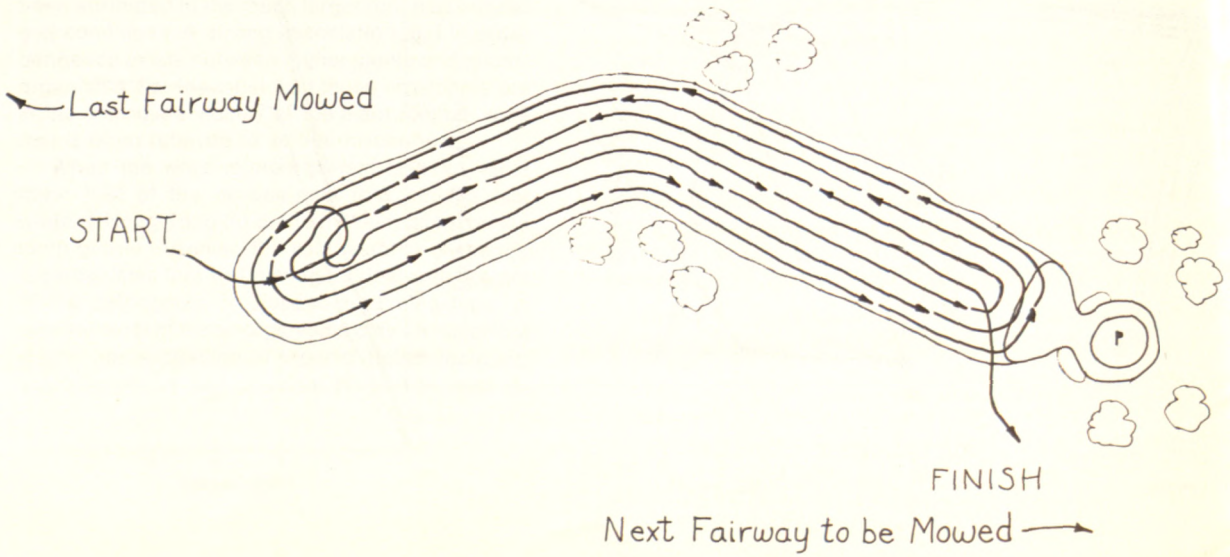
Strict preventive maintenance and thorough winter overhauls keep our equipment as reliable as possible. The expense of preventive maintenance and the expense of buying new equipment are indirect ways of saving money by reducing seasonal repairs and downtime.

NEW SHAPES AND SIZES

The original design of Normanside Country Club brought about an excellent "mating" of the golf course with our rolling, sometimes hilly terrain. In fact, only minor changes have been made during Normanside's 50 years of existence. Considering its age, the course was surprisingly well adapted to our increased mechanization.

To reduce costs, design was altered somewhat by reducing the size and shape of fairways. Not an easy task, but once accomplished, allowed faster applications of fertilizer, herbicides, etc., and more importantly, reduced mowing time. The beginnings of fairways were moved farther out from the tees, and the sides of fairways were narrowed and/or

A fairway mowing pattern; saves time, money and turf.



straightened. Parallel sides allowed fewer passes with the fairway mower and less turning around. Altered widths allowed the exact number of passes required to start mowing at the end of the fairway nearest the last fairway mowed, and to finish mowing at the end of the fairway nearest the next fairway to be mowed. This eliminated a lot of wasted transport time. (See illustration)

PREVENT LESS—CURE MORE

Some of the measures taken in this category will not be found in recommendations for growing high maintenance turfgrass! The degree to which another golf course might take these measures would be very specific to that particular course based on the number of rounds of golf played, soil, climate, member's desires, turfgrass species, etc.

First of all, seed purchases were cut to the point that only the greens are completely overseeded every year. Only par-3 and "problem" tees are overseeded, and only small repairs are seeded on fairways. No sod is purchased. We construct very little, and can use what sod we grow ourselves.

Sand purchases have been reduced by redistributing what we already have in the traps. Lower areas always tend to have deep sand that can be shoveled back up on sloped areas. We use less costly brown sand, and some out-of-the-way bunkers have been converted to rough.

I have been regulating fertilizer rates for the last few years to determine how little could be applied and still maintain healthy turf. Spring and fall fertilizer rates were cut in half and midseason applications eliminated. One or two mid-season applications were eliminated on tees as dictated by the weather and amount of play during certain periods. I have used as little as three pounds of nitrogen per 1,000 square feet on greens, but they were weaker, less dense and more subject to wear, so I now use about five pounds per 1,000 square feet. A **maximum** of ½ pound of N per 1,000 square feet is used per application.

A close watch on turf density in all areas with reduced fertilizer rates is maintained. The weather helped during the last few seasons by providing the rainfall and growing temperatures necessary for adequate growth at Normanside. If density declines and weeds start encroaching into thinning areas, or if the weather is less favorable in future years, I will adjust the rates again.

Our greens fertilizer has tiny granules; it seems to spread more uniformly than its counterpart with larger particles. The tiny granules also require less irrigation to wash them below the mow line and less is mowed off. This, of course, allows us to apply less fertilizer with the same results!

Fertilizer needs are determined from soil tests. Our greens and tees require non-phosphorus analyses which are less expensive than complete fertilizers. Choosing an analysis that matches the soil deficiencies enables more exacting applications, providing a proper balance of nutrients without wasteful or detrimental excesses.

I avoid most "combination" fertilizer products. They may suffice for preventive pest control, but we use mostly curative controls here. I rarely need or want to apply a fertilizer *and* a pesticide on the same area at the same time. Separate pesticide and fertilizer products are less costly and more flexibly applied by rates and time.

Most of the pesticides we buy are chemical concentrates to be mixed and applied with our new spray rigs. The more expensive preformulated granular types are purchased for winter and early spring applications when we cannot move our spray rigs onto the course.

Fungicide purchases have been reduced by increasing the time between preventive applications on greens, and by making only curative applications on approaches, tees and fairways. Massive outbreaks of disease are controlled on fairways, but not minor ones. My assistant and I keep a very close watch for disease outbreaks with daily checks on the course, especially during midsummer stress periods. Dollar spot and melting out are more common occurrences here than Pythium blight. Our varietal blends of turf types which have developed on our fairways over the last 50 years, help in resisting massive outbreaks of disease.

Herbicide purchases have been drastically reduced by spreading out the time between selective applications from annually to every two or three years. One year I may control broadleaf weeds, the next year crabgrass, and the third year only spot treatments on either. By making detailed weed surveys each season, the actual amount of herbicides used have been reduced too. Paper

An old, but still efficient landmark at Normanside CC.

sketches of the golf holes are marked with proportionately-sized areas corresponding to the areas of weeds on the course. Total acreage for each weed type is estimated and chemical purchases are determined.

Insecticides are only used as curatives on all turf areas. Again, we have had no epidemic-sized attacks of Hyperodes weevil, chinch bug, Ataenius beetle, etc. We do have a Japanese beetle problem, but we do not apply any chemical controls to the grub stage in turf. There are several deciduous trees on the course where the adults accumulate and feed (Norway maples, mountain ash, basswood, etc.). These concentrated areas are sprayed with carbaryl (Sevin). This is less expensive than the chemicals recommended for grub stage control, and much less is needed to spray several trees than would be needed to cover our large acreage of turf. We have not had serious damage from Japanese beetle grubs on our turf in the last few years. Perhaps the winters have been cold enough to reduce population size and perhaps the summer turf growth has been good enough to mask the damage, but, maybe our control method is also working well!

CONSOLIDATION AND CUTBACKS

One cost-saving method used was to incorporate as many jobs as possible into a smooth, timely operation. For example, while one person mows greens, another person changes cups, handles the flagstick so the greensmower need not stop continuously, checks ball washers, trash cans and towels, changes tee markers, and hand mows one or two small shaded tees. The workload is divided when the two people switch positions half-way around.

Using a mechanical bunker rake and skipping undisturbed areas has reduced trap maintenance costs.

Tee maintenance has been cut back by not mowing any slopes on tee edges or between terraced tees. These areas are now rough.

The only additional way to reduce costs in scheduling jobs was to limit the actual number of times each job was done. Priorities, desires of the members, needs of the golf course, etc. all come into play. Edging bunkers was eliminated and may become an alternate year operation. Aerating and topdressing of tees and fairways have not been done at all in the last few years. Hopefully, reduced growth from decreased fertilizer applications will limit thatch buildup. I am watching this closely, plus looking for any signs of increased pest problems. I am not sure of the eventual scheduling of these operations, but it will not be done again this year.

Less grooming is done early and late in the season. This saves on labor and equipment use.

Fairways, tees, aprons, and approaches are only mowed twice a week. Reduced growth has made this possible too. This is a tremendous savings in labor and equipment use.

We use "striped" mowing patterns only on greens. Other areas are mowed using elongated clockwise and counterclockwise patterns.

WRITTEN RESULTS

Detailed records are kept to see how money and time are being spent or saved. Year-end summaries reflect cutbacks and determine their value. Each employee maintains a daily worksheet which is summarized. Equipment maintenance sheets are kept to record everything from adding oil to complete overhauls on each piece of equipment we have. Purchases are recorded throughout the year and a running record helps us remain within budgetary bounds at all times. Pesticide and fertilizer application records are also kept and "comments" regarding new products or new application rates are used to determine the need for changes in the future.

At year's end, summaries of all records provide information for developing the next year's work schedule, equipment needs (potential repairs and replacements), supply needs, and of course, a breakdown of next season's proposed budget. Peak efficiency is impossible without thorough, accurate records.

KNOWLEDGEABLE PEER GROUPS

It is impossible to put a dollar value on the many savings that have been realized at Normanside based on information I have gleaned from the different facets of the turf industry. Membership and participation in national and local GCSAA, USGA Green Section and state and local club associations is essential. Keeping up-to-date on publications, major textbooks and periodicals is most helpful. A good educational background and attendance at turf conferences, seminars and equipment clinics is very important. But perhaps most important of all is talking with people in the field of golf course maintenance such as consulting agronomists, technical sales representatives and other golf course superintendents. All areas provide important knowledge necessary for the increased effectiveness of a superintendent's management policies.

CONCLUSION

Many cutbacks have been made to reduce costs involved with maintaining the golf course. Hopefully, most of the cutbacks were implemented in a manner that brought about the least amount of unfavorable change in playing conditions of the course. I attempted to accomplish this by reducing operations collectively. For example, fairway mowing and fungicide applications could be reduced only by reducing fairway fertilization and reshaping. Cost reduction measures are still short term, but minimums are only determined gradually and with continuous supervision.

Normanside Country Club celebrates its 50th anniversary this year. I am hopeful that, with cost reductions and increased efficiency, we will be able to provide the best playing conditions possible under reduced operating costs!

Thoughts From One Superintendent's Wife—To Another—

by CAROLINE C. TWOMBLY

I have been talking about executive's wives for 35 years. Now that I am to put these thoughts on paper, I am not at all sure it is a good idea, but I am sure that every executive's wife reading this will be certain it does not apply to her.

I have worked in electricity and electronics for 30 years while my husband worked in another profession. Through the years I met many executive's wives from all areas of the business world. I met far too few who really understood or wanted to understand what their husband's job was, what abilities he had to have to stay in that position, what it required of him or how it affected him mentally or physically. The greatest percentage of the women were mainly interested in the social level his salary permitted. What he did interested them only to the point of how many days off he could take and when he would have his next vacation.

I've been married to the same man for 49 years. Thirty-eight of those years he has been a golf course superintendent. This is why I am interested in the wives of golf course superintendents. There are some who think that, because their husband is a golf course superintendent, they are not an executive's wife? They are very wrong!

Webster's dictionary defines "executive" as any person or body charged with administrative or executive work. Your husband and mine are executives, but the calibre of the executive is up to you and him. Club members, other superintendents, officials from other areas of the golf world, club managers, golf professionals, salesmen and even his own workers look at the things he does and listen to what he says and judge the type of executive he is. If he is assured and self-confident, dedicated to his club and the personnel, they then know he has an understanding wife. His willingness to stay for an unexpected meeting or to deal with a sudden problem; his always-on-time record; his ability to return to the club in the evening or on a day off to straighten out some major problem; all of these show your love and concern for him, your understanding, your ability to adjust your life to the demands of his job.

If he is anything but assured and self-confident, chances are his wife is not understanding and he is torn between two loves. He is never sure how his wife is going to accept the demands of his position, neither is he sure how the club is going to accept the demands his wife makes on him. He tries to balance the two but rarely succeeds.

It is to this group of wives I address myself. Fortunately, they are in the minority.

When he shows an unwillingness to stay for any unexpected problem or meeting or, if he does stay, has anxiety to leave as soon as possible, he demonstrates a lack of understanding at home. His tendency to call on one of his men to take care of a problem that occurs after working hours or on one of his days off, shows that you lack concern for what happens to the club, its property or its equipment. Acres of very valuable land and thousands of dollars worth of equipment are entrusted to *his* care, not to one of the workers on the course.

He does love his work. If he did not, he would be doing something else. He loves you and wants to make the best living he can for you. You say he has competent help and he does, but if any one of those men were as competent as he, *he* would be superintendent, not your husband.

A wife must remember that chinch bugs, beetles and worms have no respect for what you might want to do. The insects are hungry and their one object is to eat as much as they can before they are discovered. Disease strikes any time conditions are right and it has no regard for what you have planned. Of course the summer rains are needed, but your husband didn't ask for them to come down in torrents to wash out sand bunkers, stand in puddles all over his golf course and, when the sun comes out, cook his grass like spinach. Summer downpours have also been known to wash out newly seeded areas and destroy important construction work he has started. Plans must often be changed.

Our men, the superintendents, are almost in the genius class. They are doctors who identify and cure diseases of the grass; entomologists who identify and destroy the insects and worms, part time lawyers who know the legal codes of

town, city, county, state and federal governments regarding electricity, gas, gasoline and noise levels. They must know what, how much and how often different chemicals can be used, labor laws and building codes. They are engineers, for they must rebuild or construct greens, tees, fairways, bridges, cart paths and in some cases buildings. They are diplomats maintaining good relations with their members, club officials, their employees, other superintendents, salesmen and various groups within their professional sphere.

Our men are great people but to be at their best, they need our understanding and our cooperation. Your man may need to release tension by talking to you. He isn't really asking for advice, just for the one he loves to listen to him. Often problems resolve themselves just by talking about them. He needs to know you love him and that you understand that he loves you. You may not understand his problems and be able to give advice, but if you don't listen, you never will understand that it is his self-respect, his integrity and his desire to make the best living he can for **you** that keeps him on the job when **you** want him home.

Some Agronomic Aspects of Turf Fertigation[1]

by G.H. SNYDER and E.O. BURT[2]

The pros and cons of turf fertigation (fertilization through the irrigation system) have been presented many times, but the lists vary little from author to author. The chief disadvantages cited relate to engineering problems, such as uneven water distribution, equipment corrosion and fertilizer precipitation within irrigation lines. Considerable attention has been paid to these problems. Methods of injecting fertilizer into irrigation systems have been described elsewhere. However, agronomic aspects of fertigation have received little attention from research scientists. In general, fertigation has been practiced on an "all or nothing" basis which makes agronomic evaluation difficult. Greatly needed is research utilizing randomized, replicated plots which provide accurate comparisons among treatments and statistical evaluation.

We have attempted to provide scientifically gathered information on agronomic aspects of fertigation for several years. However, considerably more time is needed to get a reasonably complete picture in our geographical region. Moreover, research by others is needed in other regions. Thus at this time agronomic discussions of turf fertigation must combine educated speculation with limited research data.

Light, Frequent Fertilizations

The primary advantage of fertigation is that fertilizer may be applied with very little labor required beyond that needed for the usual irrigation. Because of this, fertilizer can be applied very frequently, but at low rates per application. This aspect of fertigation is sometimes overlooked or underemphasized.

It is widely felt that frequent, light fertilizer applications will minimize the effects of poor water distribution. Observations made during the course of our research agreed with this contention, although the study was not designed specifically to test this theory, and the degree to which the theory holds will vary among irrigation installations. Probably the best reason for using frequent light applications of fertilizer is to encourage relatively constant grass growth with respect to time. Particularly in the case of nitrogen (N), frequent light applications will minimize unwanted flushes of growth which alternate with periods of N starvation, a cyclic condition that generally results from periodic heavy applications of N. We have found little difference in this respect between daily and weekly N applications through the irrigation system, which agrees with data of other workers using conventional application methods. But we feel that the above mentioned cycling may be observed with N fertigation intervals of greater than one week. Turf comes closer to requiring weekly, or even more frequent irrigations than most other field-grown crops, and in this respect is well suited to fertigation.

Reduced Leaching Losses

Since very little fertilizer will be present in the soil solution at any one time when light frequent applications are made, the efficiency of plant uptake should be good. In support of this, we have observed reduced N leaching losses when daily N applications through the irrigation system are compared to conventional N fertilization at three week intervals. Fertigation is often promoted as a

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[2] *Associate Professor, Agricultural Research and Education Center, Belle Glade, Fla., and Professor, Agricultural Research Center, Ft. Lauderdale, Fla., respectively.*

Fertigation is used by Mr. Bill Bayless to make light, frequent fertilizations on the Huntington Sea Cliffs Country Club in Huntington Beach, California.

way of reducing fertilizer rates and less fertilizer usage under golf course conditions has been reported. We were not able to establish that lower rates are justified when fertigation was compared with an efficient slow-release N source. However, the N leaching observations, cited above, suggest that fertigation may reduce the amount of N fertilizer needed as compared to rather inefficient, though commonly practiced, N fertilization methods such as infrequent applications of soluble N sources.

Simulates Slow-Release Fertilizers

In principle, fertigation can simulate the use of slow-release fertilizers. Considerable research has gone into developing slow-release fertilizers that release nutrients at a rather constant, desired rate. This rate, however, is affected by various factors such as temperature, moisture, micro-organism activity, etc. These factors are not entirely controllable by the golf superintendent. The superintendent does have complete control over the amount of nutrients applied with each fertigation. This control can be useful to the intelligent, knowledgeable superintendent, but may only confuse the less competent individual who may prefer to use slow-release materials which act on their own. We have obtained growth at least as consistent, and at times more consistent, by using N fertigation as compared to a slow-release N fertilizer. The cost of N sources suitable for fertigation is, of course, much lower than that of slow-release sources.

N Sources

We are currently studying N sources for fertigation. This work is not complete. The all-ammonium (NH_4^+) source has proven superior to a combination of ammonium and nitrate (NH_4NO_3), all nitrate (NO_3^-) or urea under our conditions. This most likely occurs because we have problems with high pH. The all-ammonium source is the most acid forming N source of the group, which improves manganese (Mn) availability. In this respect, fertigation with these sources affects soil pH in the classical manner. Thus far, it appears that the sources are equally effective when Mn is sufficiently available, under our conditions. Work is needed in other regions to determine the best N source(s) in those locals. Anhydrous ammonia (NH_3) is frequently applied to field crops in irrigation water when flood or furrow irrigation is used. But it generally is not recommended as an N source for application by sprinkler irrigation because large quantities can be lost by volatilization. Volatilization is much reduced at low concentrations. Thus when used in light, frequent applications so that NH_3 concentration in the irrigation water remains very low, volatilization losses may be acceptable if other circumstances (price, availability, convenience, etc.) greatly favor its use.

Fertigation + Conventional Fertilization

Fertigation probably can be best used to apply nutrients in light, frequent applications over the

large acreage of a golf course. The complexity of the system is greatly increased if the superintendent desires to use fertigation differentially over his course, to make heavier applications on greens and tees, for example. These heavy use areas, which will receive a low maintenance level of fertilizer by fertigation, can receive supplemental fertilization by conventional methods. Nutrients which are well retained by the soil can be conventionally applied, also, if desired. Using fertigation does not require that the fertilizer spreader be thrown away. But fertigation does offer a simple way of fertilizing the greatest acreage of a golf course—the fairways—and hopefully will allow a superintendent and his crew more time to concentrate on those portions of the course where their attentions are more appreciated (greens, and tees, for example).

Nutrients For Fertigation

Nitrogen and sulfur (S) are poorly retained by most soils. Fertigation offers a means of maintaining an adequate level of these nutrients in the soil. Sand soils do not hold potassium (K) well, and fertigation may prove useful for K in sand soils. Under high pH conditions, certain micronutrients are retained so well by the soil that they become unavailable to the grass. Fertigation may be a way of maintaining adequate availability of these nutrients. It has been successfully used to apply manganese (Mn) where high pH was causing a Mn deficiency. Fertigation may, or may not, be useful for applying other nutrients. Much will depend on the availability of soluble fertilizer mixes at acceptable prices. A superintendent may wish to make his own mixes from dry sources. However, it may prove more convenient and less expensive to purchase pre-mixed fertilizer as a liquid if a competent dealer is available. Expensive liquid fertilizers that are sold especially for foliar feeding are probably of no particular advantage for turf fertigation, since high volumes of water are used and little fertilizer will remain on the foliage. Most liquid fertilizers are competitively priced with their dry counterparts.

The Superintendent's Decision

Thus for golf turf there appear to be many agronomic advantages to maintaining a relatively constant, low level of available nutrients in the root zone. Fertigation is only one of several methods that can be used to achieve this objective. Slow-release fertilizers and frequent conventional applications of soluble materials are others. Relative to these, however, only fertigation is economical both in terms of labor and fertilizer cost, but it places new responsibility on the golf superintendent. For this reason, a Green Committee probably cannot successfully force fertigation upon a superintendent who is not convinced that it will be advantageous from a total management standpoint. On the other hand, a superintendent who is properly motivated and interested can usually make a success of fertigation in spite of unanticipated problems which always arise. They can take heart in the fact that many superintendents are using fertigation successfully in Florida and elsewhere, and its use seems to be on the rise.

In order to study the effect of fertigation on nutrient leaching soil water samples are taken from below the turf roots and chemically analyzed.

NEWS NOTES FOR MAY

What About Those Nitrogen Losses?

Dear Sir:

The article on Nitrogen Losses from Golf Greens (January, 1977) would have been more helpful if the test conditions and procedures had been given in more detail. For example, how much nitrogen was applied? How much water was applied? What were the infiltration rates? What depth of soil, sand, or mixture was being studied? What was the nitrogen source in the 12-12-12 grade of fertilizer?

I'm wondering if the authors of the article feel that 45 days is a sufficient period for study of nitrogen leaching losses from slow release sources.

The U.S. Public Health Service recommends that NO_3nitrogen in potable water not exceed 10 p pm. This value may not be in accord with the 45 p pm NO_3-nitrogen allowed by EPA but one is inclined to pay some attention to it. Assuming it to be a critical level, doesn't this change the significance of the data reported?

/s/ William H. Mitchell, Extension Agronomist

Dear Mr. Mitchell:

Relative to the concentration of NO_3-nitrogen allowed in drinking water, EPA and the U.S. Public Health Service have a standard of 10 ppm NO_3-N which is equivalent to 45 ppm NO_3.

Rates of application for the various sources of nitrogen were two pounds per 1,000. Irrigation was at the rate of one centimeter of water per day between May and September and one centimeter every other day during the remainder of the year.

Infiltration rates ranged from 0.1 inches per hour on the soil mixture to over 10 inches per hour on the sand mixture. The depth of all profiles was 12 inches of soil, sand or mixture which overlayed 4 inches of gravel.

The nitrogen source in the 12-12-12 fertilizer was urea and ammonium sulfate.

The 45-day observation period was insufficient to collect all of the nitrogen from the slow-release sources of nitrogen. However, the nitrate levels in the leachate were very low for all nitrogen sources.

I hope we have answered your questions. Most of this information should have been included in the article.

Richard L. Duble,
Turfgrass Specialist

Electric Charge Boosts Pesticide Application Effectiveness

Dr. S. Edward Law, Agricultural Research Engineer of the University of Georgia, has developed a new system for pesticide applications. Under sponsorship of the University of Georgia and Cotton, Inc., Dr. Law electrically charges pesticide spray droplets which are then attracted to the plant leaf surface. The system can cut pesticide consumption by one-half at a saving of $1 billion annually for the American farmer. The USGA Research and Education Fund is supporting Dr. Law's work as it relates to turfgrass applications.

When spraying pesticides, compressed air is used from a spray-charging nozzle to propel the electrically charged droplets toward the plant. A negative charge is usually used. As the charged cloud approaches the crop, the constraint to remain at ground voltage induces into the crop an opposite charge to that of the cloud. Thus, the negative particles are drawn down to the plants.

"Of special importance," says Dr. Law, "is the fact that not only is more pesticide deposited on the plants, but it is distributed more evenly." This means less pesticide will be needed for control and low volume spray applications will be ideal.

U.S. Patent rights were granted in January, 1977 and foreign patent applications are already filed. The equipment will be relatively inexpensive and will utilize a solid state power supply that can be run off a tractor battery. Since conventional pesticide applicators usually put only 20 percent of the material onto the target plants, Dr. Law's new technique expands agricultural scientific horizons once more.

Diseases; Insects; and Weeds—Beware!

TURF TWISTERS

How's That Gibberellic Acid?

Question: I have Tifgreen bermudagrass throughout the golf course and have difficulty in developing a good uniform rough. Any ideas? (Texas)

Answer: In preparing for the U.S. Open Championship in Atlanta, Ga., last year, gibberellic acid was used in the spring at 10 grams per acre. It stimulated early growth and uniformity was best at a 3-inch height. A good fertilization program will also be important.

For White Roots

Question: As our fairways come out of the winter some areas appear to be dead. How can I tell before greenup time if I'm in trouble? (New Mexico)

Answer: Use a soil probe or a cup cutter and carefully check the roots. If they are white and healthy, recovery chances are good. You might also cut a small section of sod, place it in a flower pot, bring it indoors and observe.

And Timing of Overseeding

Question: We plan to overseed our greens this year with bentgrass and have heard conflicting views as to the best time. When would you sow? (Oregon)

Answer: For overseeding purposes, the early summer (June) has given very good results. Even a mid-summer seeding (July or August) can be effective. Spring or fall overseedings receive tremendous competition from *Poa annua*. But one swallow a summer does not make. To be effective, putting green overseedings should be an annual affair.