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USGA GREEN SECTION RECORD

A Publication on Turf Management by the United States Golf Association

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COVER PHOTO: A golf course must be considered as having an ecology of its own. Understanding this ecology is essential to the performance of turfgrasses used for golf turf.

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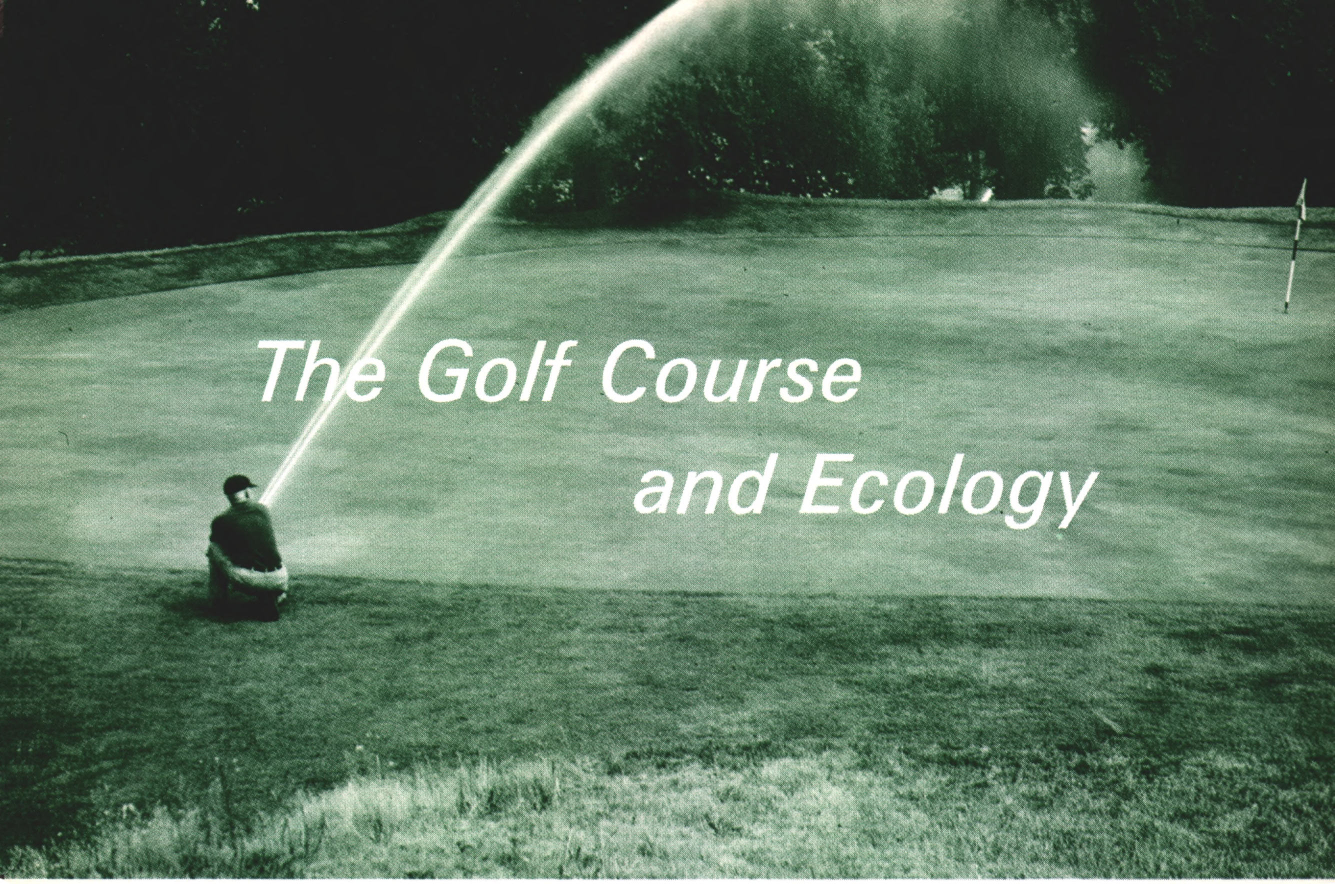
The Golf Course and Ecology



Syringing—a management practice that modifies the microclimate.

by JAMES W. TIMMERMAN, Eastern Agronomist, USGA Green Section

Ecology is a word often used but seldom understood. With the attention focused on the harmful effects of pollution, ecology is fast becoming our greatest problem. But, as one noted conservationist put it, people have only a vague idea of what ecology is all about. The same can be said for turfgrasses. Do we, as turf managers, really understand turfgrass ecology?

Classically, ecology has become known as the interaction of organisms and their environment. This means that any environmental factor—climatic, soil, and biotic—whether natural or imposed, and their interplay take on meaning as an ecological aspect of turfgrass management. However, to successfully manage turf under golf course conditions requires the employment of many management practices, such as mowing, irrigation, fertilization, etc., that grasses growing naturally would not be subjected to. From this standpoint, turfgrass ecology then encompasses environmental and management interrelationships.

Adaptation and Ecology

Adaptation of turfgrasses to a particular region depends upon all environmental factors that affect growth. The more dominant ones are climatic, soil, biological, and geographical. These factors are interrelated, and the plant's ability to survive is governed by how well it can tolerate the many forces these factors exert individually or in combination. Each turfgrass specie has tolerance limits, and if these limits are exceeded it will not persist.

The most influential factor in determining adaptation to a region is climate. It embodies temperature, moisture, light, and wind. Based on their growth habit, turfgrasses have been grouped as either cool-season or warm-season grasses. Furthermore, these are broadly classified as adapted to one of four general climatic regions: cool-moist, warm-moist, cool-arid, and warm-arid regions. However, differences in geography and employment of different management practices may render certain grasses adaptable to a region where otherwise they would not persist. As an example, grasses of cool-humid or warm-humid regions may grow quite well in arid regions if irrigation is available.

Usage and Ecology

While environmental factors determine to a large degree what grasses are adaptable to a region, golf courses must be considered as an independent ecosystem within that region. As such, how various varieties of grasses are used on golf courses is a primary ecological consideration. They must be able to tolerate conditions they are subjected to. Grasses used for greens, tees, and fairways must withstand close and frequent clipping, tolerate heavy traffic, and recover rapidly from injury. Only certain varieties of bluegrasses, bentgrasses, and bermudagrasses have these qualities. Grasses for roughs, while not clipped as close or as often, must still tolerate traffic and usually more shade and less water. Varieties of bluegrass, fescue, and bermudagrass meet these requirements.

Climate and Ecology

We have already seen that climate is responsible for the grasses adaptable for golf courses. However, the four aspects of climate—temperature, light, moisture, and air—also have seasonal environmental effects on the grasses within a region that determine their performance under golf course conditions. While not much can be done about the weather, certain management practices can modify its effects. Furthermore, it must be remembered that no aspect of climate acts upon the plant alone. It acts in combination with other aspects, and as a result it is modified by the other factors.

Temperature—All turfgrasses have three critical temperatures: minimum, maximum, and optimum. Obviously, if the minimum or maximum temperature is exceeded for any length of time the plant will die. But these temperatures are often hard to determine because the wind, soil moisture, humidity, light intensity, age of plant, and management practices all will affect the survival temperature.

Attempts, however, have been made to determine limits and optimum temperatures. Research to date shows optimum temperatures for cool-season grasses to be from 60° to 80°F. Growth slows to a minimum above 90° to 100°F, with root and reserve carbohydrates being depleted. Death due to cold weather is a combination of the effects of low temperature, moisture within the plant tissue, and degree of plant hardiness. Optimum temperature for bermudagrass is reported as 95°F, with growth slowing at 59°F and 105°F.

Soil temperatures are also critical to growth, but often it is difficult to separate the effect of soil temperature from air temperature as an ecological influence.

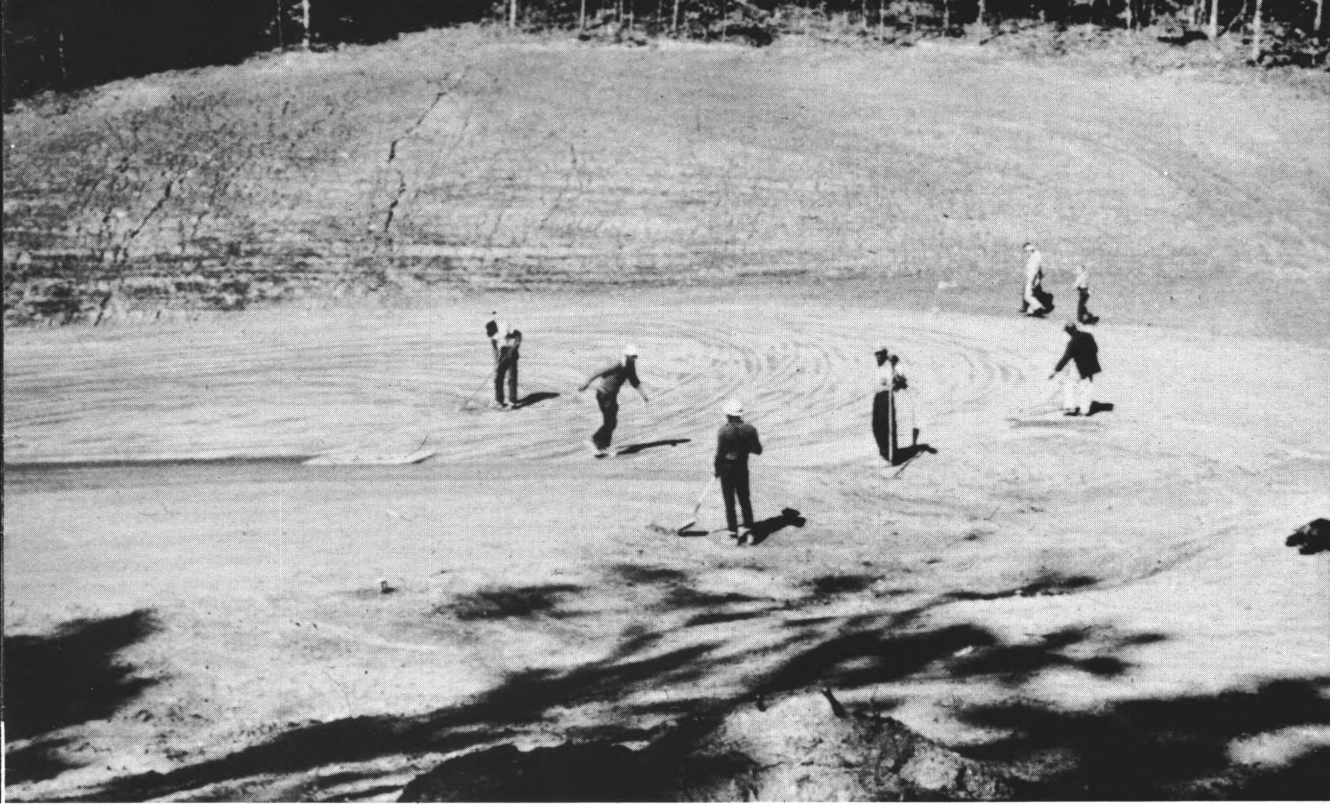
Light—In considering the influence of light on the ecology of turfgrasses, several factors must be considered—the light intensity, duration of light period, and quality of light. Light enables turfgrasses to carry on photosynthesis and respiration. These two physiological processes provide the means of obtaining energy for growth and survival. Furthermore, both of these processes are affected by temperature. At moderate temperatures, photosynthesis occurs faster than respiration with a resultant accumulation of food reserves. As the temperature rises, photosynthesis reaches a point where it levels off and it begins to fall. Respiration also increases with increasing temperature, but to a much higher point than photosynthesis. Eventually the plant uses food reserves faster than they are produced and draws upon those synthesized at the optimum temperature. If this condition prevails for a period of time the plant will suffer.

It has been difficult to determine the light requirements of turfgrasses, although the major turf species have been ranked as to their ability to grow in reduced light. However, one ecological relationship emerges: the light requirement of a turfgrass beyond that needed to keep it alive is largely determined by turf usage. Grasses subjected to heavy play usually need more light to survive. Shaded tees generally have a lower turf density than sunny tees. Reduced light intensity results in longer internodes, smaller leaves, and a more yellow color because of less chlorophyll. Moreover, grasses grown under low light have restricted roots, become more succulent and more susceptible to disease.

Moisture—Except for temperature, moisture is the most important climatic factor influencing turfgrass growth. Water is essential because it composes roughly 90% of the growing tissue, transports nutrients throughout the plant, is an important part of photosynthesis, maintains turgidity in leaves, and helps regulate plant temperature.

Due to the development of irrigation systems for golf courses, water is not a restrictive factor for survival. Water management, however, is a prime ecological factor. The judicious use of water many times is responsible for preventing wilt. Courses with automatic systems now can syringe greens and fairways more effectively, thus reducing wilt, especially that of *Poa annua.*

Overwatering, on the other hand, either from excessive rainfall or by irrigation, results in a soft and succulent plant more susceptible to wilt and disease. In this respect, research has shown that *Poa annua* watered six times as opposed to two times a week exhibited twice as many stomates (pores in leaf) to a given area.



Soils—ecologically important to good turf culture.

Another part of moisture influence is humidity, which refers to the amount of water vapor in the air. It is important ecologically because it influences water loss from soil and plants, and its association with dew and disease. Most turfgrass diseases need a moist environment to germinate and grow, and disease incidence is higher when humidity remains high.

Snow is also ecologically important in the northern states. It serves as a source of moisture in the winter and insulates and protects the turf from low temperatures and desiccation.

Air—Wind and air are the last part of climate that influences the ecology of turfgrasses. Air surrounding the earth contains carbon dioxide that plants use for photosynthesis. Wind is beneficial because it replenishes the carbon dioxide supply to the turf. On calm, bright, sunny days it has been shown that carbon dioxide concentration can become suboptimum for maximum photosynthesis.

While air turbulence is beneficial by increasing carbon dioxide supply, it can be harmful by increasing transpiration. Moving air reduces humidity which in turn increases water loss from plants and the chance for wilting. During the winter high winds result in desiccated turf if unprotected by snow.

Air pollution has recently been shown to be harmful to turf in certain industrial areas. The injury is due to the phototoxic components of smog such as ozone, and to reduced light intensity. *Poa annua* seems especially sensitive to smog components.

Microclimate—Just as climatic relationships affect the ecology of turfgrasses, so does the microclimate. It is considered to be the climate near the ground as opposed to the general climate of a region. It encompasses plant material living above ground, the thatch, and to some extent the roots. Microclimate is important because differences in environmental factors may be greater nearer the surface than farther above. Temperature and humidity are usually higher within a few inches of the soil than three to five feet above.

Thatch is a very important part of the microenvironment and influences the microclimate. A small amount is beneficial because it provides shade and lowers soil temperatures. It also provides some protection from drying winds and from frost and low temperatures. Thatch may reduce water loss and aid in the reduction of weeds.

Adverse effects of a thick thatch layer include: retention of water in the thatch layer, increases disease and insect incidence, reduces air infiltration into the soil, reduces the amount of nutrients that reach the soil, and reduces pesticide effectiveness.

Modifying the microclimate many times saves turf during periods of stress. Syringing during high temperatures cools the leaf surface and raises the relative humidity near the grass plant, alleviating moisture stress. This has been shown to be more effective if accompanied by air movement. Covering greens with artificial screens or other type mulches during the winter, and topdressing heavy in the late fall has been effective in preventing serious injury from low winter temperatures and desiccation.

Soil and Ecology

Soil plays one of the major roles in supporting turfgrass growth and therefore is a key aspect of turfgrass ecology. It is composed of mineral matter, organic matter, air, and water. The functions of soil are to provide an environment for the development of roots and to supply the necessary mineral nutrients, water and oxygen. The basis for sound turf culture begins with the soil-root environment. Roots require nutrients, water, oxygen, a suitable soil temperature, and a favorable pH range for growth. Anything which affects these variables ultimately determines the health and survival of the plant.

Roots need oxygen to grow. This is supplied by the soil air, which is composed of oxygen and carbon dioxide. The amount of air present is dependent on the nature of the soil pores. The percentage of oxygen and carbon dioxide is governed by the respiration of plant roots and microorganisms, which use oxygen and produce carbon dioxide, and by the exchange of air between the soil and the atmosphere. Soil aeration refers to the process of replacing soil air by atmospheric air and is brought about mainly by diffusion. Air in well aerated soils is similar to atmospheric air, whereas poorly aerated soils contain higher carbon dioxide levels and lower oxygen levels. Plant growth under poorly aerated soil is probably limited by low oxygen rather than high carbon dioxide levels.

So far it has been difficult to determine optimum soil air levels for turfgrass growth. However, uptake of water and nutrients is often decreased by poor aeration. Fortunately, grasses appear to be more tolerant of poor soil aeration than many other plant species.

Poor aeration also affects microbial activity. Rapid decomposition of organic matter, organic fertilizer, and thatch is slowed. The bacteria that convert ammonia and organic forms of nitrogen to the nitrite form which the plant absorbs is also inhibited.

Adequate soil water is needed for healthy turf. Like soil air, soil water is dependent on the nature of the pore space. When water is lacking the turf will obviously wilt. Too much water limits air diffusion and plant roots suffer from lack of oxygen. Plant growth is usually characterized by a yellowish-green color due to the leaching of nitrogen or reduced availability of iron. Excessive water in the soil also enhances disease activity, since most turfgrass disease fungi are favored by moisture. Compaction too is more severe when soils are overly wet.

Controlling water in the soil then becomes important to turfgrass ecology. Irrigation and drainage are generally the principle means used to control soil water. An irrigation system designed and installed properly, and managed intelligently is a must. Good surface and internal drainage should be incorporated into all portions of the golf course wherever possible. Where this cannot be accomplished artificial drainage should be installed.

Since soil under golf course conditions receives heavy traffic, compaction affects soil-root ecology. Soil compaction is detrimental because it decreases pore space and destroys aggregation. This in turn restricts the amount of air and water available to plant roots and slows internal drainage. Relieving compaction by aeration and incorporating soil amendments that resist compaction will help alleviate conditions caused by heavy traffic.

Soil temperature is also ecologically important. Minimum, maximum, and optimum soil temperatures for turfgrass growth follow closely that of atmospheric temperature. Many microbial processes in the soil are influenced and controlled by soil temperature. Again, organic matter decomposition and nitrogen transformation are critical ones affected.

Management and Ecology

Maintaining turfgrasses used on golf courses to meet the demands of today's players requires the use of many management practices. Since these practices influence the environment of turfgrass greatly, they become an essential part of turfgrass ecology. Indeed, some management techniques are so critical that an individual turf specie could not be used for golf turf without them.

We have already seen that syringing, control of thatch, and relieving compaction are all management practices that improve the environment of the grass plant. The following are others that influence good quality turf.

Heights and frequencies of mowing affect the vigor of turfgrasses. However, it is the size and morphology of a grass specie that determines mowing practices. Turfgrasses that produce stolons and rhizomes will tolerate closer mowing than will a bunch type grass. Furthermore, grasses that produce an upright growth habit cannot be clipped as low as grasses that produce many leaves near the soil surface.

Clipping upright grasses such as Kentucky bluegrasses, fescues, and ryegrasses, especially during hot weather, causes a depression of roots, rhizomes, and top growth. This weakens the turf, lowers resistance to drought, increases susceptibility to disease, and encourages thinning of turf. Also, close mowing brings more light to the soil surface and encourages weed encroachment. Mowing management of upright grasses should be based on climatic conditions. During the summer they should be clipped higher to improve vigor, reduce weeds, and increase wear resistance.

Small stoloniferous grasses such as bentgrass and bermudagrass can tolerate close clipping because many leaves remain after mowing. These will also benefit from raising the height of cut, but clipping too high will encourage a faster thatch buildup.

Frequency is also important. Allowing top growth to become tall and then mowing short is damaging. A rest from mowing greens one or two days a week will increase bentgrass vigor.

Turfgrasses need adequate nutrients to grow and recover from injury inflicted by the golfer. Nitrogen, which is the key growth regulating agent, should be used with care. Too much nitrogen causes turf to be soft and succulent and more susceptible to wilt and disease. Too little will not allow for rapid recovery from injury.

Nutrients should be supplied in adequate amounts and balance. Growth may be disrupted by an imbalance of the key nutrients, nitrogen, phosphorus, and potassium. A lack of certain minor elements, such as iron, can also affect metabolism.

Irrigation practices are critical to turfgrass ecology. Heavy, infrequent irrigation encourages root development and penetration. Light, infrequent watering results in the roots remaining near the surface where the moisture is supplied. Heavy, frequent watering is injurious because of changes in the air-water ratios of the soil pores.

The use of pesticides to control weeds, insects, and disease is certainly beneficial in improving the environment. Overuse or indiscriminate use, however, can be harmful. Residual effects or metabolic disruptions are responsible for turf injury.

The ecology of a golf course then is the interaction of natural and imposed environmental and management conditions affecting growth. The employment of the various combinations of management practices must be related to the environmental factors. Careful manipulation of these management practices can save turf in periods of stress.

SUPER SAM by Paprocki

Super Sam says, "change tee markers often."

Solving Drainage Problems at El Macero

by D. W. HENDERSON* and DON T. BRADLEY, Department of Water Science and Engineering, University of California, Davis, and
JACK JAGUR, Superintendent, El Macero Country Club, El Macero, California

After several greens at El Macero Country Club deteriorated badly in 1966 and large areas of grass died, several possible causes were investigated. Also, some different procedures for drainage were tried and evaluated. Possibly our experiences may be of value to others with problem greens.

Salinity

The water from one of two irrigation wells proved quite saline, with electrical conductivity of 3.7 mmho/cm. Although salinity of greens soils was generally below levels expected to injure Seaside bent, the well was immediately taken out of service.

Soil Conditions

Excessively wet greens had been noted frequently, and to find why drainage was so slow, the soil beneath the greens was sampled. The top 3 to 5 inches is fine sand underlain by loam to clay loam soil. Under 12 of the poorer greens, the soil is dense (total pore space typically 35 to 45%) and anaerobic as indicated by blue-black color and foul odor. Layers of such compacted soil extend to depths of 3 to 5 feet, with native soil beneath the greens mounds open and permeable, suggesting compaction by equipment during construction.

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* Dr. D. W. Henderson serves also as Green Chairman at El Macero Country Club.

Irrigation

The distribution of water from manually-operated greens sprinklers proved exceedingly uneven. Both range and spreader nozzles were 1/4-inch, and spreader nozzles caused rapid flooding close to the sprinklers while little water reached inner areas of greens. Smaller, single-nozzle sprinklers, purchased in 1968, gave a more uniform pattern, minimized flooding, and generally permitted irrigating on alternate days. Less excess water was applied, and there was a longer period for drainage between irrigations.

Drainage Test

For evaluation of drainage on various greens and the effect of drain systems installed, a procedure was evolved to obtain quantitative data. Basically, it consisted of making several holes to six-inch depth in the green with a 3/4-inch diameter, push-type soil sampling tube. Free water in the upper soil (especially the sand layer) seeps into the open hole and its depth is measured one to two hours after the holes are formed. Since sprinkling gave uneven saturation of greens, most comparisons were made 18 to 24 hours after heavy rain with 12 holes for each green or portion tested. For evaluating drainage conditions with sprinkling, more holes are needed to obtain a more complete pattern.

Drainage Installations

Several inexpensive means of greens drainage were attempted over a two-year period. Since the native subsoil under a few greens was nearly pure sand, there was a possibility that dry wells would be effective. A portion of No. 2 green was treated by making holes of 1 1/4-inch diameter reaching into the subsand and back-filling with pea gravel. The holes, on 3-foot-square spacing, were made with a hammer-driven soil sampling tube. Drainage was improved (see Table 1) and subsequently all of No. 17 green was similarly treated, using holes of 2-inch diameter at 4-foot triangular spacing. The upper two feet of each hole was made with an auger powered with a generator-driven slow-speed electric drill, and the remainder by water jetting. The jetter consisted of thin-walled conduit tubing of 1 1/2-inch diameter with a 1/4-inch-diameter nozzle at the bottom, and utilized water under pressure from sprinkler coupler valves.

Other drain systems installed were as follows:

No. 13 Green — Perforated plastic pipe (1 1/4-inch nominal-size) in 2-inch-wide by 8-inch-deep trenches on 6-foot spacing. The perforated pipe was surrounded with pea gravel top-dressed with sand.

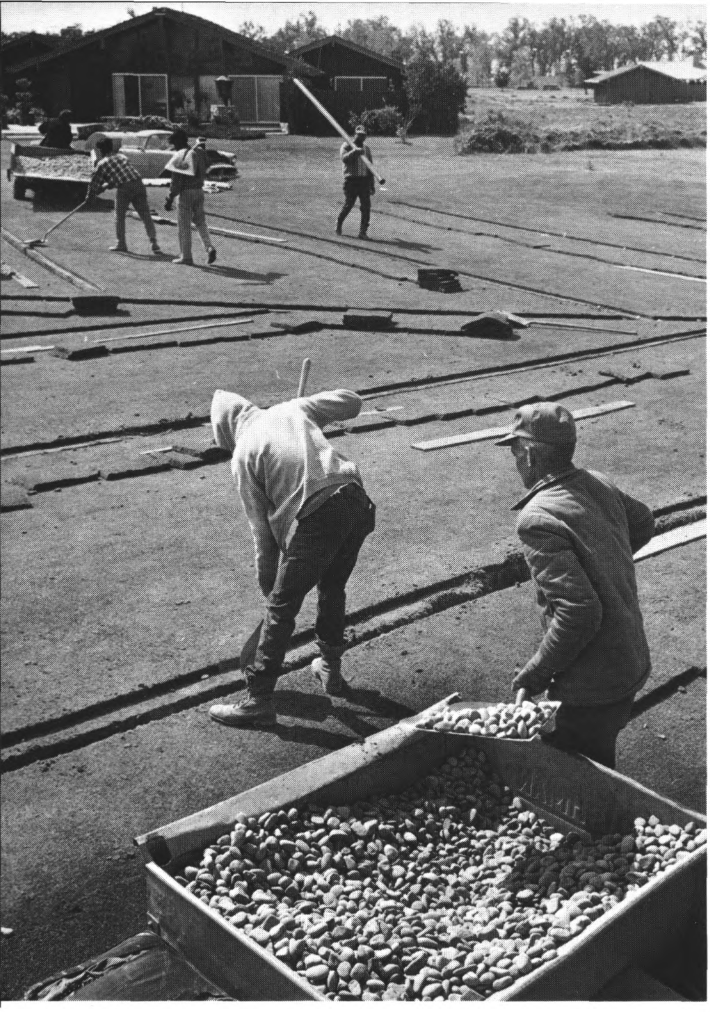
No. 14 Green — Slots (8-inch deep by 3/4-inch wide) made with a modified commercial trencher on 6-foot spacing, backfilled with gravel and top-dressed with sand. Individual slots were drained by 1 1/4-inch diameter dry wells extending into sandy subsoil at a depth of 4 to 5 feet at intervals of 12 to 15 feet. The sod was not stripped over the trenches, but the cuts essentially healed within two weeks, and the green was never taken out of play. Two attempts to cut slots with a chain saw failed because it became dull after cutting a few feet.

Nos. 1, 3, 4, 9, 10, and 18 Greens — Three-inch perforated plastic pipe main line with 1-inch perforated laterals in herringbone pattern at 18-foot maximum spacing. All pipe was placed in 4-inch wide by 20-inch deep trenches, surrounded by rock averaging over 1/2-inch diameter, covered with a filter of graded gravel and top-dressed with sand.

TABLE 1. Water depths in shallow test holes on three dates.

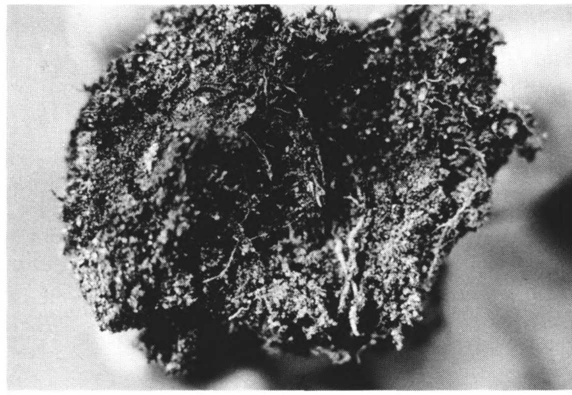
1-68		1-69		12-69	
Green*	Water Depth	Green*	Water Depth	Green*	Water Depth
—	—	1U	2.9″	1P	0.0″
2U	2.5″	—	—	2U	2.5
2W	0.0	—	—	2W	0.0
3U	1.5	—	—	3P	0.0
—	—	9U	1.9	9P	0.0
—	—	14TW	0.1	14TW	1.7
17W	0.1	17W	0.2	17W	0.0
18U	3.8	18U	3.8	18P	0.1

*Letters following Green number indicate treatment at the time of measurement. U—undrained; W—dry wells; P—perforated pipe; TW—gravel-filled slots plus dry wells.



Extensive tile installation was accomplished on the worst greens. Note the neatness of the operation.

If the architect had only built the greens properly at the outset, the drainage project would not have been necessary. This is a sample of the "soil" underlying the original greens.



The main drain was 3-inch perforated plastic pipe on a gravel base. One-inch perforated lateral lines feed into it in a herringbone pattern.

Putting green slots being cut with a modified commercial trencher. This was more effective than the chain saw method.

Superintendent Jack Jagur perforating the 1-inch plastic lateral lines.

Backfilling the drain lines with graded gravel to be followed with sand. The original sod (with a sand base) will then finish the job.

Pipe drain systems near lakes were constructed with outlets into the lakes, while others were drained into long, gravel-filled trenches, permitting seepage into the subsoil. The native subsoil below the zone compacted by traffic is quite permeable.

Drainage Costs

Material costs were essentially negligible for the dry well system and slots plus dry wells, and labor requirements were approximately 12 man-hours per 1,000 square feet. For pipe spaced at 18 feet in large trenches, material costs were roughly $50 per 1,000 square feet, and labor requirements were about 24 man-hours. Material costs for pipe in small trenches on 6-foot spacing were approximately $60 per 1,000 square feet. No labor records were kept, but the time required was considerably higher because of the greater footage, and the small trenches needed considerable cleaning by hand.

Drainage Results

Tests showed that all types of drainage were quite effective (see Table 1). The gravel-filled slots plus dry wells on No. 14, however, failed in the second winter after installation. The failure probably was caused by plugging of the relatively few dry wells.

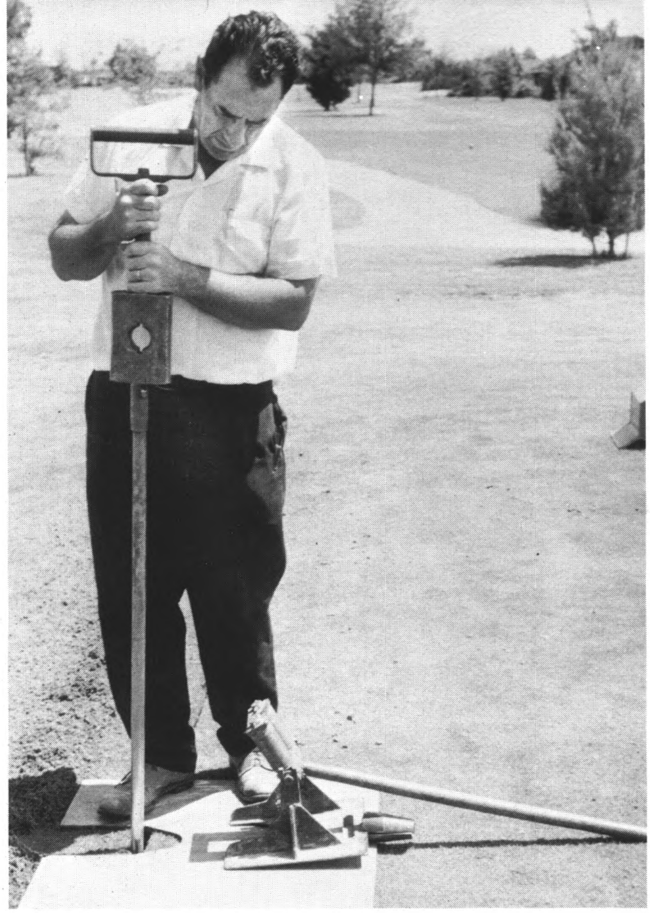
The tests show that all the systems can remove excess water from the greens by 18 to 24 hours after waterlogging. From both theory and rough observation, the dry wells have the least surface for water intake and drain most slowly, widely-spaced pipes or trenches are intermediate, and closely-spaced drains are most rapid. We are installing pipe systems at 18-foot spacing in all our poor greens and plan to supplement them with narrow gravel-filled slots on 6 foot spacing if more rapid drainage is necessary.

"Dry Spot" Treatment

On several greens, small areas of poor summer turf persisted after drainage and better irrigation were provided. Soil observations showed that in these spots the sand layer was very shallow or missing entirely, or that the sand was intermixed with silt and clay. Roots penetrated no more than two inches, with many dead by late summer.

To provide better rooting, more water entry into the soil, and better drainage, some spots were treated by removing 3/4-inch diameter cores to a depth of nine inches on 3-inch centers with an open-sided push-type tube soil sampler. Each core pushes the preceding core from the tube, so the process is rapid. After cores were removed from the green surface, a 3/8-inch tube was used to water-jet an opening at the bottom of about one hole per square foot down to permeable soil, 3 or 4 feet below. The jetted material on the green surface was allowed to dry and was removed, and the holes were filled with top-dressing mix.

Three treated spots slowly improved (as compared with nearby untreated spots) and did not recur the following summer.



Dr. Henderson at work with a hammer-driven soil sampling tube on No. 2 green.

Conclusions

The soil under several greens is marginal for growing good turf, even with drainage. Probably only the shallow sand layer can be drained effectively because the soil below is too tight. Few roots penetrate below the sand layer, and those found in soil are often weak or dead. Nevertheless, the program described (involving salinity control, careful irrigation, drainage, and spot renovation) has generally improved the greens markedly in the past three seasons. We avoided a crisis with very moderate expenditure, and we have sufficient time to proceed with future greens reconstruction on an orderly basis. Under very careful management our greens could, if necessary, last indefinitely.

Fairway Renovation at Baltusrol

by JOSEPH R. FLAHERTY, Golf Course Superintendent, Baltusrol Golf Club, Springfield, New Jersey

One of the most challenging problems facing golf course superintendents today is the contemporary players' demand for high quality fairway turf throughout the season. Turf that will retain uniform texture and vigor and provide a satisfactory lie even under the stress of high temperatures and humidities during July and August is our goal. In too many cases the older, long-established fairways are unable to meet this requirement.

This is our approach to the problem at Baltusrol. I ask the reader to bear in mind that each club's situation is unique. Procedures that have worked satisfactorily for us may be neither necessary nor desirable under different circumstances. But if you have the problem of poor fairway turf, you may be interested in the program we have followed.

Our fairways consist of the typical northern mixture of bentgrasses and **Poa annua.** The summer of 1968 was hot and humid in this part of the country. By mid-August we had lost practically all **Poa annua** and the fairways were in terrible condition. I first contemplated aerating and slicing them in several directions and then overseeding. However, years of thatch accumulation was such that the thatching machine tore out enormous sections of sod, some as broad as the hood of an automobile, leaving large areas of bare soil.

This situation, together with newly germinating **Poa annua** and a moderate infestation of goosegrass, convinced me that the scorched-earth method would yield the best long-range results, and would certainly be no more unsightly or unplayable than conditions already existing.

After several discussions with my Green Committee Chairman and visits by Al Radko, Eastern Director of the USGA Green Section, and Dr. Ralph Engel of Rutgers University, the Board of Governors agreed to complete renovation of three of our worst fairways as a trial. We decided to work on two-thirds of the fairway only, leaving one-third untouched so that play could continue: our members could always count on 18 holes in play.

The results of the trial were most satisfactory, and we decided to proceed with total renovation of 29 holes over a three-year period—1969 through 1971. The seven fairways we are not including in the program were done 15 to 20 years ago by my predecessor, Ed Casey, who began a similar program. Unfortunately, it had to be abandoned because of adverse member reaction, but those seven fairways were the best on either of our courses many years after the job was done.

In the third week of July, 1969, all fairways to be renovated were sprayed with sodium

Allen Grogan, Green Committee Chairman (left) and Joe Flaherty, Superintendent, inspecting the renovated portion of fairway on left. Note Poa annua on unimproved one-third

arsenite at a rate of 20 pounds per acre, a dose strong enough to kill all vegetation. After burning was complete, we made two passes over the treated areas with an aeroblade to break up the dead grass and thatch for subsequent removal. All dead material was then pulled off the fairways with a York rake and removed to our compost.

A large percentage of old root fibers remained in the soil. However, these later proved to be a distinct advantage in the prevention of excessive hardness of our heavy clay soil during the first year of new growth when the young grass was not sufficiently mature to provide a cushion of turf. The old root material also held the soil against erosion during heavy rains. It enabled free use of the tractor and spreader to reseed thin areas with no concern about tracking. Players were able to enter the renovated areas to retrieve golf balls, even after a rain, without sinking in mud and disturbing the grade of the fairway. This year when the new fairways are opened for play, I anticipate that this root fiber will provide more comfortable walking for our golfers until the grass has matured into a resilient turf. It provided many advantages.

With removal of the old thatch completed, we now had bare soil, and seedbed preparation was initiated. My first concern was to incorporate lime as deeply as possible into the soil. We applied lime to the treated areas at the rate of two tons per acre, followed by six to eight passes over the fairway with aerating machines.

These were set to the maximum possible depth. The transport wheels were completely off the ground and the machines were actually rolling on the spoons alone. We thereby achieved incorporation of the lime to a depth of about four inches and undoubtedly relieved soil compaction to the greatest possible degree.

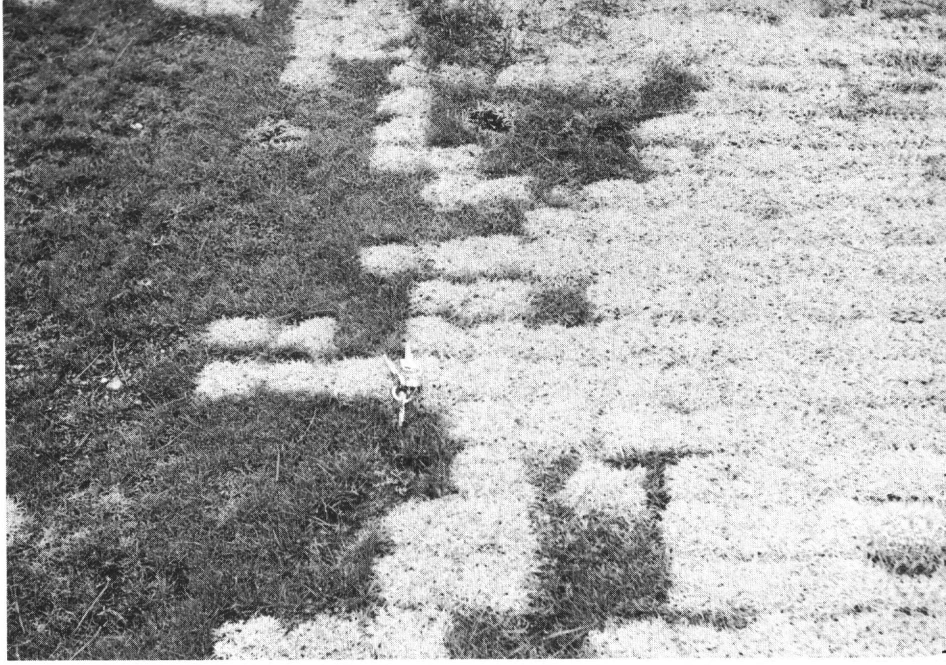
We then made two more trips across the area, at right angles to each other with the aeroblade, pulverizing the soil clods that remained.

The new fairways were seeded to a mixture of 60% Astoria and 40% Seaside bentgrass at the rate of 90 pounds of seed per acre. An 8-foot seeder was used and spread the seed satisfactorily without the necessity of mixing it with any fertilizer carrier.

All areas were dragged with a 10-foot section of cyclone fence to cover the seed. This did the job very well and required no weights or attachments. One trip over the seedbed with our fairway rollers and the application of 200 pounds per acre of 10-6-4 fertilizer completed the operation.

Bentgrass germination and coverage was again very satisfactory by October 15, and no winter damage apparent as of April 1, 1970. There is very little **Poa annua** on the renovated fairways, and I'm quite certain that the bulk of the **Poa** seed present was removed with the old thatch last August.

The York rake removes the thatch but leaves the root fiber which makes for a comfortable and firm seedbed.



The importance of making seed contact with soil. The presence of thatch, even though burned, prevents new seed from germinating.

On April 9 thru 11 of this year we applied tricalcium arsenate to the renovated areas at a rate of 500 pounds of bulk material to the acre, or approximately six pounds of active ingredient per 1,000 square feet. We plan to continue this program in the future to inhibit **Poa annua** reinfestation.

A Special Situation

Fairways Number 2 and 4 on the Upper Course required a somewhat modified approach. Due to their topography, treatment with sodium arsenite and complete removal of all cover would result in an unjustifiably high risk of topsoil erosion should heavy rains occur before the new grass was well established.

On these two holes we applied tricalcium arsenate over the entire fairway at six pounds per 1,000 square feet in early April, 1969. By August 1 the **Poa annua** was completely eradicated, with isolated patches of bentgrass remaining to protect the slopes from erosion. We then followed the same procedure as on the holes completely burned with sodium arsenite; i.e., aeration, pulverization, removal of the dead material with the York rake, limestone application, more aeration, and finally seeding and fertilization.

I've heard the statement that when calcium arsenate eradicated our **Poa annua,** we would be pleasantly surprised to find a higher percentage of bent in the fairways than we originally thought present. In my case I found quite the opposite to be true. Many areas I had assumed to be colonial bent proved most definitely to be **Poa annua.** Germination of the new bentgrass was just as successful on these two fairways, previously treated with calcium arsenate, as on the areas where the chemical had not been applied before seeding.

Let The Member Know

The most important consideration of all in a renovation program of this magnitude is public relations. The approach must be from a management-public relations viewpoint rather than a strictly agronomic approach. The membership should be well prepared for the considerable, though temporary, inconvenience they will face on the golf course. A letter in which the program was thoroughly discussed was sent to every member. Reasons for the necessity of renovation were carefully explained, operating procedures were outlined and the general scope of the project was detailed. We hoped to obtain not simply forbearance, but enthusiastic endorsement of the program by the membership.

At no time was it necessary to close a hole. As explained earlier, one-third of each hole was left untouched from tee to green, and the renovated portions treated as ground under repair.

This procedure may, at first glance, seem a bit awkward from a viewpoint of efficiency, but we believe the important goal is the treatment of a specified number of acres each year rather than the completion of an entire fairway at one time. Membership complaints are minimized when they can see work progressing as scheduled, and yet have a full 18 holes available for play at all times.

At the beginning of the program the Board of Directors must thoroughly understand that the club is at the threshold of what is, in essence, a long-term rebuilding project, the fruition of which is unlikely to be seen in its entirety for five years. Each member of the Board must be prepared to face considerable dissatisfaction at about the three-year mark, when some members will become understandably exasperated. They are tired of arriving at the club each August to find another section of the course torn up.

The Board must be convinced that the program will yield a great improvement when it is completed, and it must be resolved to see it through to completion even in the face of adverse reaction. In the absence of such resolution, the program will probably never be completed, and would be better not started. The end result would be a golf course that is a patchwork of good and poor turf, creating a drone of dissatisfaction for the indefinite future.

I have described the general approach of our club to the upgrading of fairway turf to a standard commensurate with the modern demands of golf. It is an admittedly drastic method, but in my opinion it's the one that will produce the best results in the shortest time. The areas renovated are completed in one operation; there is no necessity for subsequent treatments in following years except for the maintenance of the calcium arsenate level. It's an operation which lends itself to organization, mechanization, and efficiency.

Our costs, including labor, seed, lime and fertilizer amounted to $400 per acre. The major factor which will cause variations in this figure is fluctuations in the price of seed, which promises to be considerable in the coming years. The cost of calcium arsenate is not included in the per-acre renovation figure, since it will be applied annually in the future and, hence, is included in our regular maintenance budget with other herbicides.

I feel that our approach to fairway improvement is worth consideration by clubs facing extensive loss of fairway turf each summer due to undependable **Poa annua** and unmanageable accumulations of thatch. The success of the program depends on careful research of the problems at the particular club, determination of management to pursue it to fruition, and thoughtful organization of the mechanical procedures to be followed so that the job can be done with maximum efficiency. To date, I am very well pleased with the results. At Baltusrol we are on our way to finer summer fairway turf, adaptable to modern demands even under stress conditions.

The thatch is raked into the rough and soon removed.

Woody ornamentals placed according to design throughout a golf course provide reference points for the golfer and create vistas of scenic beauty which change when viewed from different directions.

Plants to Enhance Environment

by **ELIOT C. ROBERTS,** Chairman, Department of Ornamental Horticulture, University of Florida

We are confronted with a constant change of environment from rural areas to the central city, and we must know what particular plants will do well in an almost unlimited number of situations. Further, we must learn to manipulate the environment so that the plants which are required to produce a desired effect, whether beauty, function, or economy, will thrive.

In addition to the influence that the environment has on the use of ornamental plants, the plants themselves have a profound influence on our environment. This concept of modification or enhancement of man's environment by use of ornamental plants must be further developed and recognized by horticulturists and the public alike.

Ornamental plants are used in five varying environmental situations, i.e., **controlled** (golf clubhouses, residences, offices, museums, theaters, conference centers, hospitals, restaurants, enclosed malls, etc.) **urban** (downtown concrete canyons, high rise developments, single and multiple family residences, golf courses, city parks, outdoor shopping malls, street plantings, etc.), **suburban** (individual and multiple homesites, industrial and government facilities, memorial parks, golf courses, recreational parks, botanical gardens, conservation areas, etc.), **transitional** (freeways, highways, rapid transit systems, airports, helioports, greenbelts, etc.), **rural** (individual residences, town squares, community forests, small parks, shelterbelts, windbreaks, highways, recreation areas, etc.).

In each of these situations the placement of the proper plant in the proper place, and the proper culture and maintenance of these plants

Reflections of trees and shrubs in a small pond contribute to the enhancement of this environment for man's enjoyment.

can create a work of art that will make that place more livable, more pleasing to view, more restful, more conducive to business, or more desirable for shopping, dining, or conversation. In other situations, the landscape architect and ornamental horticulturist may create golf courses and other recreational facilities that so modify the local environment that they may revitalize tired, discouraged, or frustrated men and women. Highway design and its relationship to roadside development form but another example of the important nature of proper use and maintenance of ornamental plants. Finally, as we become more concerned with the restoration of our cities and in preventing the degradation of industrial, business, and residential areas, we must recognize the essential nature of the ornamental plant and the landscape plan in modifying environment.

Emphasis on Art

The use of ornamental plants has a closer relationship to the arts than to the sciences. Design research concerned with ornamentals is as important to ornamental horticulture as design research is to the automotive industry. In other (agricultural) terms, it may be likened in importance to using research directed toward development of new and improved products from existing substances. We have a wide variety of existing products (ornamental plant materials); we are in great need of research to determine new uses for these plants in the modification of man's functional and aesthetic environment. Design is a major criteria in these areas.

The problem in obtaining recognition for this research is related to the fact that ornamental and landscape horticulture bridges an area between arts and sciences. Agriculture is readily identified with the science aspects, but it tends to avoid confrontation with the arts aspects. The fact that design research is more like research in the liberal arts and quite different from scientific research is no reason to ignore it or fail to recognize its importance.

Another complicating fact relates to the realization that very few ornamental horticulturists are qualified to conduct design research. Most research in this area at the college level results from theses for the Master of Landscape Architecture degree. Other research is conducted by state highway departments, various agencies concerned with forestry and recreation and by architectural concerns. It seems likely that increased research in this area will come from public and private agencies outside of agriculture.

Business Aspects

Generally speaking, people who purchase ornamental plants have little appreciation for the relationship between price and quality of the plant. Further there is a widespread belief that landscaping information and landscape plants are free to hand on from neighbor to neighbor, and that these items have little relation to any specific business structure. Rather than luxury items, ornamentals should be classified as essential to environment.

Further, the value of the ornamental increases; does not depreciate. Of course we recognize that this depends on good management, and this is where ornamental horticultural research and extension programs have an influence. The importance of agricultural economics research and extension programs lies in determining ways and means of improving business aspects of ornamentals production and in providing data on the value of these plants in the environment.

The value of ornamental plants is partly aesthetic and difficult to assess in terms of money, and partly economic, since it involves the value of fertilizers, irrigation systems, pest control practices, mowers, and maintenance equipment, and requires service by specialists. All of this (value of ornamental plants) is agriculture's contact with tourism, an increasingly important aspect of the economy in many parts of the country, and one which has direct implications with golf and golf course facilities.

The production and use of ornamental plants in the United States is a far larger and more important series of interrelated activities than agricultural economists have recognized. A Pennsylvania turfgrass survey conducted by the Pennsylvania Department of Agriculture indicates that turfgrass (flowers, shrubs, and trees not included) was the largest single agricultural enterprise in the state, equal to 63% of the total cash receipts from the sale of all agricultural products. We need to recognize the importance of information of this type concerning ornamental plants.

A Further Resource

Much has been said concerning the value of projects involving ornamental plants as a means of promoting more rapid recovery from mental and physical illness. A patient who has the desire to recover because he has something enjoyable to do, such as a job to accomplish, often has a better rehabilitative record than a patient who has lost interest in life. Although not everyone is interested in ornamental plants and in natural beauty, most individuals appreciate flowers and foliage plants and are concerned about their preservation and culture. Perhaps something about the fragile nature of a plant makes the patient want to protect and nurture it, and in so doing, gain strength and satisfaction for himself. Whatever the reason, sufficient evidence exists to indicate that the concept of therapy through use of ornamental plants is a vital force, and that this procedure should be further researched. Horticulturists, along with medical doctors, psychologists, psychiatrists, sociologists, and landscape architects should be encouraged to develop projects and procedures involving ornamental plants for use in recovery programs with patients with different medical backgrounds and prognoses for recovery.

Summary

We are thus witnessing the development of a new concept involving the importance of ornamental plants in our environment. Plant materials, placed in accordance with up-to-date concepts in landscape design, modify the environment so that the mood of the individual is affected. Frame of mind and state of feeling are influenced by our surroundings, for better or for worse. We should make every effort to see that our surroundings contribute to the betterment of man.

In order to accomplish this, the art of ornamental plant use must be co-featured with the science of plant culture. Anyone who enjoys the beauty of landscape plantings should recognize the importance of imaginative uses of plant materials in enhancing our environment.

Characterization of business and economic aspects of ornamental plant production and use is essential in planning for future needs. The potential for service is great. Shortsightedness in preparing for the challenge ahead would be tragic.

Finally, the importance of ornamental plant use is not only to be identified with group response, but it also can become highly personal, as evidenced through horticultural therapy.

In all our effort to feed, clothe, and house ourselves we must not jeopardize our future by failing to satisfy our hunger for natural beauty.

Green Section Staff Change

A. Robert Mazur, Eastern Agronomist with the Green Section Staff, has resigned and entered the University of Illinois where he plans to continue work toward a Ph.D. degree. Mazur joined the Green Section Staff in 1968 after completing his MS studies at the University of Rhode Island.

Better Turf Through Research

Trees may form a textured background behind greens or along the sides of fairways that not only create an atmosphere of natural beauty but also decrease awareness of others nearby.

Research is an investment in a better future. And it costs money.

In the United States today, approximately 3% of our Gross National Product is devoted to research in all forms. If just 1% of the nation's total annual golf course maintenance bill went to research, we would have over $1 million for turfgrass studies. Think of it; $1 million annually for turfgrass research! In reality, less than one-tenth of this is being spent.

There is now a need—a serious need—for new research in this field. Recreation has become an essential part of modern living. Golf is a leader in participant sports and golf is played on grass. For this reason, the Green Section of the USGA has become a leader in turfgrass research since 1920. The need now is to move on to the problems of today: to solve them and to assure better golfing turf for tomorrow.

To date our Research and Education Fund has operated on extremely limited funds, yet a great deal has been accomplished because of our coordinated program and a careful, studied project selection. A great deal more could be accomplished if more funds were available. Research costs money and this is an appeal—a reasoned appeal—for your help and the help of all those interested in turfgrasses, in golf, and in the future.

Within the last five years our Research and Education Fund furnished support of projects in the following amounts:

Institution	*Amount Contributed*
University of California—Davis	$ 2,000.00
University of California—Riverside	5,000.00
Georgia Coastal Plain Experiment Station, Tifton	7,500.00
Kansas State University	5,000.00
Michigan State University	18,000.00
Oklahoma State University	5,000.00
Pennsylvania State University	4,000.00
Purdue University	1,000.00
University of Rhode Island	6,750.00
Rutgers University	12,000.00
Texas A&M University	10,000.00
Virginia Polytechnic Institute	2,000.00

In the past, the work has been supported by allocation of a portion of membership dues in the USGA, by part of the proceeds from National Golf Day, by donations from the Masters Tournament and charitable Pro-Am events, by the New England Golf Association, and from individual donations. As contributions have increased, grants for further research have been liberalized, but there still is a critical need for greater income to support more extensive investigation into these projects and the many other problems encountered in improving golf course turf.

In 1970, because of the work and interest of the USGA Executive Committee, $32,000 is earmarked for research. This is approximately 40% more than the total allocated in previous years and this is a step in the right direction. Funds to this date in 1970 were raised from these few sources (figures are approximate):

National Golf Fund	$15,400.00
*Augusta (Ga.) National Golf Club	2,500.00
New England Golf Association	1,350.00
Individuals	4,150.00
USGA (allocated from membership dues)	20,000.00

*1969 Contribution

Golf owes a lot to organizations and individuals who have faithfully contributed in the past, yet this pitifully small list shows one fact to be clearly evident: that a nationally coordinated fund raising effort is needed, and needed now if golf is to progress with the times. To paraphrase a Churchillism: "Never in the history of golf has so much been owed by so many to so few."

Problems to Solve

- Better grasses for fairways—breeding of dwarf types for play by the Rules of Golf or so-called summer rules play. Our avowed aim is the elimination of "winter rules" forever, and to breed types that are more winter hardy than grasses presently used.
    - Research into water management, plant-soil relationships.
- Superior grasses for putting greens. Perfect surfaces; less grain.
    - Safer turfgrass pesticides for a cleaner environment.
- Research into the microenvironment.
    - Studies in sand uniformity for bunkers.
- Traffic studies—vehicular and foot traffic problems.
    - Stronger tee grasses—strains that make quicker recovery.
- Maintenance and management aids—labor-saving equipment—more efficient machines —new techniques, new ideas in machinery.
    - Controls for root-rotting fungi.
- The value of a golf course to the environment.
    - Trees—for strategy and aesthetics.
- Keeping sand cleaner and whiter in bunkers.

Problems Now Being Researched

- Basic studies of *Poa annua* designed to provide insight into habits of this plant and better understanding of problems associated with its growth.
    - Degradation of thatch and mat. Play will be greatly enhanced when thatch and mat are controlled.
- Breeding of grasses for improved fairway types of Kentucky bluegrass, bentgrass and bermudagrass.
    - Spring Dead Spot.
- Techniques to insure better success with renovation of greens, tees and fairways.
    - Nutritional requirements of turfgrasses.
- Continued studies of weed, insect and disease control . . . better controls of present problems and a search to solve new ones as they arise.

Some Major Accomplishments

- Developed a method of putting green construction and physical soil analysis that has world-wide application. Produced a motion picture in color demonstrating the application of this construction method. The movie is available for showing to groups.
    - Initiated studies and discovered safe materials for control of devastating diseases of putting green grasses. Although discovered in the 1920s, they are still being used today.

The cool refreshing environment of the clubhouse is predicted as the golfer approaches through this inviting area of shade.

- Selected and developed improved grasses—the C strains of bentgrass, Merion bluegrass, Meyer zoysia, several bermudagrasses.
    - Set guidelines for today's maintenance and management of golf course turfgrasses.
- Researched 2, 4-D for large-scale golf course use. (Remember when golf courses were solid weeds?)
    - Supported work that brought many improved bermudagrasses to golf courses in the South and throughout the world where only southern grasses can be grown.
- Soil compaction and techniques to minimize it.
    - Researched effective controls for the major golf course weeds and insects.
- Traffic studies resulted in the modification of golf spikes and shoes.
    - Researched nutritional requirements of golf turfgrasses.
- Published and made available results of research to everyone interested in golf course management. Published the book *Turf Management,* first of its kind and a complete and comprehensive book on the maintenance and management of golf course turfgrasses.

The Green Section of the United States Golf Association is a scientific agency, established in 1920, whose sole mission is to assist in problems of golf course upkeep. The agency through which the USGA raises funds for worthwhile projects is the U.S.G.A. Green Section Research and Education Fund, Inc.

This is how it functions:

(1) Needs are recognized by Green Section staff members as they visit subscribing USGA

members throughout the nation. Turf management problems are discussed with golf course superintendents and club officials.

(2) Available research funds are then allocated to state agricultural experiment stations and colleges for specific studies on golf course related problems. Studies are performed by trained scientists and researchers expert in the particular area to be studied.

(3) Research results are evaluated under playing conditions by the Green Section staff.

(4) The total program is planned and coordinated by the Green Section staff on a national scale. It is the only agency so equipped. Thus funds are placed more efficiently, and duplication of effort is avoided. This is an important point. Duplication of effort is research money wasted. Research results then are documented, published and readily available to everyone interested in golf course maintenance and management.

(5) Funds raised through the U.S.G.A. Green Section Research and Education Fund, Inc., benefit every club and every golfer.

Contributions to the U.S.G.A. Green Section Research and Education Fund, Inc., are tax deductible in accordance with the Internal Revenue Code, section 501 C(3). Every dollar received is spent for research, *no contribution money is used for USGA administrative purposes.* Contributions in any amount are welcome. Contribute with confidence that your money will insure better turfgrasses, better maintenance and management practices, better playing conditions, and better golf courses for the future.

Make checks payable to the U.S.G.A. Green Section Research and Education Fund, Inc., and send them to the United States Golf Association, 40 East 38th Street, New York, New York 10016.

U.S.G.A. Green Section
Research and Education Fund, Inc.
"Golf House"
40 East 38th Street
New York, New York 10016

Gentlemen:

I am interested in contributing to the U.S.G.A. Green Section Research and Education Fund, Inc.

☐ My contribution is enclosed.

☐ I would like more information. Please have one of your committee members contact me.

Signed ______________________________

Address ______________________________

____

Make checks payable to the U.S.G.A. Green Section Research and Education Fund, Inc.

Contributions are tax deductible in accordance with Internal Revenue Code, section 501 C(3).

USGA GREEN SECTION RECORD
JULY 1970

TURF TWISTERS

DOUBLE IT UP?

Question: Presently I use a mixture of phenyl mercuric acetate and wetting agent to spray my fairways during the growing season to help protect them against disease, wilt, and crabgrass. Could I add 2,4-D to this mixture to control some broadleaf weeds at the same time? (Ohio)

Answer: No, 2,4-D would cause this mixture to act far more strongly as a herbicide, and the disease and wilt prevention qualities would be greatly reduced or lost entirely. Also, this mixture, applied in summer, could be potent enough to burn the grass. 2,4-D alone or in mixture with other herbicides is used in spring or fall, and very rarely at other times.

WET IT UP?

Question: *Do soil penetrants or wetting agents offer any help in reducing soil salinity?* (California)

Answer: Wetting agents provide little or no benefit in reducing soil salinity. In certain types of soils, they may offer a temporary means of water penetration. There is no substitute for good surface drainage, especially where salts are encountered. Use of tile drain lines and slit trenches would certainly be preferable and more effective than chemical wetting agents.

CALL US UP?

Question: Our club is in trouble and in need of help. We want to improve playing conditions. Can you help us and how soon? (Tennessee)

Answer: The Green Section Visiting Service is available to all USGA Member Clubs in the continental United States. We would be happy to assist you by direct visit and on-the-spot consultation. Contact any Green Section office (see inside the front cover) for details and dates.