To Live — Grass Must Be Green

Grass must be green enough to support chlorophyll production.

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HOW GREEN does a golf course have to be? This question may be answered, in part, by asking another: How essential is grass to the game of golf or, specifically, to your golf course?

And, to this question the answer is obvious. Not many, if any, new sand-oil green golf courses are being built. In fact, it is worth noting that there are probably fewer than 50 sand-oil green golf courses left in the United States, and the trend is toward fewer and fewer each year. They are converting to grass — four in Nebraska just last year!

Obviously our topic deals with grass — grass on the green, grass on the fairway, grass on the tee, and grass in the rough. Obvious also is that all of us prefer to play golf on grass, green grass. But how green must it be? Or, must it be green? For certain, golf can be played on brown, dormant grass. From a practical standpoint, greenness of golf turfgrass must be dictated by the plants' ability to sustain their photosynthetic action at a rate necessary to support the level and intensity of play, maintain the recuperative potential of the grass following damage, and to sustain the continuous process of new shoot growth. New shoots are necessary to avoid loss of turf and to maintain the level of density required to provide a playing surface free of weeds.

Turfgrass quality is judged by the standards established for its beauty, use, playability, density, freedom from pests, and uniformity of growth and color — green color.

The color green enhances the beauty and aesthetic appeal of a golf course and its environs. The plant element chlorophyll imparts this green color and is essential for photosynthesis. Photosynthesis is the fundamental process of food manufacture in nature and is the primary physiological function performed in turfgrass leaves. Photosynthesis proceeds in chloroplasts located in green plant cells and only in the presence of light, carbon dioxide, and water. Photosynthesis makes possible the existence of all plants and animals. Only *green* plants are able to convert the energy of sunlight into organic forms that are necessary for growth and survival of the plant itself.

Chlorophyll is an unstable pigment and is continually being decomposed by sunlight and regenerated through synthesis processes in living cells. It thus maintains a relatively stable chlorophyll content in leaves that is not altered appreciably during the growing season. When turfgrasses are placed under cultural regimes or exposed to environmental stress, the balance of chlorophyll synthesis to degradation may be detrimentally altered. Factors that reduce leaf area below that necessary for production of sufficient chlorophyll reduce photosynthesis activity below the

required level to maintain adequate growth and recuperative potential. If we knew what or where that point or level might be, we would know exactly how green our golf course should be. Unfortunately, this remains one of the many unknowns in turfgrass culture. From what is known, however, it is possible to point out certain limitations and constraints beyond which grass growth may be severely limited and if the responsible cultural practice is continued will likely result in thinning and ultimately in death.

ESSENTIAL or primary cultural practices are concerned basically with the development, growth, and maintenance of a green, dense, and pest-free turf. Mowing, watering, and fertilization are the primary cultural practices that affect these factors.

Cutting heights required to meet the demands of the game severely limit the number of species and cultivars that can be used on golf courses. Musser lists only some 40 to 45 species suitable for any turf purpose, and for any one purpose in any one location (putting greens), there probably are fewer than three or four suitable species.

Cutting height influence on root systems has been well documented. In fact, height of cut directly affects depth and extensiveness of root systems. As cutting height is lowered from optimum, there is a corresponding decrease in the root system. Thus, root growth is reduced by lowering heights of cut because of defoliation or loss of green photosynthetically active tissue. Golf course turf must be green enough to support this function. For any given species or cultivar in any given turfgrass situation, the lowering of height of cut and increasing the mowing frequency will effect a greater reduction of root weight.

Watering practices, rainfall, and drought all affect the amount of available water in the soil. The amount of soil water available to the grass plant will produce well-known and documented responses.

Plants extract water from soils most easily at that level of available soil water known as field capacity (0 bars). As the level of available water drops below or decreases from this point, water is absorbed with increasing difficulty. Initially, as the available moisture range decreases, there may be an extension of the root system. That this will occur as long as other variables (mowing height and fertility) remain constant and at an optimum or near optimum level is well known. However, as the plant comes under stress for water and a deficit occurs, certain detrimental physiological responses may occur.

For example, Madison has shown that verdure (amount of green plant material beneath a mowing height) decreases under even slight water stress. It also has been shown that turf cut at heights comparable to fairway heights will survive and remain green when moisture is maintained at approximately 20 percent deficit levels. However, this study did not include traffic or play as a variable.

Another significant factor in survival of turfgrass when it is stressed for moisture or when it is cut at or near the minimum required for survival, is the effect of temperature. When water is withheld, the cooling effects of transpiration and evaporation do not exist, and an increase in temperature and decrease in humidity will occur. During a drought, failure to apply supplemental water to golf turfgrass may produce dormancy, and if it is prolonged, it could become lethal.

In grass plants under stress, the lack of water will limit the rate of photosynthesis, not necessarily by its unavailability as a raw product, but because of the physiological effects produced by temperature. For example, translocation of the by-product of photosynthesis (carbohydrates), stomatal closure, exchange of gases at cell membranes and other physiological processes are all affected by increases in temperature.

AS TEMPERATURES warm to stress levels, grass will survive better at higher heights of cut. Also, lowering of heights of cut at times when temperatures elevate may increase stress to damaging levels. These conditions may be obtained when heights of cut on greens and fairways are being lowered for tournament play during July and August. Thus, from a practical standpoint, if heights of cut are to be lowered, the reduction should occur, if possible, when temperatures are favorable.

In this respect, studies in Nebraska have demonstrated a 3°F temperature increase for turfs mowed at ¾ (0.75) inch as opposed to those mowed at one (1.0) inch. This may not appear to be of great magnitude, but from a biological standpoint, a three-degree temperature differential could have significant effects on biological aspects such as rate of photosynthesis, carbohydrate translocation, and evapotranspiration.

When one manipulates height and frequency of cut to affect putting speed, water becomes more critical. It has been demonstrated that cutting below the optimum mowing height for greens, fairways, and tees is far more damaging when less than minimal amounts (i.e., 20 percent deficit) of water are applied.

Robert Wilson, superintendent of Oak Hills Country Club, in San Antonio, Texas, indicates that putting green turf can be maintained indefinitely at 5/32 of an inch as long as adequate soil moisture levels exist and as long as water may be used for regulating temperatures (syringing or misting). Under tournament conditions, however, when cut at ⅛ inch, color will begin to fade after two days of play and shoot growth cannot be maintained beyond 10 days. At that point the grass is brown, actually dormant, for if corrective action is applied, it recovers. How long beyond this 10 days the grass would remain viable and have the ability to recover is unknown.

One could speculate that withholding water at either height of cut during periods of high temperature stress would result in rapid loss of color followed closely by cessation of shoot growth, dormancy, and, unless corrected in a short period of time, death. Further, grass cut at the lower height would succumb more quickly. This speculation would seem to agree with the belief of some authorities who have indicated that the combination of less than optimum levels of water, height of cut, or fertility results in a decreasing potential for tolerance to stress. This will, one might expect, impact adversely on green color. For certain, when stress exists or persists, a decreasing number of options are available to correct or modify the effects produced by the negative manipulation of a single primary cultural practice.

This hypothesis and these observations need to be documented by research. Furthermore, they support the belief of the USGA Turfgrass Research Committee that studies involving cultural practice interactions need resolution.

HOW GREEN does a golf course have to be? From a practical as well as from an agronomic and physiological standpoint, the course must be green enough to support and to sustain production of sufficient chlorophyll to ensure a rate of photosynthetic activity

sufficient to support continuous development and growth of shoots. The plant itself must avoid prolonged dormancy during the growing season, and it must maintain density at levels needed to preclude weed invasion. Certainly, on a temporary basis, a green color is not essential for play; brown, under certain conditions, may even be preferred. For the long term, however, grass must be green to live. There is latitude for manipulation of cultural practices to compensate for an adverse effect produced by less than optimum application of one factor — either lowering the height of cut or withholding water. That tolerance, however, is substantially reduced when one of the practices (mowing or watering) is lowered to the minimum sustainable level. When two or more practices (watering *and* mowing) are reduced to minimum sustainable levels, few, if any, options are available for corrective action. Loss of color with its attendant problems will soon lead to death of the grass plant.

Finally, from an aesthetic standpoint, Alister MacKenzie, in his book *Golf Architecture*, published in 1920, states:

> Another common erroneous idea is that beauty does not matter on a golf course. One often hears players say that they don't care a tinker's cuss about their surroundings: what they want is good golf.
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> I haven't the smallest hesitation in saying that beauty means a great deal on a golf course; even the man who emphatically states he does not care a hang for beauty is subconsciously influenced by his surroundings. A beautiful hole not only appeals to the short handicap player but also to the long, and there are few first-rate holes which are not at the same time beautiful holes.
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> In other words, while always keeping uppermost the provision of a splendid test of golf, I have striven to achieve beauty.

These words are as true today as they were 63 years ago and as they will be 63 or more years hence. And, while there is great opportunity to minimize the amounts of water and fertilizers and, perhaps, to lower heights of cut and to increase speed by manipulating these and other cultural practices, we must not lose sight of the fact that if golf is to be played on grass, it must be green. And, green is beauty! Research may, and will, give us new grasses and provide us with the knowledge to reduce current maintenance costs, but only chlorophyll will provide green color and grass upon which to play.

How Green is Green? How Brown is Brown?

A MIDDLE APPROACH

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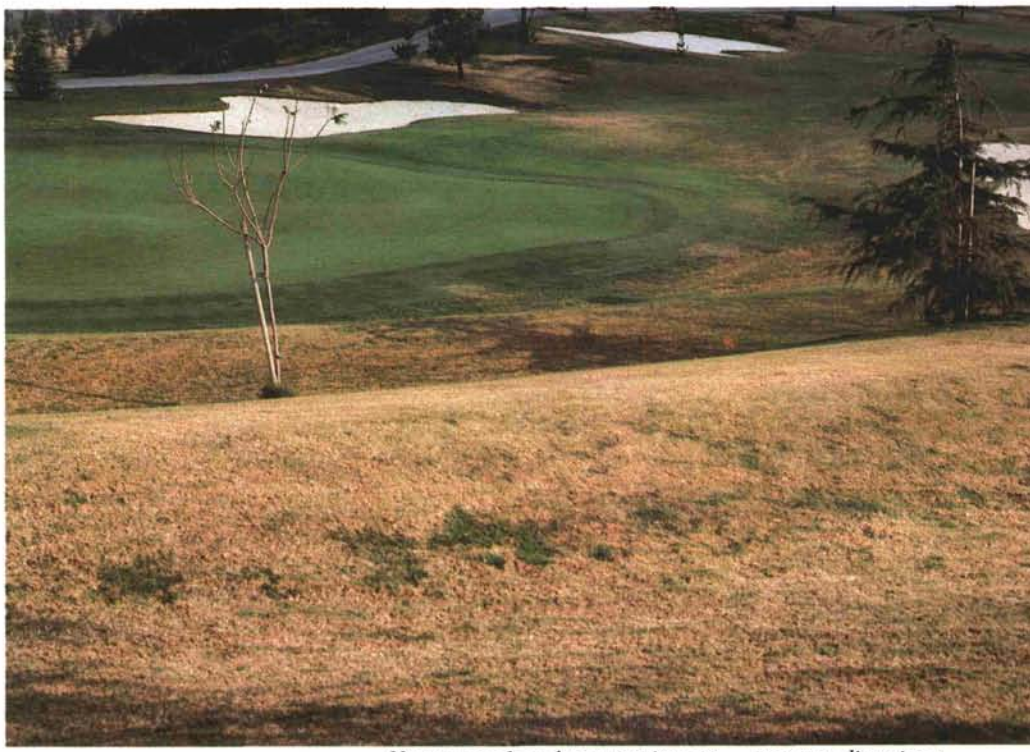

Nature needs only our assistance — not our dictations.

WHERE DOES ONE begin to develop a philosophy or declare a statement regarding just how green good turf should be, or even more basic, how green is green?

There is no doubt that universal opinions exist on one fact in this controversy — golf is played on grass, not on color!

Many have stated that golf in America has deteriorated because of the lush green condition of our golf courses caused by overfertilization. It is said that too much nitrogen is being applied at the wrong times in the growing season. It is said that even more significant negative impact on golf in America is the overapplication of water to greens, tees, and fairways. I don't disagree with these statements, but I question how such statements can be made when no standards exist to determine just how much water or fertilizer is actually required by the grass plant. Indeed, nearly all fertilizer requirements are based on research done on foodstuffs. Water requirements are even less researched. At best, the amount of water applied best represents the philosophy of the "art of greenkeeping" in that watering is done by feel. So really, what is meant by overwatering and overfertilizing? Is this an oversimplification? The point being that no reference points exist from which one can say that turf is too lush, overwatered, and overfed. So just how green is green; how brown is brown?

The question can be even further confused by admitting as evidence the