TRANSITION TRAP

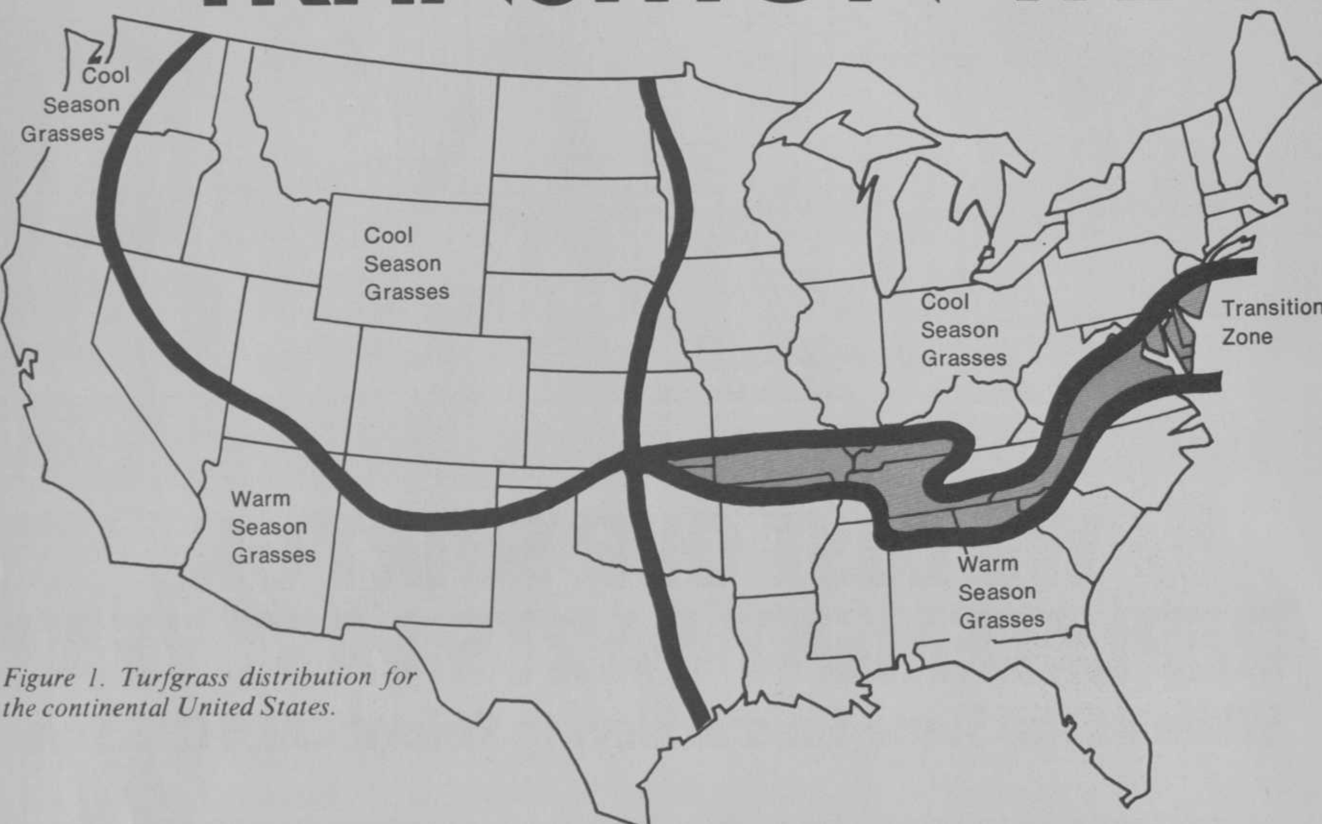

Figure 1. Turfgrass distribution for the continental United States.

Superintendents who work in the "transition" zone have an especially difficult job—which is being made easier by new findings in turfgrass research. And this work also is bringing benefits to those in other zones

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Environmental idiosyncracies as well as climatic quirks haunt those superintendents in the so-called "easy areas," where the climate is cooler, the golf season shorter and stresses to turf and its managers are minimal.

The ability and perseverance of superintendents in the "transition zone," however, are often critically tested during any given year. This zone (Figure 1) is sandwiched between two areas: one dominated by warm season grasses and the other by cool season grasses. A transition occurs for both types of grasses; the cool season grasses coming under stress by summer heat and the warm season species trying to survive the winter cold.

TEMPERATURE A MAJOR FACTOR

Distribution of plant communities has followed temperature and moisture extremes, so that regional turfgrass distribution can be easily depicted on a map of the United States (Figure 1). Boundaries, though, are not absolute. Some grasses can be used beyond the limits of their adaptation because they tolerate temperature and/or moisture extremes. Also, because of the availability of irrigation in most areas, temperature has become the major climatic factor governing species adaptation (1).*

The relationship of climate to vegetation has resulted from thousands of years of plant differentiation and adaptation to climate through natural selection, mutation, hybridization and changes in chromosomal complement (2). The magnitude of geographical distribution depends on both morphological and physiological adaptations. One example is the adaptation to dry conditions, which is related to production of cutin (2), a waterproof transparent, waxy substance deposited on the outside of the epidermis.

Initially, fine turfgrasses were native species selected for use on turfed areas. Consequently, plants that had evolved as adapted species for a given location were subjected to the intensive management required by turf uses; in some cases their quality and adaptability decreased. Continued defoliation at a low cutting height was the main practice affecting turfgrass.

Only in the past three decades has there been appreciable selection, development and release of improved turfgrass varieties, resulting in the better, widely-adapted grasses available today. This came about because larger numbers of qualified scientists became involved in turfgrass breeding programs and more old sites of intensively maintained turf from

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which to make selections became available. Frequently, superintendents of older facilities recognize colonization of areas by superior grass segregates and take the time to notify people involved in making turf selections.

Fortunately, in recent years plant physiologists have considerably increased the basic knowledge about the reasons behind geographic plant distribution. Tropical grasses, such as bermudagrass and zoysia, differ physiologically and anatomically from temperate species, such as bluegrasses, fescues and bentgrasses. These physiological differences help explain why tropical species are more vigorous during the hot summer months than the temperate species.

PHYSIOLOGICAL DIFFERENCES

Plants must incorporate carbon into their systems for use in growth. The only way plants can do this is through photosynthesis. During photosynthesis, carbon dioxide is fixed from the atmosphere and incorporated into sugar molecules through a series of reactions taking a fraction of a second. During this process, radiant energy from the sun has been "trapped" in the sugar molecule in the form of chemical energy. This energy is available to drive reactions necessary for the normal metabolism of the plant.

Warm season grasses have a different method than cool season grasses for capturing carbon dioxide out of the air. The enzyme involved in this capture has a greater attraction for carbon dioxide at higher temperatures than the enzyme in cool season species (Figure 2). This greater attraction at high temperatures is part of the reason why warm season grasses are more vigorous than cool season grasses when temperatures are high.

Plants and animals must respire to provide their systems with the energy trapped and stored in sugar compounds. When animals breathe, they take in oxygen and liberate carbon dioxide. The oxygen taken in oxidizes stored sugar and releases energy for use by the body, and carbon dioxide, which is exhaled. Plant respiration is essentially the same, the main difference being the utilization of this respired energy. Animals use most of the energy to satisfy muscular demands in mechanical movement. This demand is absent in plants; however, there are energy requirements existing in plants that are missing in animals. Energy is required during photosynthesis and nutrient uptake, to name two critically essential areas.

One striking physiological difference between tropical and temperate turfgrasses is the phenomenon of photorespiration. As the name implies, this respiration takes place in the presence of light and occurs simultaneously with photosynthesis. Unfortunately for cool season grasses, they possess this inborn error in metabolism and warm season grasses do not. Why is this referred to as an error in metabolism? As explained earlier, the respiration common to both cool and warm season grasses liberates energy. During photorespiration, however, no utilizable energy is generated for the plant. Also carbon dioxide evolves from the plant into the atmosphere just as it does when animals exhale. Consequently, carbon is lost to the air, which would have been available for incorporation into growth materials. Warm season turfgrasses, which lack photorespiration, conserve the carbon they capture from the air, and this provides an advantage over cool season grasses.

What can be done about this wasteful metabolic "hang-up"? One approach is chemical inhibition.

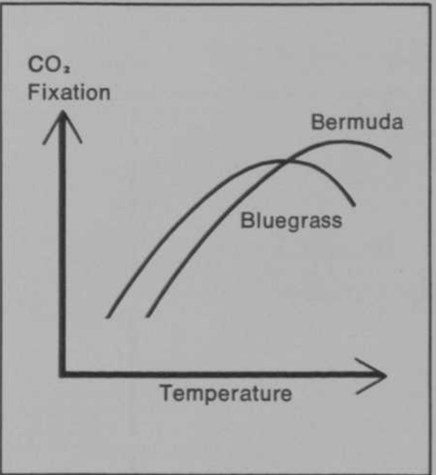

Figure 2. Effect of temperature on the photosynthesis of bluegrass and bermudagrass.

Research using disks cut from green leaves has shown that the photorespiration can be inhibited by blocking the activity of the enzyme involved. However, attempts to chemically inhibit photorespiration have failed (5). Another method used to inhibit photorespiration is the lowering of the atmospheric oxygen concentration to near zero. Because respiration is an oxidative process, a lowering of oxygen concentration will cause inhibition. Photosynthetic rates of cool season grasses exposed to normal oxygen concentrations and high temperatures have revealed that it is approximately one-half that of bermudagrass (4,5). When photosynthesis of cool and warm season grasses is measured in low oxygen air, the rate of the cool season grasses nearly doubles, while the rate of the warm season grasses remains essentially unchanged. Photorespiration can then be calculated by subtracting the photosynthetic rate in normal air from that of low oxygen air.

The total difference in photosynthesis between the warm and cool season species is not entirely accounted for by inhibiting photorespiration. As previously mentioned, the enzymes involved in the capturing process differ in their attraction for carbon dioxide. This phenomenon accounts for the remaining difference.

When Kentucky bluegrasses are ranked according to their photosynthetic rate in normal air at high temperatures, those selected from southern latitudes tend to rank higher than those from northern latitudes. The ranking for photosynthetic rate in reduced oxygen air revealed a considerable rearrangement of the order. Some from northern latitudes ranked higher than those from southern latitudes. This would indicate that Kentucky bluegrasses vary in their amount of photorespiration. Also, the implication that some Kentucky bluegrasses can regulate photorespiration, at least slightly, is significant. Germplasm undoubtedly exists that survives southern environs, and this is promising from the point of view of its inclusion in breeding programs to develop more widely adapted turfgrasses.

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Once this can be accomplished, turf managers in areas, such as the transition zone, will have better tools to use for the production of fine turf.

Research currently is being carried out at Penn State to determine if Kentucky bluegrasses with photorespiration inhibited can grow as well as bermudagrass at high temperatures. These experiments are being conducted in controlled environmental growth chambers, so temperature, humidity and gaseous components of the atmosphere can be controlled. Results from this research will help determine the practical advantages, if any, of having photorespiration inhibited on the golf course.

Hopefully, other biochemical indicators of high temperature tolerance can be developed to be used as screening tools to reduce the time required for varietal testing. The day will come eventually when predication equations for geographical performance by new grasses can be written based on results from a series of indicator tests for disease, heat, drought and cold tolerance and others.

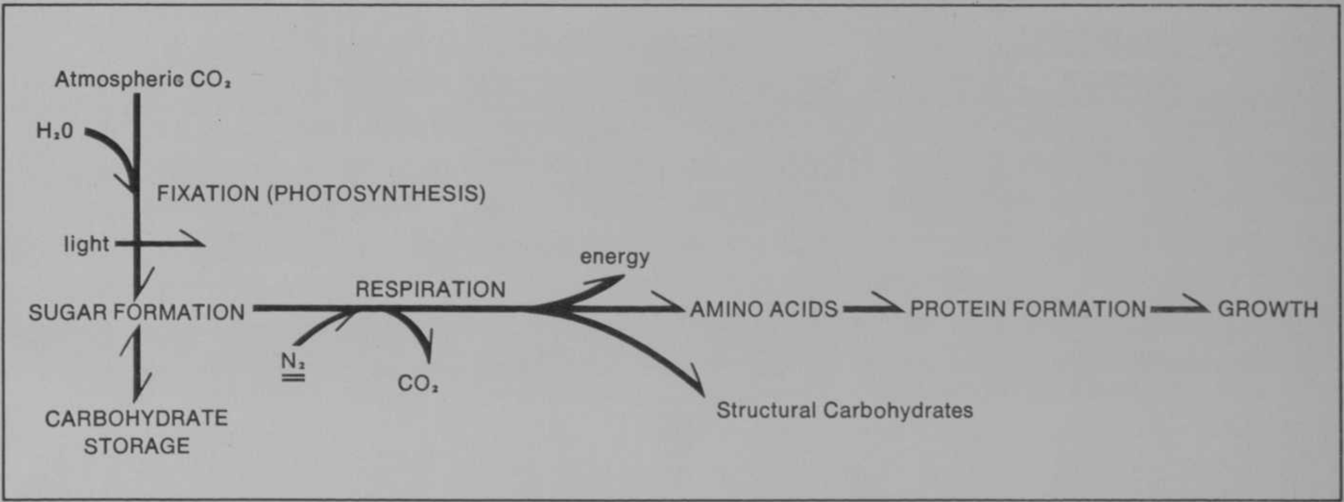

Figure 3. Schematic diagram linking various physiological processes to plant growth.

REDUCING STRESS

What can superintendents in stress areas do to increase turf quality of cool season grasses during periods of high temperatures? First, a basic understanding of how plants grow is necessary. Photosynthesis and respiration have already been discussed. Once carbon has been incorporated into sugars, the plant can utilize them immediately or store them for later use. The term carbohydrate is most often used in reference to sugar metabolism. Stored carbohydrates reflect how the plant has been growing. Carbohydrate depletion is most often a reflection of growth stimulation resulting from nitrogen fertilization, elevated temperatures, irrigation or usually a combination of all three. Increases in stored carbohydrates result when temperatures are cool and photosynthesis is rapid.

Tolerance of high temperature stresses is directly related to the amount of carbohydrates present in plant tissue. Those species that have high carbohydrates can better tolerate stresses than species with lower carbohydrates (3,4). It becomes obvious when examining the conditions that lead to carbohydrate depletion that proper timing of fertilization is necessary to maintain high carbohydrate levels. Examining a schematic drawing, one can see that nitrogen stimulates carbohydrate utilization for protein production which increases growth (Figure 3). Growth is necessary for injury recovery, however, nitrogen fertilization during hot weather is not necessary to stimulate growth. Chemical reactions involved in the growth processes are accelerated by temperature increases. As long as carbohydrates are available, growth will proceed unhindered unless nitrogen is deficient. It has been shown that Kentucky bluegrasses, grown at cool temperatures, which favor carbohydrate accumulation, increased in growth when subjected to high temperatures for at least a week (4). Once the carbohydrate level was depleted, growth subsided dramatically. During periods of normally accelerated growth, nitrogen applications complicate the problem. The resulting stimulation hastens growth cessation and initiates physical deterioration. Nitrogen should be used sparingly during stress periods. Green color can be maintained in these stress periods by very light applications (spoon feeding) of a soluble nitrogen source of one of several sources of available iron.

Cool season grasses normally have a flush of growth in the spring (mid-April to mid-May). Fertilization should be delayed until after this time to minimize carbohydrate depletion prior to entering the stress portion of the season. Usually late fall or winter applications of fertilizer will provide adequate nutrition for early spring green-up and growth until after the spring flush. The majority of the seasonal nitrogen supply ideally should be applied in fall, when photosynthesis is still high and while temperatures are cooler and growth subsiding. At this time, climatic conditions favor root growth and carbohydrate accumulation.

Another technique practiced by many is syringing. From previous discussion in this article, the advantages of a cooler microclimate can be appreciated. The resulting reduction in canopy temperature, even though temporary, occurs dur-

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ing the time of day when the temperature would otherwise be at its maximum and is quite beneficial. Excess water supplied during syringing, however, is not advantageous and represents an uneconomical use of employee time.

RESEARCH CRUCIAL

Managing turfgrasses in the transition zone is a serious, demanding, but rewarding business, and those involved should be commended for their fortitude in tackling the task. Once those of us in research and teaching can catch up with the demands for information made upon us by those in the field, quality of turfgrass areas will increase even more than in the past. The gap between where we are in research and where we should be is colossal, but it is narrowing. Financial assistance for research and graduate students from sources supported by turf managers is critical if the gap is to be further narrowed. Much of the work that has been done was the result of assistance from organizations supported by turf managers. Those of us in turfgrass research acknowledge your efforts and hope that they continue. □

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cern for environmental quality and the vital ecological role played by turf in the areas of soil erosion control, dust control, heat dissipation, noise abatement and control of visual pollution. They have ceased to discount the contribution of turf to over-all societal health by providing recreational surfaces and ornamental plant covers that surround most individuals in their daily activities at home, at work and at play.

Yet just when their priorities are beginning to reflect the importance of turf research (as evidenced by a U.S. Department of Agriculture study showing that universities were increasing four-fold their staffs in turf research), Congress is asked to cut the funds that would support proposed turf research positions, the result of which will be an overburdening of an insufficient turf research staff and an inevitable decrease in productivity.

Added to this is a continuing inflationary rise of 6 to 7 per cent per year in research costs, which, when combined with the proposed budget reduction, would amount to a 12 per cent bite into available funds for agricultural research on the state level.

The proposed cut is now before Congress for action. It may be a year before the final outcome is known, but unfortunately, experiment stations, through their respective university administrations, must initiate these cuts in anticipation of the actual event because it will be retroactive to July 1, 1973.

Golf turf, as a key segment of the over-all turfgrass industry, will be significantly affected if these cuts are enacted by Congress. Superintendents would increasingly have to rely on regional door-to-door salesmen for information, which could affect their jobs, because of insufficient support for important research centers to test and evaluate turf chemicals.

GOLFDOM readers who wish to express their concern regarding this issue should write their congressmen, and it is especially important to contact those congressmen who are members of the House and Senate Appropriations and Agricultural Committees. □

GRAFFIS *from page 11*

ciana Club at Naples. The labor situation was beating him as it has many other superintendents in Florida and elsewhere. When a man could be trained for the job often he wasn't dependable. In desperation a year ago Grant hired and trained young women. He now has 30 on his labor crew and is looking for more.

Grant's experience shows that they can be trained to carefully operate the expensive and sophisticated equipment and use to utmost advantage the labor-saving hydraulic features.

Training of women in the careful use of the new equipment is a field in which equipment manufacturers too are very much interested. Adjustment, repairs and efficient use of the newer equipment are causing headaches to superintendents, dealers and manufacturers. The trouble is not in the equipment, but in difficulty of getting intelligent operators. Some equipment dealers believe a new educational program for course workers will be necessary. Maybe the carefulness that Grant has observed in women operating machines at Innisbrook will be part of the answer.

"Uncle Joe" Friendman's 87th birthday was celebrated April 15 at New York. Uncle Joe of the Softouch Company has been selling professionals golf hosiery and other knitted items for a long time. He was one of the liveliest salesmen at the PGA, and ante-dated the USGA by eight years.

Robert C. Rosenthal now general manager at Knollwood Club, Lake Forest, Ill. He was at St. Charles (Il.) for the previous seven years . . . . *Stanley Horvatin*, after 20 years as manager, Illinois Athletic Club, Chicago, moves to Onwentsia Club, Lake Forest, Ill., as general manager, succeeding Joseph J. Stephens who retired.

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