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Stick to Greens

A beautiful year is waiting for you, walk with aims,
run with confidence, fly with achievements.
Management of GCS&MAI wishes you a healthy & prosperous 2011

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By Col Ravi Rana

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FROM THE CHIEF EDITOR'S DESK

Golf is a unique game in many respects. Certainly, no other sport requires so many skills for the development, preparation, and maintenance of the surface on which it is played. Consider, for example , what a golf course requires as compared with a football field, a tennis court, a baseball diamond, or a bowling green. There is no sport, moreover, in which effective maintenance matters more than it does in golf. The accomplished architect takes the terrain God has provided and fashion it into eighteen challenging holes. The player take the body and mind God had provided and makes them work together to fashion a golf swing. In the final analysis, however, all that God and the architect and God and the player are able to do matters very little if the golf course is not properly maintained or designed. Conversely, proper maintenance and design can realize for the architect the fulfilment of a vision and for the player the reward for a skill.

The Golf Courses all over the Country are getting crowded just like roads have been inundated with automobiles. The safety management and golf etiquettes will assume special importance and attention in the coming years, if we want to enjoy this great game of golf.

In this issue Col Ravi Rana our Vice President attempts to highlight whether the present **Teeing System** makes any sense with respect to golf architecture maintenance and the play. Dr M S Shah, shares with us the **Turf Grass Species Selection and Their Features**. Col Ravi Rana once again appears to share his words of wisdom in sofar as it relates to **Turf Grass Physiology & Environment Stress.**

This and much much more to follow in the year, I like to place on record after sharing the horrific experiences of our President, Col S K Bhattacharya that he went through at the Army Golf Course, New Delhi, I implore my fellow Golf Superintendents, Golf Managers, Golf Secretaries and all those associated with the management of golf and golf courses to bear in mind that golf courses are like shooting ranges where we use different clubs to drive, chip or putt synonymous with rifle, mortar or pistol in that order that you like to hurl the projectile i.e. the golf ball that you all know of. We have to be cautious and educate our fellow golfers on matters, **safety first always** and more importantly etiquettes of golf for this alone will ensure more enjoyable golf. Just like I need to know the traffic rules before I learnt to drive on the road, congested roads and..... now the congested golf courses !

I also take this opportunity to wish you and all members of golfing fraternity good golfing & safe golfing throughout the year.

Col SK Sharma
Editor

FROM THE PRESIDENT'S DESK

2010 was a roller coaster ride for those associated with GCS&MAI, taking stock of the year we had very many feathers added to our hat. A successful well received Asian Golf Industry Show & a befitting Seminar to showcase the cerebral strength of the golf superintendents was scuccesfully organised last year. We shall once again be a major player in forth coming Asian Golf Show in 2011 where we plan to invite selective speakers from within the Country to bring forth issues which are generic as well as peculiar to our respective region. I take this opportunity once again to request you all to send your write ups for our evaluation and including your name as one of the speakers.

With the changing scenario and the rising popularity of the game I must record some of the inconsistencies that are now getting surfaced and are causing serious concern to the game and to its followers. I must put it on record this opportunity to spread basic philosophy of design, construction and maintenance of the golf courses with all those associated and our charged with the responsibility of managing golf.

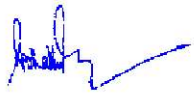
A well-maintained golf course allows the golfer to play the game with the least number of interfering and inconsistent factors. In the past, a substantial percentage of golf course superintendents knew little about the subtleties and strategies of the game itself. This was unfortunate, because the golf course if the single most important factor in determining how the game is played. This means that the golf course is the single most important factor in determining how the game is played. This means that the golf course superintendents is a behind-the-scenes official of the game. It also means that the superintendents should pursue his or her responsibilities in a professional manner. Development of a sound working knowledge and understanding of the game is crucial. The superintendents devises a philosophy of how the course should play, giving due consideration to the needs of the golfers. This philosophy is not just learned but evolves through a combination of education and experience over a period of time. Application of this philosophy involves coordinating all factors that allow a golf course to play to its full potential all the time.

The superintendents should strive to make the course the most equitable determinant in the sport. This must be done in every operation, be it routine daily practices, such as marker and cup placements, or major renovations that effect the physical nature of an entire hole. This does not imply that every inch of a well-mentioned golf course must be perfectly groomed. Most renowned golf course have areas of extreme contrast. Tees, greens, and fairways received intense grooming, while roughs, bunkers, and other hazards are left naturally rugged.

A golf course is in truly ideal condition when it presents a challenge and yet always plays fair. The actual area required for the course depends on topography; property configuration; course length desired; number and size of trees, ponds, lakes, and streams; amount of space planned between adjacent golf holes; and relationship of the golf course to surrounding real estate. A golf course length of 6,300 yards (5,758 to 5,941 metres) and a fairway width averaging 45 yards (41 metres) can be developed on a minimum of 120 acres (48.6 hectares) for an eighteen hole golf course that will include a practice range, club house, parking lot and maintenance facility plus swimming and tennis facilities et al. This is especially important if the desire is to develop a golf course with unusual character and wide separation between holes. **Although golf courses occasionally are built on less then the 120-acres minimum, this is to be avoided.** The golf course remains un-safe if it is less then that. The new concept of making golf courses with in the condominiums requires a rethink from safety point of view.

Despite my 40 years of experience at the highest level where golf courses construction, maintenance, re-construction is discussed in the sub continent, on the fateful day of 06 Nov 2010, while playing on Army Golf Course (AEPTA), New Delhi I realised how important it is to have adequate real estate necessary for the construction of a safe championship golf course. With the rising number of golfers every day the golf courses all over are getting densely populated due to the rising popularity of the game. With this the basic philosophy of the golf course design will undergo a change particularly in our sub continent . One of the underline word will be "**safety on the course first".**

I wish on behalf of GCS&MAI and fellow golfers and those who are associated with this great game of golf a very happy enjoyable and safe 2011.



Col (Retd) S K Bhattacharya
President

DOES YOUR COURSE'S TEEING SYSTEM MAKE SENSE ??

By Col Ravi Rana

If tee boxes could talk, they would likely sound like the late comedian Rodney Danger field: They don't get no respect. This has something to do with not being as photogenic, as varied, as "sexy" as greens, bunkers, and other elements of golf course architecture. Commentators during the U.S. Open Championship couldn't stop talking about Pinehurst No. 2's turtle-shell-contoured putting surfaces and elaborate green complexes. But, having logged my share of tube time watching the event, I recall almost no pearls of wisdom concerning tee placements, beyond the observation that, like most classic courses, No. 2's tee boxes tend to be relatively close to the preceding green.

Fair enough, except that for all us non-Open players, tee placement and maintenance are immensely important to strategy and – more important in this "let's-grow-the-game" era – in attracting and retaining new and infrequent players, who tend by definition to be less accomplished. So while I'm not surprised that Pinehurst's greens are the story of the tournament, I am frequently amazed at how little understanding of, and attention to, the tee box system receives from managers who should know better. And though the reasons for this lack of regard may vary, it seems to apply across the spectrum of facilities: public and private, high-end daily fee, you name it.

An unreconstructed perspective on tee box options may even be deliberate, rather than inadvertent. Having often encountered resistance to the suggested additions or alterations to various courses' network of tee boxes, it is noticed that this reluctance was usually explained not as stubbornness but as devotion to the game's traditions: "Our tees haven't changed in a quarter of a century. Why would we do it now?" Sadly, such a defense of the faith generally coincides with a decline in rounds played at pay-for-play courses, a struggle to retain members at private clubs.

During my two decades in golf industry as course Supdt/Manager, examples of faulty tee design and placement have come in innumerable forms. But it is fair to classify the vast majority into five significant problem areas, as follows:

1. Failure to include forward tee options suitable for beginners and high-handicap golfers.
2. Inadequate matching of teeing options with the variety of regular players at the course, public or private, in question.
3. Angles of play that impede rather than promote the course's strategic attractions, especially "risk / reward" options.
4. Sight lines that fail to capitalize on design elements, natural or man-made.
5. Teeing areas that make maintenance difficult or impossible due to size, location, or composition.

Fortunately, there is a flip side to the relative lack of attention devoted to the tee box's contribution to the playing experience, namely that all the above are also comparatively easy to fix: In most cases, it is a lot easier and less costly to rebuild a tee box than a green.

1. Failure to include forward tee options suitable for beginners and high-handicap golfers.

Though the guilty party shall remain nameless, one of my recent projects – at a respected private club in the Great Lakes region – illustrates the point. Asked to make suggestions on the remodeling of a couple of discrete areas on the course, A look at the scorecard revealed that the forward-most tees played more than 5,800 yards. When I questioned two club officials about the length, they replied with obvious pride, "We have always wanted to ensure that our club is very challenging from all tees, even the forward ones."

Of course, the club's target market is similar to that of the game generally. But as obtuse as the point may seem, novice golfers, like high-handicappers, need a realistic challenge. Personally, I like to see courses offer a forward tee that can be played between 4,800 and 5,300 yards, depending on other variables affecting the design decision; and favorable reaction from clients, both private and public, confirms that golfers welcome the practice. Player

enjoyment, not some arbitrary concept of a "stern test," ought to be the guiding principle.

Indeed, where possible and appropriate to the clientele, I also recommend that courses offer a "young junior" set of tees for beginning golfers, pre-teens, and super seniors that can be played at about 3,500 yards. Usually, it is unnecessary to build permanent tees for this golfing population, as movable tee markers, placed along the edge of the fairway, with play limited to certain days and times, will suffice. The sense of making these tees "official" can be instilled by printing separate scorecard -- a nice touch.

Again, it sounds elementary but – take it from a guy whose job is to visit lots of golf courses – the scarcity of playable forward tees is a pervasive, industry-wide problem. And it is important enough to beginners and high-handicappers to represent a crucial impediment to expanding participation in golf.

2. Inadequate matching of teeing options with variety of regular players at the course, public or private, in question.

The existing teeing system of a public course at which I noticed another common flaw. In this case, the scorecard described the four-tee selection thus:

Blue Tee = 6,950, White Tee = 6,750, Gold Tee = 5,950
Red Tee = 5,200

Plainly, what was needed was a middle teeing option measuring roughly 6,300 yards. This, despite the owner's acknowledgment that complaints from patrons regularly had to do with the course playing either too long or too short; and that among these complaints, most came from golfers playing the white or gold tees, seldom from those playing the blues or the reds, that is, the longest and shortest sets of tees. The topography at the course in question will make the addition of a new set of tees easy – which begs the question of why it wasn't done before. But ask yourself: How many courses have you played where the first review of the scorecard revealed the need for a "missing tee?".

Similarly, the differentials between multiple tee placements can appear to have no rhyme or reason. Absolute, constant proportionality – 10 percent increments in yardage, say, between one tee and the next one farther back or forward – are seldom possible on every hole, due to pre-existing landforms that make such a rigid scheme implausible. Still, it's surprisingly often the case that no semblance of proportionality exists, thereby negating the fundamental purpose – to equalize the golf experience for players at all levels of competence – of multiple tees.

3. Angles of play that impede rather than promote the course's strategic attractions, especially "risk / reward" options

A cousin of tee design shortcoming #2 ignores another strategic aspect useful in making a round of golf both exciting and manageable for a variety of players. It is to make tee shots easier or more difficult according to their angles, not just the distances involved, particularly those involving forced carries

4. Sight lines that fail to capitalize on design elements, natural or man-made.

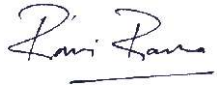
As many noted golf course architects have observed, a golf course's setting, its purely "cosmetic" aspect, is key to the golfer's appreciation of the experience, and this is even more true of the average player than the scratch player, who may be interested primarily in his ball-striking. It is often possible to maximize tee-box vistas without seriously jeopardizing "shot values" or other strategic aspects associated with playing the course. Many times, in fact, all that is entailed is to move a tee box laterally, typically10 to 25 feet. As a designer, I know this has worked when someone says, "Wow, I never really appreciated the view on this hole. The scenery in the distance is beautiful."

5. Teeing areas that make maintenance difficult or impossible due to size, location, or composition.

Most golfers would cite canted tee box surfaces, threadbare turf, and other defects as proof positive of inattentiveness on the part of management; and while this is sometimes a valid complaint, some tee box configurations simply cannot be maintained adequately regardless of the expertise and dedication of the greens keeping staff. Many times this is attributable simply to the tee box's size, or lack thereof, which leads to excessive wear from player use. A tee box that is too big is a problem both vastly less common and less serious.

With all the attention greens receive in terms of soil testing, I would venture to guess that about 20-30 percent of courses I have visited have tees that contain a soil mix incapable of proper drainage and turf nourishment. The solution is to analyze the soil mix using a USGA approved testing lab. If soil quality is the problem the solution is to rectify it through deep aeration and aggressive topdressing or rebuild the tees using proper tee mix. Other problems plaguing healthy tees are restricted access routes, excessive shade, root problems from trees, inadequate sprinkler coverage, and poor turf grass choices.

In conclusion I must say ike much of golf course architecture, a good tee box system has much to do with common sense. But as elementary as all of this sounds, the five points listed above will resonate with many, even most, golf course owners. And the issues may be simple, but their resolution is far from trivial in the pursuit of new members or the golfing public at large. A good place to start is to consult a golf course architect to discuss potential areas of improvement. Your tees still can't talk, but your customers will thank you.



Col (Retd) Ravi Rana

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TURFGRASS SPECIES SELECTION & THEIR FEATURES

By Dr M H Shah

Selection of proper turf grass species is one of the most important decisions to be made when establishing a golf course as it is important to select a grass species adapted to the area and to the intended level of management. The species selected must also be capable of meeting basic purpose besides, aesthetic expectations.

The turf grass manager has a choice over which grasses are used on the golf course. For those fortunate enough to be involved at the out set of a new project, there is the choice of which to sow out. Those managing established turf may wish to bolster the existing grasses or try to replace them with something more. Do not ignore the impact of ongoing management on species selection, as the maintenance employed will directly effect which grasses will perform best. Each grass species has its own requirements with regard to the environment it favors and the maintenance regime it will tolerate. The following lists the main grasses used on golf greens, tees and fairways describes the major maintenance practices and environmental influences which will favors or impair their growth and will, hopefully, help in the decision as to which species would be sustainable in a given situation.

The grass species are discussed under the following two categories.

(a) Warm Season Grasses :
(b) Cool Season Grasses :

Warm Season Grasses :
Bermuda Grass: (Cynodon spp.) is a major turf species for sports fields in general and golf courses in particular through out the tropical and sub- tropical areas of the world. The genus Cynodon comprises nine species with Cynodon dactylon being the most widespread. It is tetraploid with broad genetic variability.

Cynodon Dactylon(L.) is commonly called Bermuda grass in many areas of the world and is also known by other numerous names including"kweekgras"(South Africa); Couch grass(Australia & Africa);devils' grass (India) and Gramillia (Argentina).

Bermuda Grass (C.Dactylon (L.) pers.) is a highly variable sod forming perennial that spreads by stolons, rhizomes and seed. Stolons of Bermuda grass readily root at nodes. Lateral buds develop at the nodes to produce erect or ascending stems that reach 5 to 40 cm in height.

Bermuda has a fibrous, perennial root system with vigorous, deep rhizomes. Roots are produced at nodes after new leaves or tillers are produced during the growing season and after new shoots are produced in the spring.

Cynodon dactylon is drought tolerant and well adapted to sunny conditions. It is medium coarse textured grass with grey green in color, but it becomes dormant and loses its color in cold weather.

Used throughout the golf courses to regularly mown areas. This is the most widely used warm season species on golf courses. Relatively fine leaved hybrids have been bred which produce high quality putting surfaces.Whilist the parent, known as common Bermuda grass, remains widely employed on fairways. Established by sprigs (vegetative stems). Seeded varieties are available- though these can not yet claim to produce as high a quality of turf as the best sprigged hybrids.

Nitrogen inputs can vary between 25 and 60 kg per growing month for greens and to the lower end of this range for fairways. Will tolerate periods of drought bur respond well to irrigation. Hybrids can be mown as close as 2.5 mm on greens and 5mm for older varieties. Grain and thatch production are issues requiring frequent treatment to address. Light combing, coring and frequent top dressing needed and intensive, disruptive operations should be avoided due to slow recovery rate. Potentially damaged by many diseases and insects pests but in reality, many of these can be controlled through good cultural practices. Gives poor performance in shaded conditions and require 8 hrs of sunshine per day.

Dormancy occurs when soil temperatures drop below 10 to 13 degrees C, though new varieties have been bred with cold tolerance.

Plant in spring or autumn at a rate of 1 1b seed/1000 sq ft.

There are new seeded cultivars of common Bermuda grass that have improved turf grass quality characteristics, viz.

Hybrid Bermuda Grass: Cultivars of hybrid Bermuda grass include Tifgreen; Tiffway11 and Santa Ana. All these cultivars form thatch that must be removed periodically by verticutting.These hybrids are drought tolerant, but irrigation practices enhance their competitiveness.

Tifgreen: Is well adapted to sunny conditions. It becomes dormant and loses color during periods of cold temperatures but less than common Bermuda grass. This cultivar is fine textured with dense prostrate growth. It has a deep blue green color.

Tiffway11. Is also adapted to sunny conditions. It retains its color in winter better than any of the other Bermuda grasses. This cultivar has a medium fine texture, dark green color and dense growth. It can withstand traffic better than Tifgreen.
Sanata Ana: It has excellent wear characteristics and a dark color. Its requirements are similar to those of other hybrids, but are more tolerant of smoggy conditions.

Bermuda Grass (var-yuma). One of the major grass species used on most exclusive golf green worldwide. Perennial sod

former, dark green, drought resistant, low growing, fast repairing, full sun with fair salt tolerance, can be mown closely, forms a dense turf, goes into dormancy when temperature drop below 60 degrees F and greens up fast when temperature rises. Once only grown from sod or sprigged, it is now available as seed in both common and improved varieties. It spreads by rhizomes and stolons and is highly diversified grass.

Princess 77 Bermuda grass: It is one of the newest seeded Bermuda available on the market. It produces a dense green turf that is highly comparable to the sodded varieties. The establishment costs are much lower than sod. It makes an excellent dense turf that can be mowed low for a green type look or kept maintained at higher heights for a denser fairway look.

Yukon Bermuda: Is a high quality turf variety similar in turf quality to princess 77 but with higher cold tolerance (winter survival).It can be usable for home putting greens and high input courses where low mowing ability and density is important. It is very popular variety due to its dark green color(very similar to Tiff way 419 in color) along with excellent cold tolerance and slower growth for less mowing.

Seashore Paspalum(Paspalum vaginatum): Used throughout golf course to regularly mown areas. sprig and seeded varieties are available.

-Relatively low fertilizer requirement, up to 50% of that needed by hybrid Bermuda grass. Will tolerate salt water and other alternative irrigation sources e.g. recycled, but requires fresh water during establishment. If using water with high total dissolved solids (TDS) regular leaching is required. A high thatch producer, but strong lateral and rhizomatous growth produces excellent recuperative properties which enables intensive thatch management, particularly aggressive top dressing and rapid recovery of divot scars to tees and fairways.

Maintain good quality turf in shade and cloudy conditions.

-Retains better color than Bermuda grass when soil temperatures decline but does not loose greenness, albeit for a shorter period.

Zoysia (Zoysia japonica and z. matrella var.matrella). The use of this grass tends to be restricted to fairways and the first cut of rough. Establishment is quite slow up to first two years, but once established, it has low maintenance requirements.
Can be sustained with no nitrogen input but appearance can be enhanced by applying up to 20 kg n/ha per growing month. At low nitrogen rates, irrigation requirement is also reduced and irrigation only required if extended drought occur.

Prone to thatch production at high nitrogen rates.

Excellent recuperative capability for rapid divot repair.

Cutting height generally no closer than 13mm, though the upright growth and stiffness of leaves develop a tight sward upon which the ball sits.

Resistance to most common diseases but is susceptible to brown patch and pythium. Considered the most resistant warm season species to insect pests.

Kikuyu Grass (pennisetum clandestinum). A grass for fairways and the first cut of rough. It can be mown down to 10 mm. Kikugrass produces strong stolons which can look unsightly if grass cover is not kept dense and light.

Nitrogen requirement low 5 to 15 kg/ha per growing month.

Needs to be irrigated during dry spells.

Regular verticutting required if excessive shoot growth seen, usually as a result of higher N application.

Cool Season Grasses:

Creeping bent (A.grostis stolonifera also known as A. Palustris). Used on greens, as a monoculture, and on green surrounds, tees, fairways and first cut of rough.

-High maintenance grass:120-300 kg/ha per year on greens to establish turf, needs regular irrigation in dry periods and susceptible to numerous diseases, notably take-all patch,fusarium,brown patch and leaf spot.

Successive generations of creeping bent have required more intensive management, whilst tolerating increasingly closer mowing. The newest generation performs best at cutting heights of 3mm, though such very close cutting result in scalping if the ground is heavily contoured or has a high thatch content.

-Rapid growth rate.

Produces large quantities of thatch, requiring intensive thatch management.

-High cost.

Brown Top Bent (Agrostis tenius also known as A. capillaries)

-Suitable for use throughout the golf course.

-Relatively low inputs: 60-100 kg N/ha per year on greens to establish turf, Reasonably drought resistant,succeptible to fusarium patch disease and take-all patch. The later can be devastating but is only usually seen to immature surfaces before a stable microbial population has developed.

-Tolerant of occasional and short term salt water contamination and can tolerate salt concentration of up to 2700 micro siemens/cm

-Will benefit from regular mowing at or above 4mm.

-Relatively slow growing.

Produces a fibrous thatch.

Moderate cost.

Fescue: chewing fescue (Festuca rubra ssp.commutata) and slender creeping red fescue (Festuca rubra ssp.litoralis).

-Suitable for use throughout the golf course.

-Low inputs: 50 kg N/ha per year or less on greens to establish turf, drought resistant, potentially zero pesticide. Susceptible to red thread and dollar spot disease but these are considered to, be of cosmetic nuisance value. Will benefit from regular mowing at or above 5mm. Slow growing and most cultivars discolor to tan during prolonged dry weather.

-Requires free draining soils and good excess to light and air. Low cost and the most environmentally sustainable cool season grass.

Perennial Ryegrass: Used to green surrounds, tees, fairways and first cut of rough. If used in mixes with other grasses will tend to dominate to worn areas which can give an uneven appearance to turf

High maintenance grass to keep in good order: 15 to 35 kg/ha N per growing month and irrigation required. If this grass dries or receives inadequate nitrogen, it develops extremely fibrous tissue which is difficult to cut cleanly, leaving white fibrous strands at the cut edge and a poor appearance.

Susceptible to many diseases e.g. red thread, brown patch, rusts, grey leaf spot. A high cost grass to retain good appearance.

Kentucky Blue Grass: (poa pratensis) Used to green surrounds, tees, fairways and first cut of rough .If used in mixes with other less wear tolerant grasses will tend to dominate worn areas.

High maintenance grass, fertilizer requirement between10-30 kg /ha N per growing month, the higher rates in irrigated situations.

Susceptible to a variety of diseases including dollar spot, leaf spot, powdery mildew and rusts.

High thatch producer

High cost grass to retain good appearance.

So depending upon your requirement you can pick-n-choose the type of grass to your liking.

The author is Former Director Research and Dean Faculty of Agriculture, besides a keen golfer and can be emailed on admin@gcsmai.com

Disclaimer : This article is solely the concept and opinion of the writer. GCS&MAI do not desire to deal with any query or correspondence in this matter. Readers are requested to directly interact with the writer.

"No, playing golf isn't a sin. However, lying about your score, swearing, playing for money, wishing the other players will play bad, and not returning that 7-iron you found is."

Membership Fee for GCS&MAI :

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Yearly Subscription	: Rs 300/-

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Yearly Subscription	: Rs 5000/-

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Registration Fee	: $ 250
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Registration Fee (Golf Clubs)	: $ 500
Yearly Subscription	: $ 300

TURFGRASS PHYSIOLOGY & ENVIRONMENT STRESS

By Col Ravi Rana

Good turfgrass management decisions are based on a scientific understanding of how plants grow, develop, and acquire resources through out the year. The study of this process is called **plant physiology.** All plants physiological processes are interconnected. The process of photosynthesis plants with energy and biomass. During photosynthesis, leaves capture energy from the sunlight and store this energy in the chemical bonds of newly synthesized sugar molecules. Photosynthesis require carbon dioxide (CO_2) from the atmosphere and water (H_2O) from the Soil; the process eventually releases Oxygen (O_2)

Overall Chemical Reaction Of Photosynthesis

Light

$6\,CO_2 + 6\,H_2O$ ---------- $6O_2 + C_2H_{12}O_6$

Carbon Dioxide Water Photosynthesis Oxygen Carbohydrate Sugar(Carbohydrate) formed in photosynthesis are transported through the plant, bringing carbon and energy to sites where they are needed. During respiration, the reversed of photosynthesis occurs.

Photosynthesis. The reason why some plants , such as Bentgrass," prefer" cooler climates. While other , such as Bermudagrass, "prefer" warm climates was not fully understood until the 1950-1960. During this time researcher discovered the existence of two distinct photosynthesis pathways. One C3 cycle, operates primarily in Cool-Season turfgrasses such as Bentgrass while the other, C4 cycle, operates primarily in warm- season turfgrasses such as Bermudagrass and Zoysiagrass.

Understanding how these photosynthesis pathways differ in physiology and stress response allows our Superintendents and Managers to manipulate environmental conditions which allows turfgrass species to grow in areas where they do not naturally occur.
The chemical reaction of photosynthesis can be divided in two phases;-

Phase-I ------ Light reactions
Phase-II-------Carbon reactions

The light reactions are identical in C3 and C4turfgrasses.

Basic Reaction of Photosynthesis. The simple reaction of photosynthesis shown earlier disguises the complex nature of the photosyntic process which involves numerous materials photosynthesis; CO_2 and H_2O on the right- hand side are the products; O_2 and $6CO_2$ sugar molecules such as glucose. The equilibrium constant for this equation is approximately 10~500, measuring this reaction is impossible without a large input of energy. Light provides this energy.

Nature Of Light. Light is a form of electromagnetic radiation with the qualities of both a particle and wave . One light particle is called a photon. And each photon contains a discrete quantity of energy called a quantum. The magnitude of photon's energy is related to the wavelength. The higher the wavelength of light, the less the energy contained in its photons. The energy;-

- The energy of blue light(430 nm) is "High"
- The energy of red light (680nm) is "Low"

The human eye can perceive light within the wavelength range of 400nm (Violet) to 700 nm(Red) photosynthesis uses light within the same range. For this reason, light between 400-700 nm is often referred to photosynthesis- called active radiation or PAR.

C3 Plants. Cool season turf species such as Bentgrass, Bluegrass, Fescues and Ryegrass all are C4 plants, thus , they are adopted to cooler regions. As temperature increases, the concentration of CO_2+O_2 decreases. As a result Photorespiration increases relative to photosynthesis .When grown in high temperature environment regions, C3 plants weaken. Optimum temperature for 60 to 77 F (15.6 To 25 C) Photosynthesis. Optimum temperature for 50 to 65 F (10 To 18 C) Root growth

Photorespiration. Photorespiration in C3 plants when normal carbon dioxide (CO_2) levels are depleted due to closed stomata, which reduce transpiration during heat stores. This favors oxygen (O_2) uptake and utilization.
Photorespiration is a key reason C3 grasses grow poorly outside their naturally adopted cooler regions.

C4 Plants Compared to C3 Plants. In addition to the differences in carbon fixation efficiency, leaf anatomy, water usage, and energies of photosynthesis, these are other differences between C3 & c4 Plants. These physiological differences affect plant response to various environmental conditions and growth or productivity.

Nitrogen Use. Not only are C4 plants more efficient at utilizing CO_2& water compared to C3 plants, but they also utilize nitrogen more efficiently.

Temperature Tolerance. C4 plants have an ability to withstand certain other environmental pressure which C 3 plants cannot. C4 plants better adapted to high temperature. However, as the temperature gets cooler, C4 plants do not photosynthesize as well as C3 plants. This is perhaps related to the cold sensitivity.

Light. Another factor influencing plant growth is Light. C4 plants require full sunlight for optimum photosynthesis, C3 plants, however, are fully saturated at one Half of full sunlight. Thus light intensities also greatly influence turf grass growth. C4 plants such as Bermuda grass grown best when exposed to full sunlight. When full sunlight hours are reduced below o8 hours Bermuda grass, especially in shorter mowed areas such as Greens, will generally thin. Taller mowed Bermuda grass such as in fairways and approaches can with stand less sunlight due ti their height of cut, thus they provide more leaf surface area to capture available light. Bermuda grass

greens, therefore require eight hours minimum of full sunlight, year round like we need 08 hours sound sleep. C4 grasses have relatively poor shade tolerance compared to C3 plants. Bermuda grasses when mowed excessively low, such as in a golf green, it is frequently invaded by other pets and algae.

Resiperation. Respiration is essentially the reversal of photosynthesis when the sugar and starches (Carbohydrates or food) synthesized during photosynthesis are utilized to provide energy and metabolites for plant growth and maintenance. Oxygen released from photosynthesis can be used directly in respiration while Co2, released from respiration can be used in photosynthesis.

Note: "Winter Kill" or low temperature stress on Bermuda grasses fairways. Proper mowing height, fertilization, drainage , and crown desiccation prevention help prevent this Warm season C4 turf grasses begin their growth in the spring (green up) when ambient temperature exceeds 60 F(15.6C). At this time lateral buds at the nodes of rhizomes and stolons begin to break dormancy, the store food reserves are converted to soluble sugar and the growth or greening process begins.

Low temperature or cold weather damage to plants is a collective term used to describe any form of injury related to low temperature with several forms of injury. It is important to distinguish between these form of low temperature injury and have an understanding of the conditions promoting the specific type of injury. In general, the major types of low temperature injury are caused due to the following:-

- Hydration
- Direct low temperature exposure
- Desiccation
- Traffic efforts
- Snow flakes
- Frost behaving
- Diseases

Fertility. Turf grasses susceptibility to low temperature stress can be reduced by applying a late summer application of 4:1:2 or 3:1:2 ratio of NPK fertilizer.. Adequate level of potassium (K) has been shown to improve low temperature tolerance. Potassium plays a regulatory role in plants relation which is important in low temperature tolerance. Medium to high is desires.

Drainage. Poor surface and /or subsurface drainage can result in direct low-temperature drainage or injury to the crown of turf grass plants. The level of water or moisture contents within the turf grasses crown in positively correlated to the degree of low temperature injury-Turf grasses plant growing in areas with poor drainage , high compaction or excessive irrigation are at a greater risk of low temperature injury. Similarly irrigation, mowing, pests control, thatch level , traffic are also important factors to be kept mind by the Superintendents & Managers and follow the best management practices to minimizing low temperature stress..

(a) Documentation. Maintenance practices should be documented for each hole and protective management plans initiated to improve problem areas

(b) Frequent Soil Sampling. Soil sample should be taken on a frequent basis , at least twice yearly. Mowing height should be increased in winters for warm seasons turf grasses prior to the onset of cold weather and in the summer for cool seasons turf grasses to enhance the rooting, rhizome growth and carbohydrates or food accumulation. Thatch level control should be managed with aggressive soil cultivation and topdressing program. Fertility program should be based on soil test results for specific turf grasses specie and/or cultivars present. Herbicide usage should be limited in winters.

Salinity. Saline water can cause stress and injury to plants by several means. Direct salt injury occurs with the accumulation of salts such as Sodium, Chloride, Boron and other ions in soil as well as ions accumulation in plants. Salts, however , reduce plant growth . Salt stress is similar to draught stress in appearance.

Fertilization. Proper fertilization is also important to minimize high temperature stress. During early summer, prior to the onset of high temperature, reducie the amount on Nitrogen fertilizer and increasing the amount of "K" fertilization on cool season turf grasses is generally recommended.A fertilizer with N:K ratio 1:1 often utilized prior to onset of high temperature. Slow release "N" source should be used cautiously to avoid excess "N" release under high temperature. On putting greens , liquid application are used to control "N" availability during this time.

Pest Control. It is of paramount importance during high temperature stress period on turf grass. Preventive fungicide application should be utilizes where possible to minimize disease potential.

Biostimulants. Biostimulants are material which promotes plant growth when applied in small quantities. It will increase photosynthesis rate, reduce turf grass senescence, enhance seed germination and root growth, help sod establishment faster and increase salt tolerance and draught resistance after application.

Conclusion. Golf courses are continually increasing in number, as well as sophistication in terms of design, management, and increased scrutiny from general public and regulatory agencies. It has become important for Superintendents and Managers to understand the grass science and overcome the environment stress by adopting the best culture practices to provide the consistent putting surface to the golfers.

Col (Retd) Ravi Rana

Disclaimer : *This article is solely the concept and opinion of the writer. GCS&MAI do not desire to deal with any query or correspondence in this matter. Readers are requested to directly interact with the writer*

THE ORIGIN OF GREENKEEPERS

By the end of the 1700's the first greenkeepers came into being. The term was "greenkeeper" not "greenskeeper," Historically, the term "green" referred to the whole golf course and not just to the putting greens. Not unlike today, the greenkeepers were charged with making things better for the golfers. In the record of the Aberdeen Golf Links in 1820, mention was made that the club agreed to pay Alexander Monroe four pounds a year for "taking charge of the links and providing accommodations for the members ' boxes. "Monroe was also to pay particulars attention to keeping the holes in good order. Two years later, Monroe's salary was reduced to three pounds a year !

And so care of the "green" had its beginning. The early golf professionals frequently became greenkeepers. Neither job was known for its security, even in those days. Old Tom Morris, four times winner of the British Open and still considered and grand gold man of golf, became greenkeeper of St. Andrews in 1865 and remained so until 1904. He had two rules for his turf maintenance program :

"Mair saund Honeyman his cry for his assistant, Honeyman, to apply even more topdressing of sharp sand to the greens, tees, and fairways. Tom Morris said it was needed to "maintain the character of the gress.

'Nay Sunday play. The golfe course needs a rest even if the golfers don't.'

To this day there is "nay Sunday play" on The Old Course. The first patented hole cutter was developed by one Charles Anderson and presented to Old Tom Morris as a tribute in 1869.

Chief Editor

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