IGU Greenkeeper Education Programme
Course Notes

Micah Woods, Ph.D.
Chief Scientist | Asian Turfgrass Center
www.asianturfgrass.com

November 2011

Contents

1 Introduction to the course

In this course, we have the objective of sharing information that can be used to improve the grass conditions on golf courses in India. This course includes sections on greenkeeping practices, on the different types of grasses that are suitable for use on golf courses here, and it involves both classroom lectures case studies that you will work on yourselves, field training sessions, and an equipment section about mowing and equipment maintenance that will be provided by trainers from the Asian Golf Industry Federation.

On a golf course, we have some clearly defined areas. The most important is the putting green. When playing golf, more than 50% of the shots are made either hitting to the green or on the green. Much of the maintenance work must be focused on keeping the putting greens in the best possible condition. We also have tees, fairways, and rough, which can be divided into primary rough and secondary rough. The primary rough is highly visible and in play and must be maintained to a relatively high standard, while the secondary rough is farther from the line of play, less likely to have a ball hit in it, and requires slightly less maintenance. There are also bunkers, water hazards, landscaped areas, and a turfgrass nursery to maintain.

2 Course maintenance standards

To begin, we need to have a set of standards. Course maintenance standards can be used to set a reasonable objective for what type of playing conditions should

be produced. The maintenance work can then be done in a manner to produce the desired playing conditions. Sometimes a golf course needs to be maintained to a very high standard such as a course that will be hosting a major tournament. Sometimes a golf course needs to be maintained at a standard suitable for everyday member play. And there are also courses where the objective is to maintain it at the most basic level of playability for the enjoyment of people who are not especially concerned about the perfection of every blade of grass. This all begins with a simple document – the course maintenance standards.

This document can define the standard of playing surfaces that are to be produced and list some of the most important maintenance practices that must be performed to achieve these standards. The weather has a large influence on the grass growth and playing conditions. When the weather conditions are relatively constant throughout the year, it may be possible to have simple course maintenance standards. When the weather conditions change in the year, whether that be in temperature, rainfall amounts, or in sunlight intensity, then the course maintenance standards must be adjusted for those changes in the weather.

2.1 Example maintenance standards

Greens

Fairways

Tees

Primary rough

Secondary rough

Bunkers

3 Turfgrasses

Grasses used on golf courses have a common characteristic – they can tolerate regular mowing. Grasses grow from the crown of the plant, and the crown sits near the ground. Cell division and the development of new leaves occur at the crown of the plant.

Leaves capture light from the sun and carbon dioxide from the atmosphere. Grass roots obtain water and mineral nutrients from the soil. In the process of photosynthesis, the energy from the sun is used to create carbohydrates that the grasses store for future use. During the process of respiration, grasses break down the carbohydrates that were created during photosynthesis, releasing energy in the process.

Grasses grow when the carbohydrates produced through photosynthesis are greater than the carbohydrates used through respiration.

3.1 Cool-season or C_3 grasses

Some common cool-season grasses include creeping bentgrass, annual bluegrass (*Poa annua*), fine fescue (*Festuca*), perennial ryegrass, and kentucky bluegrass (*Poa pratensis*).

The optimum temperature range for growth of C_3 grasses is from 15°C to 24C. As air temperature increases from 20°C to 30C, photosynthesis doubles. So it seems that the grasses should grow more with increasing temperatures. But a characteristic of C_3 grass is something called photorespiration. This occurs when O_2 is substituted for CO_2 in the first step of photosynthesis. The net effect of photorespiration is to use carbon, not to store it. And during that same air temperature increase from 20°C to 30C, when the rate of photosynthesis doubles, the rate of photorespiration triples. Photosynthesis becomes less efficient with C_3 grasses as the temperatures increase.

3.2 Warm-season or C_4 grasses

Some common warm-season grasses include bermudagrasses (*Cynodon*), zoysiagrasses (*Zoysia*), seashore paspalum (*Paspalum vaginatum*), and broadleaf carpetgrass (*Axonopus compressus*). The optimum temperature range for growth of C_4 grasses is from 27°C to 35C. Photorespiration is not a problem for C_4 grasses, so as temperatures increase, so does photosynthesis.

At high light intensity, photosynthesis of cool-season grasses is limited by a lack of CO_2. Cool-season grasses are not able to utilize all of the light. Warm-season grasses do not have this problem; consequently, the photosynthetic rate of warm-season grasses increases with light and with temperature.

4 What affects photosynthesis?

Understanding photosynthesis and the factors that influence it is critical to producing the desired playing surfaces. Why? Because the basis of greenkeeping is controlling the growth rate of the grass, and photosynthesis is what drives the growth not just of grass, but of plants in general.

There are four main factors that influence photosynthesis of golf course turfgrasses. These are light, temperature, water, and nitrogen. We notice that grass grows well in open, sunny areas, provided it has enough water, but that grass does not grow well under trees. Why is that? Because of light. We notice that grass grows well in open, sunny areas, when it is provided with water, but grass in an open, sunny area, without water, does not grow well. We notice that a grass such as bermudagrass grows well when the temperature is 30°C but it does not grow well when the temperature is 10C. And we notice that when we add nitrogen to grass, it responds within a few days by becoming more green and growing more rapidly, compared with a grass to which nitrogen was not applied.

These are the factors that influence how fast the grass will grow. And how fast the grass grows has an impact on a number of playability and maintenance issues, including:

- green speed
- thatch development
- mowing requirement
- irrigation water use

- susceptibility to weed invasion
- susceptibility to disease
- traffic tolerance
- recovery from damage such as divotting or traffic
- shade tolerance

The growth rate of the the grass has a huge impact on how a turfgrass surface will perform. Maintaining and modifying the growth rate of the grass, adjusting that growth rate as necessary to create the desired playing surface, is at the heart of greenkeeping.

4.1 Light

As a general rule, we want as much light as possible in order to have good-performing turfgrass. We must also mow the grass as high as possible, keeping as much leaf on the grass as we can, in order to capture the maximum amount of light.

4.2 Water

Turfgrass growth will slow when soil water content, by volume, drops below about 10%. We can see when turfgrass starts to suffer from drought stress because the leaves become soft and take on a silver or grey color, footprints on the turf do not bounce back, and we term grass at this stage to be wilting. When the grass is wilting, the soil moisture will probably be just under 10%. Maintaining soil moisture in the range from 10% to 30% is usually effective in keeping turfgrass growing enough to recover from traffic damage.

4.3 Temperature

Warm-season grasses grow faster with increasing average daily temperatures in the range from about 15°C up to more than 30°C with optimum growth expected to occur when average temperatures are in the range from 27°C to 35C.

4.4 Nitrogen

Greenkeepers can control the growth of grass by applying or withholding fertilizer, especially nitrogen fertilizer. A standard application rate to produce good turfgrass conditions in this climate is 3 to 4 grams of nitrogen/m^2 per month. Adding more will cause the grass to grow faster, and adding less will cause the grass to grow slower.

The nitrogen application rate for warm-season grasses can be adjusted with temperature, because the grasses have a relatively low nitrogen requirement when temperatures are cool, but a relatively high nitrogen requirement when temperatures are warm.

5 Bermudagrass or *Cynodon*

Bermudagrass performs well when it has enough sunlight. The major problem with bermudagrass is weed invasion, and weed invasion occurs when light levels decrease or when not enough nitrogen fertilizer is applied. Bermudagrass does not grow well in persistently wet soils. If you are able to provide enough light and fertilizer, combined with good drainage, then bermudagrass will be a good grass.

6 Seashore Paspalum or *Paspalum vaginatum*

Seashore paspalum has an impressive green color compared with bermudagrass or the unimproved native zoysia commonly found growing in Asia. Improved seashore paspalum varieties such as Sea Spray and Sea Isle 2000 can maintain a green color and steady growth even under dry soil conditions that have caused the Salam variety to go dormant. In Southeast Asia, the Salam variety is used at most sports turf sites, and Salam dies in Southeast Asia under low to moderate maintenance programs because it is overgrown by bermudagrass or zoysiagrass under dry conditions. Seashore paspalum grown in Asia is also more susceptible to disease than is zoysiagrass. Although seashore paspalum can produce an excellent playing surface, it generally requires more inputs (water and pesticides and mowing) than does zoysiagrass or bermudagrass.

7 Zoysia

Zoysia is native to East and Southeast Asia and performs well in those climates, growing relatively disease free in Southeast Asia, producing a dense turf that is resistant to weed invasion, and is more resistant to damage from some insects than are seashore paspalum or bermuda. Although zoysia is thought of as a slow-growing species, we commonly find zoysia overgrowing bermuda, probably because of the better shade tolerance of zoysia. During areas with a monsoon season, zoysia can grow much more rapidly than bermudagrass. Zoysia may recover slowly from traffic damage, yet the overall growth rate of zoysia throughout the year may be faster than that of bermudagrass. It is important to manage the traffic on zoysia to avoid severe damage that may require too much time for recovery. Zoysia is relatively tolerant of traffic but once damaged can be slow to recover.

8 Carpetgrass or *Axonopus compressus*

Carpetgrass is particularly well-suited to shady sites, to the understory of treed areas, and in soils that retain moisture for much of the year. This grass has been or is used as a fairway turf at prestigious clubs in Asia such as Hong Kong GC, Wack Wack CC (Manila), and Singapore Island CC. It performs best as a fairway turf when mowed at 8 to 10 mm.

9 Turfgrass growing environment

While photosynthesis is affected by four things (temperature, light, water, and nitrogen), turfgrass growth and playing surface characteristics are affected by the greenkeeping work that is done. Most of the greenkeeping work involves modifying the growing environment of the grass. There are many types of work, but the work can be divided into categories, or ways of modifying the growing environment.

9.1 Light

Grasses perform their best when grown in full sunshine. As a general rule, turfgrass that receives less than 6 hours of sunshine per day may need special attention to

keep the quality of the playing surface from deteriorating.

Some of the standard maintenance practices that can be used to improve turfgrass conditions when light is insufficient for good turfgrass performance include:

- raising the mowing height
- reducing the frequency of mowing
- reducing the nitrogen application rate

9.2 Air in the soil

Turfgrasses are expected to perform well when soil air content is maintained at more than 25% by volume.

Maintenance practices that help to maintain air space in the soil include:

- sand topdressing to match the production of organic matter, constantly diluting the organic matter by mixing it with sand
- slicing, solid tine aeration, hollow tine aeration, or other means of turf cultivation
- controlling the growth rate of the grass so that thatch does not accumulate

9.3 Water in the soil

Optimum soil moisture content for a particular site depends on the grass type, soil condition, and desired surface characteristics. It is generally desirable to keep soil moisture as low as possible while still maintaining a rate of turfgrass growth sufficient to recover from traffic damage.

9.4 Fertilizer

Nitrogen can be applied based on experience, grass type, desired growth rate, and especially based on time of year (temperature and sun). For most warm-season grasses, a monthly rate of about 3 g N/m^2 is a good estimate of nitrogen rate, and that can be adjusted based on turfgrass performance.

Other nutrients such as phosphorus and potassium should be applied based on the result of soil tests.

Turfgrass leaves usually contain, on a dry weight basis, about 4% nitrogen, 0.5% phosphorus, and 2% potassium. Fertilizers applied to turfgrass will usually produce a good result when the ratio of nitrogen, phosphorus, and potassium applied to the grass over the course of one year is about 8:1:4, the same as is found in the leaves.

9.5 Insect, Disease, and Weed control

Insect, disease, and weed problems should be identified and then controlled, with different pests having different control options. This is a complex subject and will not be dealt with in detail in the first year of this programme. As a general rule, healthy turfgrass should be maintained, and a good growing environment for turfgrass should be maintained, and that will minimize problems from insects, diseases, and weeds, although it will not eliminate them.

9.6 Mowing

Mowing is the most important maintenance activity. Care must be taken to mow the grass with carefully-adjusted mowers, at the proper mowing height, and with the proper frequency. A standard guideline for mowing is to cut off no more than 33% of the leaf blade at each mowing. Cutting off more than 33% of the leaf will probably give some stress to the grass.

9.7 Miscellaneous surface and course preparation

In this category we do not modify the growing environment of the grass, but we do work such as rake and edge bunkers, set the tee markers, and other activities that prepare a golf course for play.

A technique such as rolling can be included in this category. Using lightweight rollers on golf course putting greens results in a smoother putting surface with faster ball roll across the green.

10 Greenkeeping activities

Mowing

Verticutting

Aeration

Topdressing

Fertilization

Divot repair

Irrigation

Weed control

Pest management

Disease control

Marking the course

Tee markers

Bunkers

Hole changing

Rolling

11 Additional turfgrass and golf course information resources

If you wish to study more about turfgrass, I can recommend a number of websites that contain information likely to be of interest to you.

www.in.asianturfgrass.com – information related to this programme including presentation slides, handouts, and photos

www.blog.asianturfgrass.com – information about turfgrass in Asia, including a long list of links to further information

www.randa.org/TheGolfCourse – The R&A's site about sustainable development and management of golf courses

http://tic.msu.edu/ – I quote from the home page of this site: *The Turfgrass Information Center (TIC), a specialized unit at the Michigan State University Libraries (MSU), contains the most comprehensive publicly available collection of turfgrass educational materials in the world.*

http://turf.lib.msu.edu/gsr/ – Every article published in the Green Section Record since 1921, in a database which one can search, browse, and download.