Cultural practices and their effects upon turf grass growth and stress tolerance

Nowadays, greenkeepers are under increasing pressure to provide near-perfect playing conditions right throughout the year. Today's golfers have come to expect playing conditions, that only a few years ago seemed impossible. The demands of the modern game of golf have resulted in stressed turfgrass plants - with reduced leaf area, limited photosynthetic capacity and increased susceptibility to disease infestation.

Continue to learn

Tim Butler outside Michigan State University

Greenkeepers are continually evolving to meet these demands and using every technique and practice at their disposal to meet the fast-changing needs of the modern golfer. However, have you as greenkeepers ever seriously thought about what is happening within the plant itself, or below your feet in the rootzone as you implement the many cultural practices that have become an integral part of every golf course's day-to-day schedule?

Mowing, fertilisation and irrigation, are probably the main turfgrass operations needed to sustain turfgrass quality. These practices are interdependent on each other, for instance, a change in mowing height or frequency will require changes in the irrigation and fertilisation programme used. It is easy to simply look at each cultural management technique separately and forget that how you manage any specific practice, will ultimately affect all other aspects of your specific cultural programme, whether obvious or not.

Of all cultural practices used in turfgrass management, I believe that mowing has the greatest effect on plant growth, development and stress tolerance.

Golf greens are an extreme example of a stressed setting. It is easy to forget the impact of low mowing heights on the turfgrass sward's ability to make carbohydrates, which provide energy and raw materials for metabolic processes within the plant. Grasses grow by cell division and thus the oldest part of a leaf is its tip and the youngest its base. The practice of mowing removes the mature part of leaves, which are active photosynthetic tissues and give the main contribution to the energy needs of the plant. The photosynthetic process comprises the use of energy, carbon dioxide and water by the plants -used to make carbohydrates, which the plant then uses for food. In combination with fertilisation, photosynthesis provides the plant with the raw materials for new growth.

At higher mowing heights, the plant is able to store the carbohydrates as reserves, to use if under stress. However, at low mowing heights the plant is unable to store these carbohydrates because of the continuous removal of the carbohydrates produced. Photosynthetic rate is also reduced under low mowing regimes, because plant cells that contain chlorophyll are removed and consequently stomata number which are used to allow CO2 to enter the plant are reduced. To try and compensate for the reduction in reduced leaf area experienced under low mowing heights, plant leaf chlorophyll content increases. Chlorophyll molecules secure the sun's energy, and thus the plant tries to save more energy, since its leaf area is reduced.

Another turfgrass response to low mowing heights is reduced rooting depth, because carbohydrates are used in root production. Shoot density increases, at the expense of root density as mowing height decreases, although tillering number is increased.

The turfgrass stand's ability to tolerate biotic and abiotic stresses will ultimately be affected by this limited root system, with a weaker grass plant as the final outcome. The problem is compounded by the use of inert sand-based mediums as on many golf greens, which have limited amounts of soil organic matter and poor water holding capacity. Coupled with this, there is potential for leaching of applied nutrients and pesticides as a consequence of the reduced root mass. Shoot water content (succulence) increases at lower mowing heights. Shoot succulence decreases cell wall thickness, which makes the turfgrass plant more susceptible to environmental stresses and diseases.

Fertilisation is the practice of supplying essential plant nutrients as part of the turfgrass management strategy. Correct nutrition is essential for the plant to maintain high quality and to carry out physiological processes. Fertiliser's represent an invaluable chemical tool, without which, turfgrass management would be very difficult. Nitrogen, phosphorus, and potassium are the main macronutrients that greenkeepers are confronted with on a frequent basis. These nutrients are required by the plant for growth and function.

The effects of a low height of cut

By Tim Butler

Nitrogen is the mineral required in greatest quantities by the turfgrass plant. Nitrogen is required for tissue growth, good turf colour and wear tolerance. However, the concept that it's better to apply more than less - as applies to N application - may not be beneficial. It is well known that excessive nitrogen concentrations can create succulent tissue, reduce carbohydrate reserves, resulting form increased shoot growth, reduce rooting and reduce wear tolerance of the turfgrass sward. Thus excessive N applications weaken the turfgrass sward, making it more susceptible to disease and reducing stress tolerance.

Phosphorus is important to turfgrass because it enables energy transfer within the plant, which is required for growth. Phosphorus is of particular importance at the turfgrass establishment stage, since it promotes root development.

Potassium is vitally important for photosynthesis, and also regulates water uptake in the plant system. It is also of great consequence in increasing wear tolerance and plant resistance to environmental stresses.

Water is a major growth-limiting factor of all turfgrasses. Grass plants require adequate water to maintain quality. The question of frequent, light irrigation versus infrequent, deep irrigation is still unanswered, with theories suggesting that infrequent, heavy irrigation, helps to increase root mass and plant stress resistance.

The ability of a turfgrass plant to uptake applied water, is ultimately affected by the length and density of its root system, with extensively rooted grass plants having greater access to a larger rootzone volume. Field capacity type irrigation management, where irrigation is applied before any signs of wilt are visible, is a highly effective method of irrigation. This system reduces problems such as localized dry spot, and salt build-up in the rootzone.

However, there is a fine line between applying enough water to satisfy the plant's needs and over-watering the rootzone. Over-watering leads to a reduction in root growth because the roots are basically sitting in a highly saturated soil on a regular basis. Over watering can also cause leaching of applied fertilisers and pesticides, a reduction in air-filled porosity, an increase in soil organic matter and thatch and a weaker grass sward.

The hardest part of irrigation is balancing the needs of the plant with the amount of water that is lost through drainage and transpiration. Transpiration is the process where water is lost from the grass leaf into the atmosphere as water vapour, through small openings on the leaf surface called stomata. The combination of transpiration with evaporation - which is the loss of water from the soil surface - is known as evapotranspiration.

Soil cultivation has become an integral component of management programmes on almost every type of turfgrass system. Cultivation practices are principally designed to reduce soil compaction and thatch build-up.

The main types of cultivation used include: coring; solid tining; water injection and vertical mowing. Coring, solid tining and water injection, are principally used to improve soil physical properties, such as air filled porosity, bulk density and drainage rate. These practices are often followed by top dressing. By improving the physical properties of the rootzone, turfgrass growth should also be increased. This type of cultivation basically breaks up the rootzone, which makes it easier for the turfgrass root system to penetrate into the underlying soil, helping to create a more expansive root mass, hence increasing the plant's stress tolerance levels.

Vertical mowing can be used to prevent grainy grass swards, to reduce thatch and organic matter accumulation and to reduce compaction. Grainy refers to horizontal growth of grass leaves and stems, which will negatively impact ball roll. Organic matter increases water-holding capacity of the rootzone, and reduces water infiltration rates, which can lead to a moist playing surface and shallow rooting. This increased shallow rooting may reduce turfgrass wear tolerance, playability and stress tolerance.

Plant growth regulators are used as often as weekly, by many turfgrass managers, and are very important in turfgrass management, particularly under shaded conditions. Shade effects are a problem for nearly every turfgrass manager, be it shade due to buildings or trees. Shade alters the microclimate, including increasing the relative humidity, decreasing air movement and reducing temperature. Shade affects light quality, quantity and duration. Morphological and physiological changes that occur to plants grown under shade include:

- Shoot elongation
- Thinner leaves
- Reduced tiller numbers
- Reduced shoot density
- Reduced respiration and transpiration
- Reduced photosynthetic rate
- Increased chlorophyll content
- More upright growth habit

Plant growth regulators such as paclobutrazol and trinexapac-ethyl reduce cell elongation. Cell elongation is one of the main problems caused by shade. Under shaded conditions, the shorter light wavelengths are blocked and the longer light wavelengths reach the plant. The longer wavelengths cause the long spindly growth, which you as greenkeepers have seen far too often. Thus the plant growth regulators are a means of reducing this long weak grass growth. Plant growth regulators have also been found to increase plant tillering, density and rooting.

Many challenges face the greenkeeper of today. The science of turfgrass is continuously evolving and bringing with it new concepts and technologies that are aimed towards providing the perfect putting green. As a greenkeeper, every single management strategy employed will eventually impact on the turfgrass performance. Understanding the implications of each practice is a step further to achieving that prefect-playing surface.

Tim Butler is carrying out research in the area of turfgrass nutrition for a doctorate degree at both University College Dublin, Ireland, and Michigan State University, USA.

An aerator carrying out hollow tining