There are those who think that the management of golf turf requires no scientific understanding or input at all. Conversely, do not get hung up with science, apply it, use it, question it and you will quickly realise that the wonderful world of golf course management encompasses the best of both worlds - science and practice. David Rhodes, Senior Lecturer in Sportsturf Agronomy, at Merrist Wood College beams us up into the 21st Century...

The appliance of Science

The dictionaries tell us that science means fact or knowledge, understanding. I think this places the importance of science within golf course management today. I will define my philosophies on the application of science and try to show how it can be directly applied to modern turf culture. How it can be used as another tool to assist in creating a good golfing experience through good golf course turf.

The Endaphic Environment

As our limited understanding of endaphology expands, we are becoming more and more responsive to turf grass rootzone needs. I believe that good soil can help in producing good turf and the study of this important area can really assist in your work.

Examples of this type of work currently being undertaken include research looking at the effects of Vessicular Arbuscular Mycorhizal fungi in turf grass roots and the symbiotic links with turf grasses. Endaphology is defined as the science that deals with the influence of soil and other media on the growth of plants.

The practical application of findings and fact is equally a challenge that we must embrace. We will move towards proving things and justifying to ourselves and others that operations and tasks undertaken actually work. Those managing golf facilities in the public sector will feel the implications of the search for quality under the umbrella of best value.

Of course there are benefits in adopting this approach. Who wants to undertake tasks that are achieving nothing or even worse are detrimental to our golf turf? A good example of this is so called aeration.

Science has taught us that amongst other things plants and microbes in our soils require oxygen for aerobic respiration. In order to achieve optimum gas exchange (the exchange of 02 and CO2 between the atmosphere and soil) we must produce a soil that has a distribution of varying pore spaces. The difficulties in achieving this in the field are wide ranging, therefore we tend to employ methods of cultivating our rooting mediums to encourage this. I believe that one should ask several questions in relation to what we are trying to achieve.

Do we fully understand our objectives, and the factors that may influence our achievement of these?

Can we discount the rules of science applicable in this case because it doesn t suit us?

How do we know we are employing the best methods to aerate our site?

How can we measure this both scientifically and practically?

Let me offer further explanation. Unless we define what we are trying to achieve, we make the assumption that we are achieving something positive (oxygen content of the atmosphere is 21% so one might argue that soil oxygen levels should be comparable). Realistically between 10–20% is achieveable.

Of course other factors can affect actual achievements in relation to rootzone oxygen concentrations for example:

- Soil texture
- Structure
- Type of ground cover including species
- Rainfall / precipitation
- Topography
- Contouring
- Moisture content of soil

The appliance of Science

Above: Applying science to the management of golf turf

Top right: Merrist Wood, an ideal seat of learning

Increases in plant and microbe respiration require additional inputs of oxygen (an example being seedling respiration). This can vary depending on the time of year.

Unfortunately the calender of science was not designed around the Golf Club competition calender so lateral thinking is called for. Alternatives are both available and feasible.

Should we assume that machinery available to us actually aerates the soil? No, it depends - what options does one have?

Where, when, how? Ask questions.

Germination and PLS

The fairly diverse number of grass species found on today's golf courses perhaps indicates that species selection for use can offer more options than is traditional.

The sentence above does not detract from fine fescues and bents but I believe that plant breeders have now made available alternatives to cope with the demands of the modern game - after all it is fair to assume that the so called traditional species may not be suitable in all instances , equally so new species may not be either.

One thing we do know however is that a seed requires water to germinate. Simply put, a seed imbibes water through the testa or coat due to internal salt concentrates, Gibberellin is produced which stimulates the alurone layer to produce an enzyme called analyse which in turn breaks down the reserves of starch to sugars and fuels initial germination until the plant can look after itself.

If you understand the full spectrum of a plant's requirements then it can throw into question seed mixes, seed rates, seeding techniques etc, (hence the reason drill seeding has become popular). Species to watch include:

Definite
- Perennial rye grass Lolium perenne
- A and G series bents

Possible
- Poa annua reptans
- Poa supina

Pure live seed calculations are simple to undertake and can assist with cost effective selection of seed species and cultivars. Any reputable seed supplier will supply data sheets for a given cultivar which amongst other things gives valuable information on purity and germination (viability). Before use by any purchaser the seed is produced to meet % purity and % germination figures as laid down by law. The percentages are usually higher than required by law because of a voluntary standard that seed companies work to. The laboratory tests show actual seed species (including weeds) and debris , for example 1% Poa annua seed by weight equals 250g x 3000 seeds per gramme which equals three quarters of a million potential plants in a 25kg bag. The viability of the seed, (number germinating in a petra dish) can be related to the condition, age and care of the seed.

All in all it gives the user valuable information when selecting and costing seed. The calculation is simple:

Purity x viability	=	99% x 99%
÷ 100	=	98.01%
90.25% of 25kg	=	24.502 g

This means that nearly 0.5 kg of the bag is weed or waste and if we divide by the cost of a bag it gives us a cost per kg for comparison between suppliers.

When the seed has been purchased, post seeding mortality and factors in the field will also contribute to overall loss and species success.

Quality measurement can and should take place in golf course management. When benchmarks have been established, operations should show a continuation or improvement in standard, workable routine tests that are easily carried out or requested include:

Species Quality and Composition
- Turf speed
- Grass frequency and density

Soil Quality
- OM Content
- Nutrient content & availability
- pH
- Porosity

Overall one can build a picture of where the course and particularly the turf lies in relation to perceived quality and current thinking on golf course agronomy. This provides additional support and justification to your decisions. Remember assume nothing.

I hope you have enjoyed reading the article and it stimulates you into finding more out about science.

Here's to good turf!

Water - Water
Why can you skim stones on a pond? Why can you fill a glass with water just above the rim? The answer lies in the chemistry of water. H2O is a wonderful molecule that reacts and changes all the time. The forces of adhesion and cohesion should be studied in detail to understand a lot more about water management and its use on golf course turf. It will help you understand the perched water table or suspended water table construction more as well.

Dormancy
True dormancy is defined as the suspension of physical and physiological processes that occur within the plant and this rarely occurs on cool season turfgrass. I believe it is more appropriate to use the term resting when we would normally use the word dormant as this explains what cool season plant actually do. True dormancy turns turf brown in colour and affords maintenance opportunities in its own right. There is a greater likelihood of true dormancy occurring in this country in summer not winter. Remember the right word choice implies greater understanding and more knowledge of the subject.

Etiolation
Solve this one if you can! This has been noted widely in golf turf management with several explanations offered for this unusual symptom. At particular times of the year, autumn being a common season, a chlorotic (lacking chlorophyll) singular leaf emerges rapidly from fine bents and poa annua. This disfigures the turf and is difficult to remedy.

Reasons suggested include:
- Of fungal origin - mildews
- Nematodes
- Stress
- Shade

We know that the production of this mutant singular leaf is caused by a release of ethylene (a growth hormone) and its extended functioning is reliant on other parts of the plant for water and nutrients etc. Frictional contact between the new shoot and rootzones seems to stimulate this ethylene production and this may be one reason why verticutting or grooming the turf may actually stimulate adverse reactions and short term results are not achieved. Any advance on this?

Allelopathy
Why does Yorkshire fog tend to form patches in established turf? There have been many explanations offered over the years to answer this question. We all know that the plant can stand close mowing regimes and grooming / slashing operations as well. I offer this most interesting answer - its allelopathic.
The production of toxins by plants is not a new phenomenon, but little is understood about it in grasses particularly amenity grasses. Recent research has shown that Yorkshire fog along with fescue and perennial ryegrass produces toxins typically phenols, cumarins, tannins etc to control the dominance of other species (interspecific competition). The result of this is more apparent in Yorkshire fog than the other species but nevertheless offers a scientific reason why the species seems to patch itself on fine turf. It is also one of the few grasses that flowers twice a day.