An Outdoor Game

STRI

Tim Lodge, of the STRI, looks at the science and variables involved in playing the game of golf.

The more I learn about golf the more amazed I am at the enormous number of variables that golfers appear to consider when making even the most straightforward of shots. I think they must assess some of these variables in their subconscious and use an intuitive approach to their game. But there are measurable scientific principles behind almost every link in the chain of events that leads from the 1st tee to the pin at the 18th.

The science of golf is a massive subject area. Research workers in the field include physicists, material scientists, biomechanics specialists, physiologists, psychologists and more, not to mention turf scientists. Volumes have been written, particularly on the more lucrative aspects such as equipment design. Rather less work has been published on the ways in which the turf interacts with play. This is surprising given the controversy that circumstances can often create. In this article, from tee to green, I consider how some turf-related factors can affect the game.

TEE SHOTS

Though not usually a problem at major tournaments, replaced divots can create an unstable and unpredictable surface on which a following golfer's footing could be loosened at a critical point in the swing. It is now accepted that the replacement of divots should not be carried out on tees but that the scars should be immediately filled with a blend of fertile but free-draining soil and seed.

LIE OF THE BALL

When the ball lands short of the green its immediate surroundings determine what shot the golfer will then play. In order to understand the mechanisms involved we need to look closely at what happens at the moment of impact between the club face and the ball.

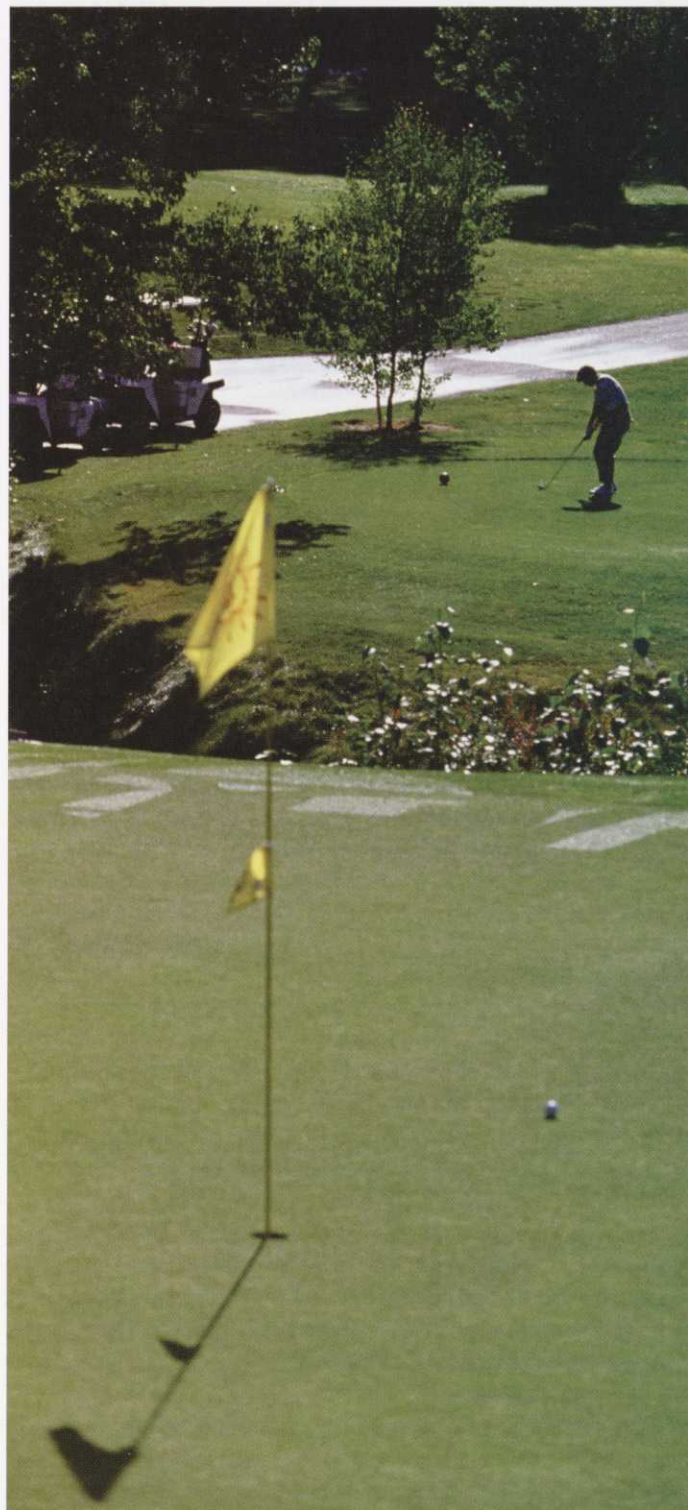
The club passes energy to the ball in two forms: linear (for distance) and rotational (for spin). There is only so much energy available, so the more that goes into rotation, the less there is for distance, and vice-versa.

The angled face of the club can generate spin of up to 8000 rpm. It does this by pressing against the ball slightly below its central point making it rotate backwards towards the club. For a tiny fraction of a second the ball actually climbs up the clubface. The extent to which it does this affects what proportion of the total energy is transferred as spin and what goes into distance. The process is governed by the amount of friction occurring between the two surfaces.

In wet conditions, friction is reduced so balls leave the clubface faster, but with less spin. Especially in the rough, grass leaves may come between the ball and the clubface. This also reduces spin, making such shots especially difficult and less predictable.

The grooves on the clubface help generate spin by increasing friction. Some players maintain that the more modern U-shaped grooves lessen the effects of wet grass on spin, but there has been some controversy over the move away from the more traditional V-shaped grooves. The R & A stipulates the permissible forms of grooves in the 'Rules of Golf' (Appendix II, 5, c (i)– 'Grooves').

The factors described also affect the amount of spin, if any, that is imparted as 'side'. This causes the ball to 'hook' or 'slice' if in error, or to 'fade' or 'draw' if the golfer has deliberately set out to curve the ball towards its destination. The mind that is able to compute these variables and fade an accurate shot out of a wet grassy rough is remarkable indeed.



THE GOLF BALL IN FLIGHT

After leaving the clubface, the spin, velocity and angle of the golf ball trajectory are the main controllable factors that affect the outcome of the shot. Other factors, such as the construction of the ball, the number of its dimples and the materials and design of the clubs, also affect the outcome but these will have been decided upon before the golfer sets out onto the course.

The table below shows the range of most typical angles (to the horizontal) at which the golf ball will leave the face of each club and also indicates the average distance subsequently travelled by the ball (on a still day). Clearly, distance is significantly compromised when golfers have to play out of a tall dense rough, or over obstacles in front of landing areas.

Typical angle of lift (degrees)		Average distance travelled (yards)	
		Men	Women
WOODS			
No 1	11	220-300	160-180
No 2	13	210-250	155-170
No 3	16	200-230	150-170
No 4	19	190-220	145-165
IRONS			
1	17	190-220	145-165
2	20	180-210	140-155
3	23	170-190	135-150
4	27	155-175	125-140
5	31	140-155	115-130
6	35	125-145	110-120
7	39	120-140	100-110
8	43	110-125	90-100
9	47	90-120	70-80
WEDGES			
Pitching	51-54	70-100	50-85
Sand	58	-	-
Putter	0-4	-	-

LIFT ANGLE AND RANGE PER CLUB
(Reproduced by kind permission of John J. Monteleone)

Wind speed and direction cannot be controlled but they need to be taken into account when playing the shot. The same would apply to the intensity of any rain that might be falling.

Since the turf itself is not directly involved in the flight of the ball, we will not go into any of these aspects here. This is, however, a fascinating subject about which a great deal has been written.

SHOTS FROM THE ROUGH

For a golfer unfortunate enough to find him or herself there, the nature of the rough may affect club selection. A dense rough, perhaps containing a large proportion of coarser grass species, such as perennial ryegrass or Yorkshire fog, will be more likely to affect a ball passing through it than a rough containing more wispy species such as fescues. The height of the rough will affect the ball in a similar way and by emerging at a steeper angle the influence of the rough on the flight of the ball may be reduced.

IMPACTS ON THE GREEN

Spin, velocity and angle are also the main factors that govern the behaviour of the ball when it hits the green. Two phases can be identified. Typically, the ball bounces (usually twice or more) before entering a 'roll' phase. Different qualities of the green affect both these processes.

BOUNCE

Well-struck shots by the top professionals usually result in short bounces. This is because the ball tends to come down relatively steeply. Balls do not therefore bounce far even on very hard greens.

Short bounces also follow when a golf ball 'plugs' into a soft green. This can occur even with shots coming in at shallower angles. Such shots are usually struck by less able golfers and this is unfortunate because they then acquire the impression that they are better at 'holding' the ball on the green than they actually are. Subsequently they demand soft greens all the time, which brings a range of problems for the greenkeeper and does nothing to improve the standard of golf of both low and high handicappers playing the course.

Attempts have been made to model the behaviour of greens during golf ball impacts. Models have employed the physics of springs and dampers (shock absorbers) to do this. At the highest levels of the game, however, these processes may be of less significance than the manner of golf ball flight mentioned above, and how the ball behaves on the surface of the green.

ROLL

After bouncing, the backspin retained at the roll phase reduces the forward motion of the ball. Friction between the ball and the green can slow a forward roll, check the roll entirely or cause the ball to 'screw back' from its position at the end of the bounce phase. Sometimes the ball will screw back beyond the point of initial impact. Watch out for this when the top golfers are playing with lofted irons or wedges from very close to the green.

The surface of the green affects the consequences of this spin retention. It does this by the nature of the 'grip' or friction that develops between the ball and the turf. In my own research, back in 1994, I found that a full and dense grass cover was able to grip the ball more effectively and allow the spin to pull the ball back on itself to a greater extent than a thinner, more open sward.

PUTTING

About 43 % of the shots played in The Open will be made with putters on the greens. It is in putting that the greatest interaction between the ball and the turf takes place.

On impact with the putter the ball first slides over the surface and then, as friction between the ball and the grass takes effect, the ball rolls towards the hole. Various turf-related factors affect the distance the ball travels over the surface, usually referred to as the green speed. Features of the green that affect speed include:

HEIGHT OF THE SWARD

A lower sward height will give a faster green speed. This can be achieved by cutting more closely but this puts the turf under a great deal of stress. An alternative approach would be to build up the ground level at the base of the grass, effectively reducing the sward height from the bottom up. This can be achieved by top dressing.

LEAF WIDTH AND GRASS TURGIDITY

The more contact that takes place between the ball and the turf the greater will be the resistance to the forward roll. Wide, stiff, upright leaves will touch more of the golf ball than narrow and flaccid leaves and a green made up of such coarser plants will therefore be slower.

Excessive use of fertiliser and water has long been known to reduce green speed. The resulting rapid growth will place more leaf in the path of the ball and slow down its forward motion. Where the grass is growing vigorously, as a result of excessively moist and fertile conditions, green speed tends to fall during the course of the day as the leaves extend.

Factors related to leaf width may also explain why greens get faster on hot, dry days. As dry conditions develop, the leaves of grasses, bents in particular, curl up to conserve moisture and effectively become narrower, presenting less resistance to the ball's roll.

DENSITY OF THE SWARD

Short turf with a very high shoot density can give a faster surface. This is because the size of the individual grass plants is necessarily smaller (so they all fit into the space available), resulting in less contact with the front face of the ball. Also, the ball will sink less into a dense sward which will therefore present less resistance to its forward roll.

A high shoot density can develop, in certain circumstances, if the grass is persistently mown very close. This occurs for example on some links greens. However, this carries a plethora of risks and implications for the welfare of the green.

Conversely, where shoot density is very low, faster surfaces can also result. This is because the ball is then rolling over a surface provided chiefly by bare ground (sand or top dressing) rather than grass.

It is probably by reducing the size of individual plants that procedures such as verti-cutting and grooming are able to increase green speed. The reduction in shoot density and/or plant size will lessen the general resistance to the roll of the ball. Vert-cutting also allows the integration of top dressing into the sward which can improve pace through its effect on the height of the sward as mentioned above.

SPECIES

It is widely acknowledged that different grass species produce different green speeds. Thus, for species normally found in the UK, fescues give faster surfaces than bents, which in turn give faster surfaces than annual meadow-grass (assuming all are at the same height). This corresponds, in most circumstances, with the leaf width and general size of the plants. For example, the needle-like leaves of fescue will support a golf ball but will not touch so much of its surface as will a lush, annual meadow-grass leaf.

GRAIN

This only tends to be an issue on creeping bent greens, most common in the northern United States and southern Europe. Speed is lower against the grain, into the tips of the leaves, than with it, along the lie of the leaves. Intensive verti-cutting is usually required to reduce the nap and create a more uniform, upright sward.

SURFACE MOISTURE

The presence of surface moisture usually increases the drag at the contact points between the ball and the turf. It is likely that these effects will be greater on lush greens where such contact points are already more abundant.

There are also those factors that affect the course taken by the ball on its journey. These include:

UNIFORMITY OF SURFACE

Bumpiness can result from the varying growth rates of different grass species. This often occurs where a mosaic of grasses in a green are all growing at different rates. The phenomenon is most common in early spring as the grasses respond differently to rising temperatures.

Another source of unevenness may occur where aeration procedures have been carried out resulting in the stimulation of growth in one place, for example over a hollow core hole, but not to the same extent in the area immediately around this. The use of a top dressing with a grit content can also create a bumpy surface. The results are that putts follow an unpredictable, and hence unfair, path.

SLOPE AND BORROW

These are the elements of the green's topography that are fair and must be read by the golfer when visualising the course of his putt. Some work has been done on how a ball behaves going straight up and straight down a uniform slope, but I have been unable to find any research work on the rationale behind putting across varying slopes and the prediction of the route taken by a ball over an undulating surface. This is clearly an area where the intuition of the golfer takes over, but the subject seems to me to be ripe for a more objective study.

IN THE HOLE

Some good science has been done on the process of 'holing'. Though not really related to the qualities of the turf, this is interesting nonetheless. Some facts (from 'The Science of Sports' by Sharon L Blanding and John J Monteleone):

- If a ball is rolling without sliding it must be moving at 1.63 metres per second or less to be holed. Otherwise it has enough velocity to sustain the straight-line path across the top of the hole. A ball leaves the end of a Stimpmeter at 1.9 metres per second.
- Between 1.31 and 1.63 metres per second the ball will hit the opposite rim. What happens then is determined by how much the ball bounces against the walls of the cup and on how much friction is generated from the ball's rotation against the rim.
- If the ball is bouncing or skidding it can be holed at greater speeds. This is because such a ball has less angular momentum that can provide 'kick' to bounce the ball out of the hole.
- It has been found that it is easier to sink a wound ball than a two-piece ball.

CHAMPION!

I don't think that Ernie Els and Tiger Woods concern themselves too much with the biophysics of golf ball impacts on greens or the leaf extension rates of bents and annual meadow-grass. But it is surely the case that, by breaking down and focussing on these issues, the greenkeeper can empathise with the processes I have described and deliver even better playing surfaces.

Healthy Soil is the Future

Two months ago Bob Taylor of the STRI wrote an article based on limited trials data. This suggested that using bacterial and fungal additives as part of a maintenance programme, to re-establish natural growth processes on substantially sterile greens, would not work.

The trials and article were based upon a common misconception that a single microbial product can be a magic cure-all that will produce fantastic results, like a new improved fertiliser. This is wrong.

Given the different physical and chemical make up of greens and tees from club to club single site trials for a single product are very unreliable guides.

Adopting a biological approach means reintroducing, as far as possible, normal plant growth processes that have evolved over millions of years.

In this quick look at what goes on underground I will try and set out what happens in the soil and how natural processes can be used to produce better playing surfaces. My comments are based upon a large number of academic studies and our own research and observations at Symbio, gathered through collaborative research with local universities and practical experience of applying these techniques to hundreds of golf courses over the last eleven years.

Apart from commercially sensitive information concerning specific microbes nearly all the data is published on the internet.

Grasslands are part of a major food web, which stretches from man above ground to the smallest microbe in the soil below ground. There are probably thousands of mechanisms to ensure growth continues in times of stress to stop these chains breaking down to prevent mass starvation through the entire food web.

Since the 1920's when inorganic fertilisers were introduced which override natural nutrient uptake sports turf soil has been prone to excessive fungal disease, dry patch, thatch build up and black layer.

Excessive fertilisers, fungicides, water and iron damage the soil food chains, blocking recycling, natural growth and disease suppression. More chemicals are introduced to treat more symptoms and the soil can become less and less fertile until it becomes too toxic to support healthy grass growth.

LET'S LOOK AT HOW TO SOLVE THE UNDERLYING PROBLEMS.

Plants photosynthesise taking energy from the sun, carbon from the air, and nutrients from the soil producing carbohydrates, proteins and fats. In grasses, about 50% of this energy goes into top growth, to feed the above ground food chain and 50% goes back into the soil via the roots and exudates to feed the underground, mostly invisible, food chain (Figure 2).

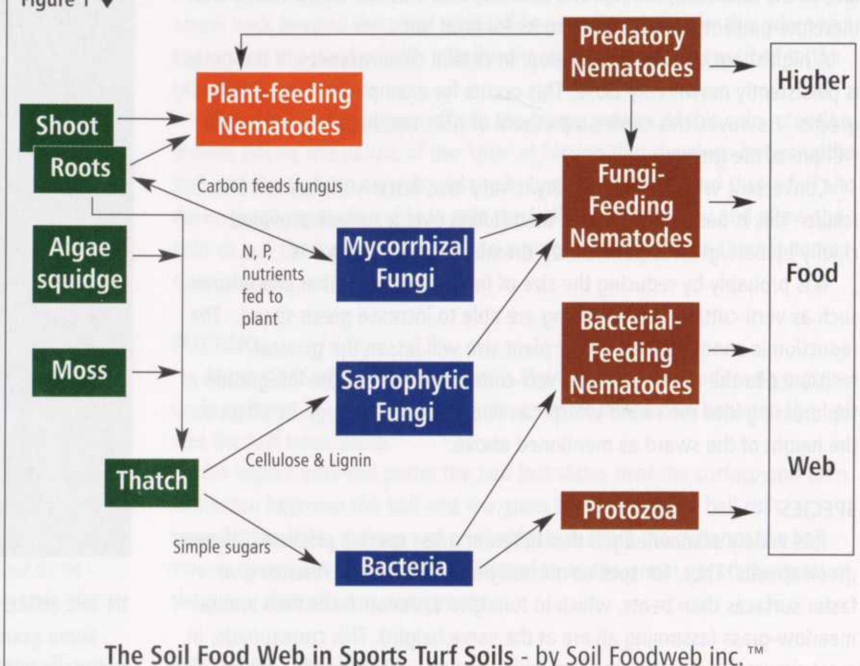
OUT OF SIGHT

Out of sight used to be out of mind, but by using molecular analysis and scanning electron microscopes that allow identification of individual bacteria, fungi and other organisms, we can now start to understand how natural processes work on a golf green and how to use them to our advantage.

THE SOIL FOOD WEB (Figure 1)

Food underground comes from exudates from plant roots, in the form of proteins and carbohydrates, which includes sugars and starches. Sugars are the main food for bacteria. (Figure 2).

Figure 1 ▼



The Soil Food Web in Sports Turf Soils - by Soil Foodweb inc.™

When grass dies (i.e becomes thatch) it is full of cellulose and lignin. These are the tough structural materials that give grass the strength to resist bending and trampling. You only have to look at a dead tree to know this is the favourite food of fungi which convert dead grass, leaves and twigs to humus - the nutrient store and foundation for future plant growth.

Bacteria and fungi form the foundation of the whole food chain. The good (saprophytic) microbes only live on dead matter. There are about 20,000 enumerated soil bacteria and 15,000 fungi, of these, most greenkeepers know only the few disease - causing (pathogenic) fungi which live on live plants, by name.

Certain fungi known as Mycorrhizae form extremely close associations with the roots, actually growing inside them. The plant provides these fungi with carbohydrates (sugars) and in return the mycorrhizae use their hyphae to suck up phosphate, nitrate, trace elements and water and feed them to the plant, effectively giving the plant a vastly extended root system. This is a two way dependant partnership and both partners rely extensively on the other for survival.

It must be said that very little is known about how all these bacteria and fungi interact but we do know how they fit into the food chain.

In a gram of healthy soil you may find about a billion bacteria weighing about 100 μg and a similar weight of fungal biomass, only half of each may be active but for fescue and bent grass growth it is important to have

Martin Ward, of Symbio, looks at some of the progress which has been made by the bio-tech industry in recent years.

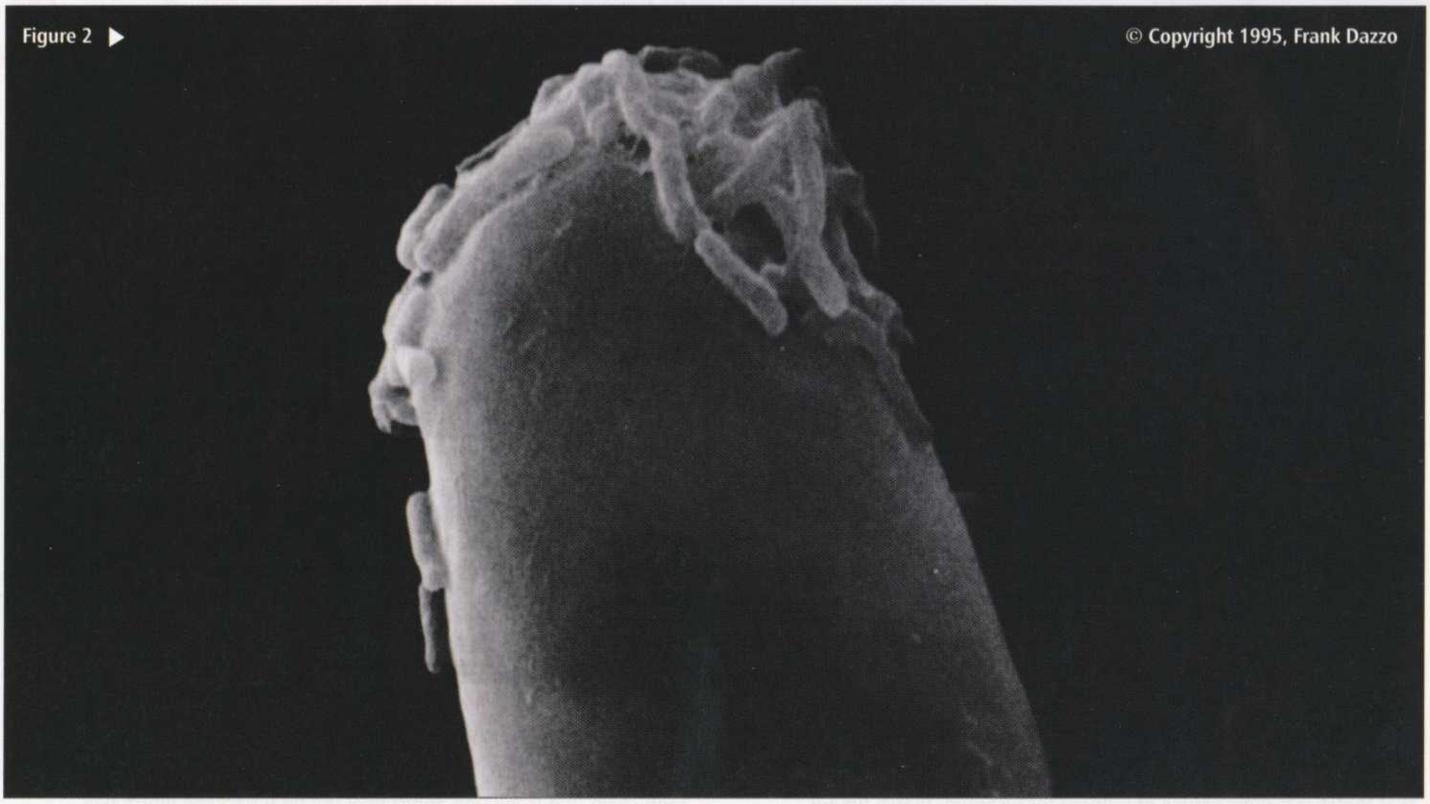


Figure 2 ▶

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approximately equal bacterial and fungal biomass.

A few bacteria fix nitrogen from the atmosphere; others take it from recycled nutrient in the soil. Locked up in a bacterial cell or fungal hyphae nitrogen is not available to the plant. To release nutrient the microbes have to die or be eaten by the next stage of the food chain comprising protozoa and nematodes. There may be 10,000 protozoa in a gram of soil but only a few hundred nematodes. Some nematodes can be seen with a magnifying glass.

Protozoa and nematodes eat the bacteria and fungi, they use the carbon to grow and excrete excess nitrogen as ammonium, which feeds the grass when converted to nitrate by nitrifying bacteria in the presence of oxygen

There are two other types of nematode, root - eating and predatory. Root - eating you know about but they are kept in check by the predatory nematodes which eat all nematodes, These in turn are eaten by small worms which create small spaces in the soil leaving little tunnels full of excrement (ammonium) for roots to grow into and feed on and so the chain expands up to moles and other burrowing animals. For golf course purposes we try to stop the food chain at non-casting worms but up to that point all aspects of the chain are necessary for natural healthy grass growth.

Working together all these microbes and organisms ensure a constant supply of nutrient for the plant, avoiding the boom and bust of the fertiliser cycle, they protect the grass from disease, because if the grass dies the whole food chain is compromised and they recycle dead grass back into usable nutrient.

WHY ARE GOLF GREENS STERILE?

Dumping a tonne or more of inorganic fertiliser (salts) per hectare per year means that the plant is swimming in a sea of food. The plant does not need its associations with microbes to live, which coupled with the fact that bacteria like sugars, not salts, the use of fungicides, excess water and compaction which deprives the microbes of oxygen, the removal of animals which replenish the microbes via excrement and near daily cutting mean that large parts of the food chain cannot survive.

We often find that golf greens have less than 1% of the microbial biomass of healthy soil and that the total fungal biomass is much less than that of the bacteria, though as we shall see fungi are extremely important to your greens management programme.

You can now see the reason for adding bacteria, fungi and selected food sources is to re-establish the primary links in the soil food chains.

HOW DOES THIS HELP THE GREENKEEPER?

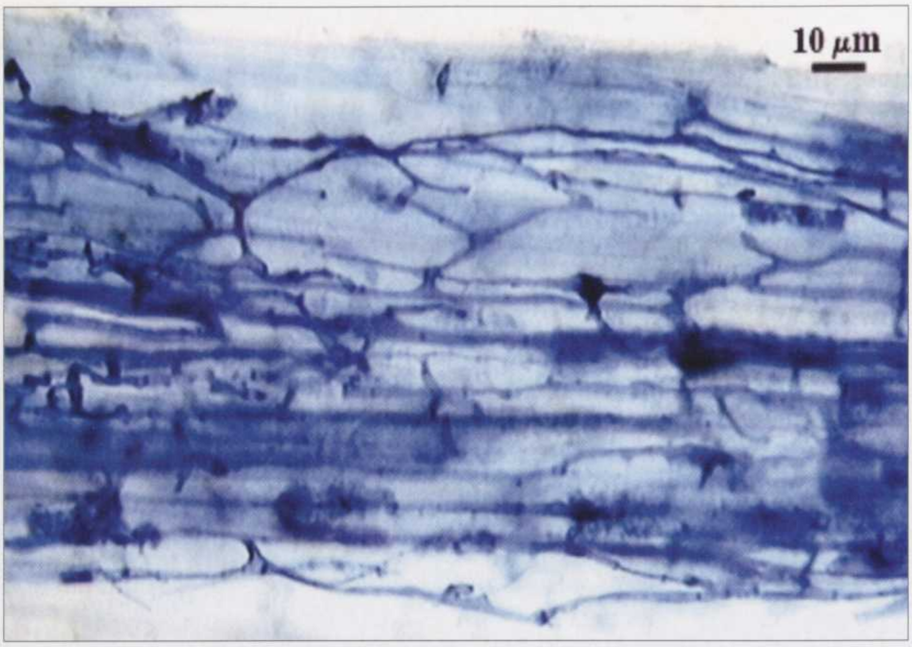
DISEASE MANAGEMENT

There are of course specific remedies for each disease as they metabolise in different ways but in general, diseases occur on sports turf because fungal pathogens, which cull weak plants as part of natural selection, have a lot of weak grass to attack and very few of the natural defence mechanisms to stop them.

If all the grass dies we all starve, so nature has worked out some clever tricks to keep the plant and food chain alive. Figure 3 is a root covered in mycorrhizal and other fungi which shows blue in the picture, you can hardly see the root for fungi. It effectively forms a barrier against any disease-causing organism that wants to penetrate the root.

The good fungi and bacteria also get to any freely available nutrient first and out-compete the pathogens, this is called competitive exclusion. A third way that some soil microbes keep their host plant alive is to produce toxins active against disease causing organisms.- Finally in times of stress and food shortage some microbes will eat other microbes,

Strengthening the sward and replacing the defence mechanisms has to be an essential part of any IPM programme.



◀ Figure 3

THATCH AND DRY PATCH MANAGEMENT

A hectare of greens with 4cm of thatch has about 400 m3 of dead organic matter that is full of excellent nutrients diluted with top dressing. Current wisdom is to hollow core or rip it out and replace it with – top dressing plus dead organic matter full of excellent nutrients. Weird or what?

The simple solution is to convert thatch into humus as it is formed, releasing the locked-up nutrient thus providing a building block for future plant growth that holds moisture and increases cation exchange capacity. To do this you need fungi that eat cellulose and lignin.

Other advantages of microbially activating and degrading thatch are that thatch is a great source of nutrient for fusarium, thatch fungus, basidiomycetes (The fungi that causes dry patch) and other nutrient loving fungal diseases. If the thatch is already full of beneficial fungi the pathogens cannot get a seat at the table so they cannot grow.

Percolation rates increase giving faster play after rain and as we shall see, thatch degradation helps reduce pH and promote the growth of bent and fescues.

Aeration is needed of course, as it would be for a 400 m3 compost heap, but generally once the process has started, weekly or fortnightly aeration with needle tines or a sarrel roller that does not upset the playing surface are all that is needed for thatch reduction. This is in addition to the aeration needed to address deeper compaction and drainage problems.

FINE GRASS PROMOTION

We do not exactly understand the mechanisms involved, and there is very little published research but we have seen the following reactions so often that it is worth mentioning here.

If you analyse soil supporting poa annua greens you find a bacterial biomass about 10 x greater that fungal biomass but soil that supports old established fescue and bent grasses has a nearly equal amount of fungal and bacterial biomass. Most greenkeepers report a sudden sustained increase in Agrostis tennuis grasses when they start to degrade thatch in situ, i.e. when the fungal population increases. Research has shown that Poa annua does not associate as well with mycorrhizae as perennial grasses which gives all fine grasses an advantage on mycorrhizal greens but additionally, the combination of increased thatch reduction and reduced fungicide application during the growing season combine to substantially increase the colonisation of bent and even fescues. The common theme is that fungal biomass has to increase and pH in the thatch layer reduce as humus and humic acids are formed by biological thatch degradation.

HOW DO I GET MY SOIL TO WORK?

Key parameters that will stop a healthy soil food chain forming are excessive chemical residues in the soil, and a greens committee that won't let you aerate.

If you do not suffer either of these impediments you should work with a company or agronomist that can advise how to build up each part of the food chain that is missing and supply the total package which will probably vary year to year as the soil quality improves.

You will join the fortunate band that already benefit from having their soil working 24 hours a day to produce an excellent playing surface and contribute to maintaining the natural features of our fantastic heathland, links and downland courses.

My thanks go to the professors and researchers at the universities of Oregon, Surrey and London for information contained and to Soilfoodweb Inc for the electron micrograph pictures, the technical team at Symbio and especially to the greenkeepers who have helped us with their time, feedback and advice in developing this technology.

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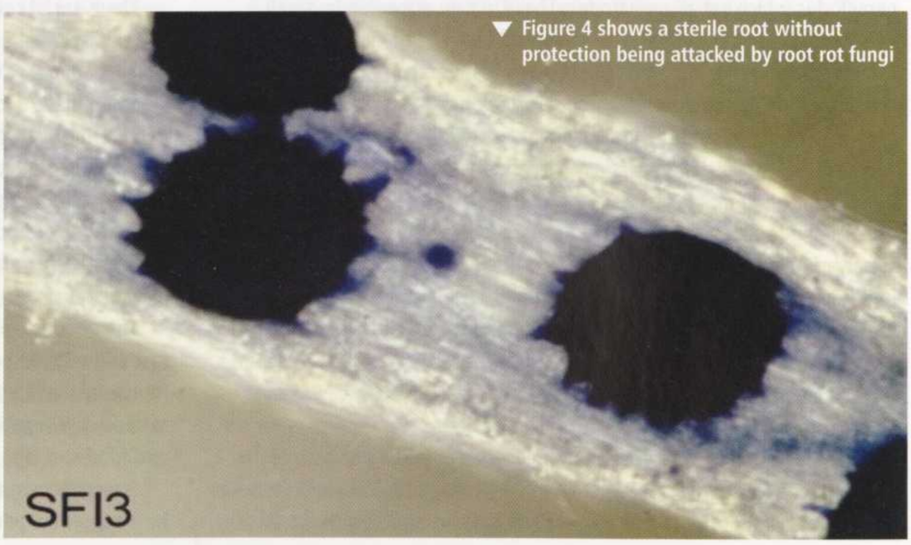

▼ Figure 4 shows a sterile root without protection being attacked by root rot fungi

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Ransomes Jacobsen Scholar Judith Colley outlines the work she has been able to carry out on the strength of receiving her scholarship.

Change of Career

In September 2002, I took the decision to change my career and embark on a three year Foundation Degree course in Turfgrass Science and Golf Course Management at Myerscough College. I had been employed within the pensions industry for over 14 years and was ready for a fresh challenge. Due to financial constraints, I opted for part-time study, while continuing to be employed in pensions, albeit on reduced working hours which I negotiated with my employer.

Although I have studied to degree level in the past, balancing the work-study commitments has not been easy. In addition, I had no previous turf or golf knowledge but now appreciate to some extent the complexities faced by those involved in the maintenance and development of a golf course. With the support of other students on the course and the enthusiasm of the teaching staff at Myerscough, I have successfully completed the first year of my studies and subsequently obtained casual, full-time employment on a golf course to obtain greenkeeping experience and expand my knowledge in this area. I finally exchanging my stilettos for a pair of steel toecaps!

At the end of May 2003 it was a great relief to have completed the exams and I was looking forward to a relaxing, assignment-free break over the summer period. However, reflecting back on what I have learned over the first year of the course and the new contacts I have made within the turf industry, I am now keen to start the second year and develop my knowledge and experience of turf further.

WHAT HAVE I LEARNED SO FAR?

The Foundation Degree is made up of 12 modules, with four subjects being studied each year when following the part-time route:

YEAR 1:
Plant Biology (Grade Achieved: 77%)
Soil Science and Land Management (Grade Achieved: 73%)
Golf Course Presentation and Management (Grade Achieved: 82%)
Turfgrass Establishment and Maintenance (Grade Achieved: 91%)

YEAR 2:
Cultivation Practices in Sportsturf
Turfgrass Growth and Development
Ecology, Conservation and Sportsturf Management Pests, Diseases and Weeds

YEAR 3:
Surveying, Planning and Design
Sportsturf Machinery Management
Irrigation Systems, Installation and Management
Construction Systems

Attendance at lectures is required for only one day a week, although it is necessary to undertake additional reading and research. Myerscough College now offers the Foundation Degree as an on-line option for those not able to attend.

While the lectures were interesting, I found that undertaking the assignments was the most stimulating part of the first year. For Plant Biology, students were required to complete a laboratory workbook, which included plant morphology and anatomy drawings of the different parts of both monocots and dicots (stems, leaves, roots). We then had to answer questions relating to the duration of various plants (annual or perennial), their structure and physiology, with particular reference to their use and management in different sportsturf surfaces (fine turf, seedbeds, rough).

Soil Science also involved the submission of a practical portfolio: a soil sample was taken from a sportsturf area and analysed in the laboratory to identify the properties of the sample (texture, level of organic matter, NPK status, pH, particle size distribution and hydraulic conductivity). Once the analysis had been completed, we were required to comment on the suitability of the soil for the use to which it was put (eg as a golf green, football pitch) and, if necessary, recommend appropriate soil management operations to improve the soil's performance.

For me, the assignment briefs for Golf Course Presentation and Turfgrass Establishment were initially the most daunting, due to my lack of golf/turf knowledge, and required a lot of research so that I could familiarise myself with the basic greenkeeping terms. It was a steep learning curve. These assignments did, however, prove to be the most enjoyable and rewarding.

Golf Course Presentation and Management consisted of two assignments:

- Practical Book and Record - A diary of the various operations involved in the daily maintenance of a golf course over the period of one semester, giving a general overview of the selected course, a report of the duties undertaken (including any further recommendations for work to be carried out), and costings involved in the completion of the maintenance tasks. As I was not employed by a golf course at that time, my diary was based on the 9 hole golf course at Myerscough College and I would like to thank John Berry, the Head Groundsman, for his assistance in gathering the necessary information to complete this assignment.
- Investigation and Review of a Stated Topic - This involved selecting a topic such as recent research, product information or a golf course concept, investigating and reviewing the literature available on this subject, and preparing a report to evaluate its application within the current golfing environment. We also had to make a presentation of the report to our lecturer and fellow students - thoroughly enjoyable once the first few minutes were over. I chose "Achieving Definition on the Golf Course" and spent many hours surfing the internet for photographs of bunkers, water hazards, mounds and various mowing patterns. Unfortunately friends now think I'm a bit mad when I get excited about bunkers or other well-presented features on a golf course.

Again, Turfgrass Establishment required the completion of two assignments. Firstly, a practical logbook explaining the processes involved in the establishment of a suitable sward for a specific sportsturf use and the on-going

◀ Applying Rubber Crumb

maintenance schedule required. For this assignment I selected a tee that was in need of renovation. Initially, the problems of the teeing area had to be identified (ie whether it was smooth, level and firm, had any problems of weeds, pests or disease, and the type, density and coverage of grass species).

Visual assessments, quadrat sampling and subsurface assessments using a soil auger were used. Following on from this, a renovation programme was proposed, including costings.

The second assignment in this module was broken into two parts: another literature review of a particular product but also incorporating a research trial to assess the effectiveness of this product on turf. With the increasing number and range of products available for use within the sportsturf industry, it is important to be able to evaluate products to enable sound decisions to be taken. This will require judgements to be made with regard to the accuracy of sales claims and published information, and the ability to accurately test a product. The objectives of the assignment were threefold: firstly, to familiarise ourselves with major research establishments, governing bodies, relevant suppliers and publications; secondly, to develop skills of evaluation and analysis; and, thirdly, to present effectively the results of our investigations in a written, illustrated report.

As the use of rubber crumb in sportsturf is a relatively new development, I chose to review its use as both a topdressing material and a rootzone amendment, looking into the general reasons for using rubber crumb, its manufacture and the products available for turfgrass purposes. A lot of research in this area is currently on-going and most of the literature that is available is in the form of research papers and recent magazine articles.

For my own research into the product, I set up a trial to investigate the effect on seed germination in rootzone material amended with rubber crumb. I would like to thank Brian Tebbutt, of Tebbutt Associates, for supplying literature and the rubber crumb material to undertake the research, and also the laboratory staff at Myerscough College for their assistance in carrying out the trial. A brief outline of the trial and a summary of the results are shown in Figure 1.

PRACTICAL EXPERIENCE

Although I have completed the academic side of the course successfully (with final grades between 73% and 91%), I am very much aware that it is one thing to have the theoretical knowledge and another actually to put it into practice. If the Foundation Degree is followed on a full-time basis, there is a separate module in which the student is required to undertake a work placement for one year. There is a similar requirement for those wishing to follow the part-time route, although it is not a module subject to assessment. While I have had some experience during the summer of working on a golf course, I would find that a more structured practical training programme useful.

My original reasons for undertaking the Foundation Degree were out of general interest in the subject, rather than to become a greenkeeper or groundsman. Since commencing the course I have recognised areas in which my previous employment experience could have a more supportive capacity within the sportsturf industry. What may be appropriate is a fast-track programme, similar to graduate training schemes adopted by large companies in other industries. Under such a programme I would gain hands-on experience of all aspects of greenkeeping (general maintenance operations and larger project work) over a relatively short period of time. Given the structure of the greenkeeping business and size of "companies" involved, I feel it would be more appropriate for such a programme to be devised and co-ordinated within the college environment, although the tasks would be undertaken at a golf club. This type of training may also be appropriate for others entering the sportsturf industry and wishing to transfer skills acquired in other business environments.

While I recognise that the student should take responsibility for their own development, such a training programme would need the support of the teaching staff at the college.

The colleges could negotiate with their local contacts to ensure that the student performs certain tasks at least once: possibly arranging with different clubs a series of week-long placements so that the student is involved in projects such as building a new green or attending a Greens Committee meeting as well as the routine general maintenance operations undertaken at various times of the year.

I appreciate that such a programme would require much co-ordination and commitment from students, teachers and golf clubs alike. However, given the changing nature of the sportsturf industry and career patterns in general, such training may be suitable in the future if the sector wishes to attract personnel from other sectors and tap into their skills.

People entering greenkeeping from a business-orientated environment may be comfortable undertaking the more office-based tasks associated with the increasing emphasis on administration, legislation and budgeting (which many Course Managers/Head Greenkeepers tend to shy away from). A fast-track training approach may offer an incentive to such professionals wishing to enter course management, where the traditional route has been to work up through the ranks, and give them a general overview of the practical tasks involved in the maintenance and development of golf courses, etc. In this way, they could support and assist the Course Manager/Head Groundsman in carrying out their duties, while recognising the knowledge required by greenkeeping staff that can only be acquired through several years of practical experience.

WHERE DO I GO FROM HERE?

As mentioned earlier, I am looking forward to resuming my studies and successfully completing the course in May 2005. In the meantime, I am investigating more fully how my administration, management, organisational and communication experience can be utilised within the greenkeeping profession. A job as full-time Personal Assistant to a Course Manager would be ideal but these jobs are few and far between. So currently I am considering a new business venture offering support to several Course Managers/Head Greenkeepers, particularly in areas such as budgeting or Health and Safety. In assessing the market for such services, I am beginning to recognise how differently each golf club functions in relation to the greenkeeping section and how it interacts with other areas of club management. Another learning experience!

In order to survive financially over the coming months, I will be resuming employment on a part-time basis back in the (dry, warm) office environment, although this will be outside the pensions industry. It is also a temporary measure until I manage to secure a suitable full-time, permanent position in the sportsturf industry.

I would like to thank Ransomes Jacobsen for providing sponsorship for my studies, thereby assisting in my transition into a more exciting and rewarding career.

Judith Colley, BSc, APMI

Figure 1: Seed Germination in Rootzone Material Amended with Rubber Crumb

Where rubber crumb is to be introduced as a rootzone amendment, the area will require either reseeding or returfing after the construction work has been completed. It is, therefore, important that the addition of rubber crumb has no negative effects on the germination of seeds. A laboratory trial was set up to study whether the incorporation of rubber crumb into rootzone material would affect the germination rate of perennial ryegrass seed.

Materials and Method

Several incorporation rates were tested (rootzone material :rubber crumb by volume: 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50) using two different grades of rubber crumb (0.5mm - 2.0mm and 1.0mm - 3.0mm). The crumb was incorporated by hand into a sand-dominated rootzone material, which contained a small amount of organic matter, and put in seed trays with 30 perennial ryegrass seeds being scattered on top. The trays were placed in a growth cabinet and watered daily using distilled water. At periods of 7, 14 and 21 days after the initial sowing date the germinated seeds were removed and the number of seedlings in each tray was recorded. A duplicate study (Trial 2) was set up to check the accuracy of the results.

Findings

Analysis of the results indicates the following:

a) Total Number of Seeds Germinating

After 21 days the lowest rate of germination was found in the tray containing no rubber crumb with the total number of seeds being less than a quarter of those in the next lowest germinating tray. The higher levels of germination generally occurred in the trays containing the 1.0mm - 3.0 mm granule size. The incorporation rate does not appear to have a consistent effect on the total number of seeds germinating, although those incorporated at 50:50 had germination rates at the higher of the scale and those at 90:10 were found in the lower end of the scale (see Charts 1 and 2).

Chart 1: Effect of Rubber Crumb Incorporation Rate on Total Number of Germinating Seeds: 0.5mm - 2.0mm

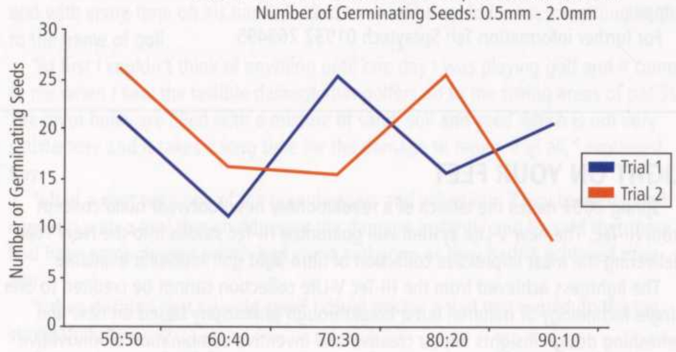
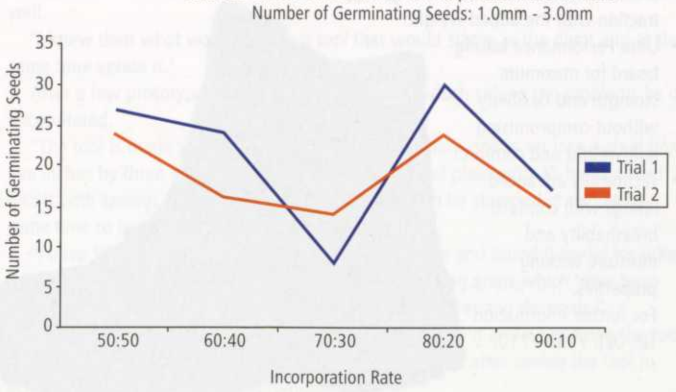


Chart 2: Effect of Rubber Crumb Incorporation Rate on Total Number of Germinating Seeds: 1.0mm - 3.0mm



b) Rate of Germination

Seven days after the date of sowing the trays containing no rubber crumb had the lowest rate of germination. It also tended to be lower in trays with the 1.0mm - 3.0mm granule size. The number of seedlings appearing during this period was higher in the trays that were incorporated at the 50:50 rate for both granule sizes, although the remaining incorporation rates did not show consistent results across Trials 1 and 2.

Fourteen days after sowing, the trays with no rubber crumb incorporated into the rootzone were again showing a lower germination rate. Germination in this second week of the trial was lower in the 0.5mm - 2.0mm granule size, rather than the 1 .0mm to 3.0mm granules which had been experienced in week one. As indicated in the first seven days, the incorporation rates did not show any consistent trends between the two trials, although those incorporated at 50:50 once again appeared to be germinating at a faster rate while those at the 90:10 incorporation rate were slower at germinating.

The final week of the trial showed that the germination rate in the 0.5mm - 2.0mm granule size was lower (as had been experienced in the second week of the trial) and that incorporation rates continued to be inconsistent between the two trials.

Conclusion

Results of the trial indicate that the addition of rubber crumb to rootzone material does not have a negative effect on the germination of perennial ryegrass seeds, in fact, the evidence suggests that the germination rate over a period of three weeks is enhanced by the addition of rubber crumb - the level of germination with a rubber crumb rootzone amendment being increased by more than four times. After the three week period, both the size and incorporation rate of the rubber crumb granules appear to have an impact on the total germination rate. Seeds also germinated faster over the three week period where rubber crumb amendment was the greatest. Although the smaller granule size had higher rates of germination in the initial period, the comparative rates were lower after the first seven days.

More extensive research would be recommended to check the accuracy of these results. A larger number of seeds and a second duplicate trial would minimise further any effects of the seed purity and germination rates on the results. I would also suggest further studies to assess the impact of rubber crumb on germination over the longer term and on other turfgrass species.

▲ Before applying Rubber Crumb

▲ After applying Rubber Crumb

Patent was granted in Europe April last year for the use of rubber crumb on grass.

Tebbutt Associates can be contacted Tel: 01253 342003.

NEW PRODUCTS

SAFE POURING

Whether you manage a golf club, sports complex, football stadium, playing fields, private estate, market garden, orchard, horticultural facility or small arable farm the problems are going to be the same if you handle chemical concentrates in small packs.

You have to pour into a measuring jug before adding the concentrate into the sprayer. Then you have to triple rinse the jug to ensure it is clean. And worst of all you are required to do it with an impervious full length suit, gauntlets, boots, mask, helmet and face shield, even in hot weather! If you don't, you are taking a risk with your long term health and putting your employer at risk. Chemlok frees you.

You can discard your measuring jug – and the chemical suit too, because using Chemlok does not require protective clothing.

The flow controllable valve allows you to measure precisely in 25ml increments and a built in spirit level lets you know that the gauge is plumb.

Full transfers can be completed at the rate of half a litre in eight seconds The chemical is mixed into the filling stream.

The integral power rinse facility, using clean water from a tap or irrigation system, thoroughly cleans containers, removing more than 99.99% of the product, so that empty containers are safe for disposal and there is no wastage.

Chemlok will handle:

- Any liquid formulation from any manufacturer in any container from 1 – 1000 litres.
- Containers of 1 – 10 litres are processed through the valve.
- For larger drums and IBCs, use the optional drum extraction.
- Standard thread size across the Northern Hemisphere is 63mm, but we also have 45mm and 60mm adaptors and can make other screw-in thread adaptors if required.

Chemlok is driven by clean water from any source. It is connected to an irrigation system by the side of a green, but can also be driven by a mains supply or from a non-pressurised source using the pump and sprayer controls.

But principally, because Chemlok is an engineering control within the meaning of the COSHH regulations, it does not require ppe to be worn, unlike an open induction hopper.

For further information Tel: Spraytech 01932 269495.

NEW RANGE OF VACUUM SWEEPERS

Trilo has introduce the new SG800 into the range of quality vacuum sweepers. The SG800 has the ability to collect leaves and litter using the two metre suction hood and brushes or use the big cab controlled hose. Uniquely the hose can be used on either side of the machine, giving greater flexibility for the operator. The material passes through the armoured fan and housing into the seven cubic metre hopper, being chopped and mulched on the way through.

For further information Tel: 01638 720123.

LIGHT ON YOUR FEET

Spring 2004 marks the launch of a revolutionary new footwear build concept from Hi-Tec. The new V-Lite system will guarantee Hi-Tec strides into the New Year delivering the most impressive collection of ultra-light golf footwear available.

The lightness achieved from the Hi-Tec V-Lite collection cannot be credited to one single technology or material but a breakthrough philosophy based on new and refreshing design insights with a creative and inventive combination of innovative materials and build construction. The result is exceptional – the most lightweight collection of footwear on the market, without any compromise on style, comfort or performance.

All shoes in the V-Lite new collection weigh in at less than 400g and include standard features such as:

- Dual Density phylon V-Lite Sole providing an ultra lightweight unit that offers unbelievable levels of cushioning, support and traction with the added weight.
- Ultra Performance lasting board for maximum strength and flexibility without compromising lightweight and comfort.
- Technically advanced linings with comfort, breathabilty and moisture wicking properties.

For further information Tel: 020 7940 1710.