suspense

hold water in the pores against the downward pull of gravity. Water is eventually held more tightly in the pores in the rootzone than the gravitational pull at the interface of the rootzone and the underlying coarse material so vertical drainage ceases. The fact that unsaturated flow rates in the gravel are so slow is a complementary process reinforcing the effects of moisture retention in the rootzone.

Moisture profiles in golf greens

After heavy rainfall, drainage takes place with water being lost from the largest pores until gravity and capillary forces are balanced. This equilibrium situation is often termed field capacity and is generally reached in 24-48 hours. Evaporation from the surface and water use by the grass (ie transpiration) allows the soil to dry out further, with around 20 mm of water per week being consumed in summer conditions in the United Kingdom. In winter however evapotranspiration rates are low (often less then 3 mm per week) and thus moisture content in a golf green profile will be close to field capacity for long periods - wetting up during rainfall then draining back to equilibrium. The moisture profile at this equilibrium position is therefore very important as it influences the quality of the grass, especially its root development and also the playing quality of the surface.

Some of the factors involved can be demonstrated using results from a recent study at the STRI in which we examined moisture profiles of a number of rootzone constructions. Profiles were built inside plastic tubes which had an internal diameter of 150 mm. Two rootzones were examined, firstly a fine rootzone (77% medium-fine sand, 9% fines less than 0.125 mm diameter) and secondly a coarse rootzone (84% medium-coarse sand, 4% less than 0.125 mm). In addition there were variations in rootzone depth, blinding layer characteristics and in the gravel drainage layer.

We measured soil moisture content at intervals of 50 mm and the first thing to note is that equilibrium moisture content after 48 drainage varied considerably depending on the texture of the rootzone material and the height above the interface with the gravel.

On both rootzones moisture content approached saturation at the base of the rootzone and moisture content decreased with height above the interface of the rootzone and the underlying gravel, rapidly for the coarser rootzone but only slowly for the fine rootzone. This is a good demonstration of the suspended water table phenomenon and how equilibrium moisture content is influenced by particle size distribution.

Some practical points also need to be considered. For the finer rootzone the volume of water held at a depth of 100 mm from the surface of a 300 mm deep profile was approximately 30%. As the total pore space was only 39% this only give 9% air-filled pore space which is only marginal for healthy grass growth, especially as in wet weather the volume of air-filled pore space will decline further. Air exchange in the soil would be restricted and the root development could suffer. In contrast the contents of water and air at the same depth for the coarser rootzone were about 13% water and 25% air. Under these circumstances there should certainly be no problems in terms of air supply to the root system.

With respect to drought susceptibility, knowledge of the variation of equilibrium moisture content with depth helps prediction of how much water is available to the grass plant. Assuming that root depth is 100 mm and if the average volumetric moisture content of the top 100 mm of the coarse rootzone is 12%, then 12 mm of water is held within the depth of rooting. In contrast if the corresponding moisture content for the fine rootzone is 25% then 25 mm of water are held within the depth of rooting. In contrast if the corresponding moisture content for the fine rootzone is 25% then 25 mm of water are held within the depth of rooting. About 6 mm of this water is held so tightly in the finest soil pores that the suction exerted by the grass roots cannot extract is, so it is unavailable to the plant. Therefore the available moisture content is approximately 6 mm for the coarse rootzone and 19 mm of the finer rootzone. In hot summer weather between 2 mm and 3 mm of water are lost daily by evapotranspiration thus there is only two or three days' supply of water available in the coarse rootzone but around one week's supply for the finer rootzone. These figures somewhat simplify the situation on a real green as in practice soil moisture would move upwards from the lower part of the profile as capillary suction would increase as water was removed by the plant. Furthermore, evapotranspiration rates would slow down as the grass became more drought stressed and in addition the root system in the coarser material may be more extensive to compensate for the lack of water near the surface. Nevertheless differences in the moisture profiles would have a profound effect on irrigation management.

Effect of underlying layers on the rootzone

The work also showed some other interesting effects. Firstly the depth of the rootzone had a major effect on the moisture content of the surface 100 mm of the profile. The shallow 150 mm rootzone had a much higher moisture content than the 250 mm and 350 mm deep rootzones and particularly when the finer rootzone was used the pore space would have been very close to saturation. In practical terms a 150 mm deep rootzone would be unlikely to be used on a golf green because of the depth required by the cup. However tees constructed with only 150 mm of rootzone over gravel could be very water retentive and many bowling greens that are constructed with such shallow rootzone depths must be close to saturation throughout the winter with consequent risks of anaerobic conditions and black layer developments.

An excessively deep rootzone could also create problems especially if the rootzone were coarse and had a low water retention capacity. I have certainly heard of problems occurring on some courses in the USA and Australia where coarse rootzones have been used because of high intensity rainfall but rooting is often restricted because of summer heat stress. Under these circumstances a 300 mm rootzone can potentially be too deep because the main part of the suspended water table lies well below rooting depth.

From a soil physics of view there is a strong case to adjust depth if either very coarse or very fine materials have to be used because more suitable materials are not available. For example I once had to increase the profile depth of a soccer pitch construction in Saudi Arabia from 250 mm to 350 mm because only very fine sands could be found around the site.

Although our study showed that the use of different gravels in the underlying drainage layer had no effect on moisture retention, we did find that material selection for the blinding or intermediate layer had an influence on moisture content in the rootzone. When the intermediate layer was omitted moisture contents in the rootzone were higher, mainly because there was a very pronounced difference in grain size at the interface of the rootzone and underlying gravel, meaning that there was no extra capillary pull from the underlying layer. In contrast for the finest blinding layer material there would have been some continuity in pore size and moisture content at the surface of the rootzone was slightly lower. We are currently investigating these effects in more detail in a study being carried out for the USGA.

Assessing water retention characteristics of rootzones

An indication of the potential soil water status of the rootzone material can be obtained from samples compacted in controlled laboratory conditions. USGA guidelines for rootzone materials are:

Total porosity	35-55%
Air-filled porosity	15-30%
Capillary porosity	15-25%

These requirements are designed to cover a range of climate zones and for United Kingdom conditions total porosity values would normally fall between 35-50% and very high air-filled porosity values are not normally needed, especially as this will be generally at the expense of capillary porosity, thus making rootzone materials potentially more droughty. When these limits were originally specified they were based on laboratory tests using a tension of 400 mm of water but in 1994 the test tension was revised to 300 mm to be compatible with the rootzone depth. On soil physics grounds this change in tension was entirely logical but as the requirements for air-filled porosity and capillary porosity were not also modified we have notice that this did seem to cause some apparently perfectly suitable mixes for UK conditions to fail because of slightly low figures for air-filled porosity (eg 13 or 14%) and slightly high figures for capillary porosity (eg 25-28%). The change in test protocol favoured coarse rootzone materials which although suitable in other parts of the world would be harder to manage in this country on fescue/bent (and annual meadowgrass) greens.

Unless the requirements are adjusted it is proposed that for United Kingdom conditions tests should be carried out at 400 mm tension and unless specifically requested the STRI will carry out all future tests at this tension.

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THE NATIONAL GOLF TOURNAMENT

The wonderful Letham Grange Resort plays host to BIGGA's National Tournament in association with Scotts/Miracle in August. As Scott MacCallum found out it should proved to be a event not to be missed...

Home on the Grange

If there is one nasty habit of which sports writers are guilty - I can hear the incredulous cries of "Only One!" - it's labelling.

How often have we heard about "The Next George Best!" A young guy called Peter Marinello laboured under that burden with a spectacular lack of success for Arsenal in the '70s, while Ryan Giggs has come a little closer to living up to the billing... and at least plays for the same team. Isn't Ronaldo supposed to be "The New Pele"?

How many times have Wales come up with "The New Barry John" or "The Next Gareth Edwards", or there is a middle order batsman who can bowl a bit and all of a sudden he sees his name in the papers as "The New Botham"?

In golf the list of players who have struggled to live up to being called "The New Nicklaus" or "The Golden Bear Cub?" is embarrassingly long - Johnny Miller and Ben Crenshaw at least won a few Majors but the likes of Hal Sutton and Scott Verplank, to put it mildly, didn't get very far in the chase to match Nicklaus' 18 Major Championships. At least

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they had the same colour of hair!

However, another subject of journalistic "labelling" in the golf world hasn't suffered from the same damp squibb fate as some of those mentioned and has, in fact, actually enjoyed its comparison with a more illustrious cousin.

About 12 years ago a former boss of mine, Malcolm Campbell,- he was Editor of Golf Monthly - travelled to Angus with three times Open Champion, Henry Cotton, who had been invited to open a new golf course.

When he came to write about Letham Grange, near Arbroath, Malcolm labelled it "The Augusta of Scotland". Many people scoffed but Malcolm did speak with a level of authority. He'd visited hundreds of golf courses during his journalistic career, including Augusta National, and his opinion was one which was genuinely held.

Visiting Letham Grange, which this year plays host to BIGGA's National Tournament, in association with Scotts/Miracle, you will be able to see how Malcolm came to that conclusion.

Sure, the real Augusta, in Georgia, offers so much that can't possibly be matched by this little corner of Scotland, but it would be a very unforgiving eye which could not see some similarities.

"I believe the spirit of the quotation was that Letham Grange felt like Augusta rather than that we were trying to duplicate it. It is designed as a tribute to Augusta," explained Resort Manager Gordon Kingsford-Smith.

Having said that there are individual holes which have a more than passing resemblance to their transatlantic relations. For example the 2nd is a short par three guarded by a lake which is an obvious close relation to the 16th which has seen so much drama at Augusta.

But is is not just Augusta from which Letham Grange draws its inspiration. The run of three holes between the 8th and 10th have been compared to the run of 10th,

New Head Greenkeeper 'David Mathie' with Resort Manager Gordon Kingsford Smith

11th and 12th on the Jack Nicklaus course at St Mellion which was home to the Benson and Hedges International Open for several years. It is also possible to spot influences from Pinehurst and its relatively near neighbour, Gleneagles.

The Old Course at Letham Grange is superb and within a couple of years of opening featured in Golf World's top 50 courses in the country. A remarkable feat.

All the more remarkable when you consider that it was designed not by an Alister MacKenzie, a Jack Nicklaus, a Tom Fazio or a Donald Steel. Letham Grange was designed by Ken Smith.

Now don't waste time searching through Golf Architect directories for his name or to discover where else carries the Ken Smith stamp. You won't find anything.

Ken was a potato farmer whose dream it was to transform a Victorian mansion into a luxury hotel and built his own golf course. He was no more than an enthusiastic amateur when it came to designing golf courses but he is obviously one of those people who is a natural. Someone who could probably juggle five balls while his little chums were still learning to catch, recite Rabbie Burns while everyone else was still chanting nursery rhymes and no doubt played to scratch within two weeks of taking up golf.

Letham Grange would defy anyone to mark it down as the work of anyone other than a seasoned professional.

"He actually went to America and visited the top golf courses, brought back ideas and put them all together at Letham Grange," said Gordon.

Not only that, Ken Smith was also hands on when it came to the construction of the golf course working closely with the then Head Greenkeeper, Jim Grainger.

"The trees that were already on the Estate had been there for 300-400 years and they just happened to be in the right place for the holes which Ken had designed. He used what nature had provided," explained Gordon.

There are only three or four holes on the Old Course which don't feature water to a greater or lesser degree with several requiring a carry over water to make the green.

The new Head Greenkeeper, David Mathie, only took over the reins at the beginning of April but there was no disguising the excitement he felt as he spoke a few days before starting work.

With the Old, and the slightly shorter but still impressive New Course, to manage David has already formulated his five year plan.

"I am going to go around the course hole by hole and assess what is required but I know that I'm going to do quite a bit of rebunkering to give the courses a bit more of a Scottish feel to them," said David, who arrived from Strathmore Golf Centre having previously worked in the the South East. He is a former student of Sparsholt College.

"I also intend to undertake a big conservation project planting 8 - 10,000 trees and, working alongside Jonathan Smith, bring in conservation areas," explained David, who also promises some fine, quick greens for August and the National Tournament players.

Letham Grange now has new owners who are keen to give the resort a major lift.

THE NATIONAL GOLF TOURNAMENT

"There is so much to offer in this area," said Gordon. "As well as our own courses we are in easy reach of Rosemount, Carnoustie, Downfield, Montrose, Strathmore and Monifeith to name just a few while St Andrews is under an hour away.

"We are also sold out for the week of next year's Carnoustie Open Championship," he revealed.

One of the innovations brought in by the new owners have been the Stones of Good Fortune which are scattered strategically around the course and now feature in the Resort's logo.

"These were put down in 1996 and blessed by a Buddhist Priest, who was also the landscape architect," explained Gordon, who added that they were giving away little pieces of the stones and asking the recipients to pass on any tales of good fortune which had occurred since.

"Amazingly two weeks after they were blessed the Queen announced the return to Scotland of the Stone of Destiny, which had been in Arbroath Abbey for hundreds of years.

"In a small way we felt involved and some of the staff went to Edinburgh to watch the Stone come home. It's a nice tale."

Letham Grange has another unique feature in that it has the only curling rink in the world which boasts chandeliers for lighting.

"This was another innovation from Ken Smith who built the four lane curling rink in the function suite. It goes down in October and stays until March and the chandeliers are a nice quirk."

That function suite can seat 500 people and it will be the venue for the banquet on the Tuesday of the National Tournament.

"We feel that Letham Grange is a haven of peace for our visitors - an ideal place to unwind." said Gordon.

You can't but agree and the opportunity to pit your wits against the Course that Ken Built and enjoy everything that Letham Grange has to offer is one not to be missed.

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At home on the Grange

FACTFILE

Letham Grange is 4 miles from Arbroath
Arbroath is 8 miles from Carnoustie
Arbroath is 17 miles from Dundee
Arbroath is 40 miles from Perth
Arbroath is 70 miles from Edinburgh
Arbroath is 98 miles from Glasgow
Arbroath is 250 miles from York
Arbroath is 350 miles from Birmingham
Arbroath is 450 miles from London

Think Arbroath and for many what immediately comes to mind is the Arbroath Smokie - the delicious smoked fish which is cured in smoke-houses close to Arbroath Harbour.

A few miles away in Forfar they also lay claim to their own delicacy - the Forfar Bridie - a magnificent cross between a pie and a pastie.

Arbroath has a fine football team which plies its trade in the Scottish Third Division. What it is famous for, however, is having the coldest ground in Britain. Visit Gayfield Park and freeze!

The Declaration of Arbroath proclaiming Scotland's independence was signed in Arbroath Abbey in 1320 and the Stone of Destiny was housed in the Abbey for hundreds of years before being taken to London. It is now back in Scotland, in Edinburgh Castle.

Dundee is the nearest city to Letham Grange and can offer a wide range of attractions. Originally known as the City of the three Js - Jam, Jute and Journalism it is now the City of Discovery as it is home to Captain Scott's famous ship upon which he made his first polar expedition, and is also the birthplace of Dennis the Menace and Desperate Dan! It also has Shaw's Dundee Sweet Factory, Camperdown Park with its Wildlife Centre and the superb Olympia Leisure Centre complete with five waterslides, waves and spa pool.

Glamis Castle, childhood home of the Queen Mother, is only a few miles from Letham Grange and is open to the public.

More Information can be obtained from Arbroath Tourist Information Centre Tel: 01241 872609 Fax: 01241 878550 or the Angus & Dundee Tourist Board Tel: 01382 434664 Fax: 01382 434665 E-mail: arbroath@sol.co.uk Website: http://www.angusanddundee.co.uk

Anyone who wishes to stay at the wonderful Letham Grange Hotel to be on hand for all the activities of the National Tournament, in association with Scotts/ Miracle should contact BIGGA Headquarters.

Angus and Dundee Tourist Board Advance Booking number for all types of other accommodation in the area is 01382 434664.

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Ad Ref 59

Golf Course grasses are required to face up to much greater demands than ever but, as Gerard van 't Klooster explains, breeders are trying to keep ahead of the game...

Taking the Strain

Grasses have been used for different sports for a long time but now we ask more from grasses than in the past.
On golf courses, we want to play all year round (summer and winter) and clubs have more members than in the past. When you see the number of rounds played on a golf course during a year, it is much more than 20 years ago and it should be to nobody's surprise that grasses are likely to be worn out.
New golf courses are being built differently from the older generation. The mowing height of the greens, fairways and even the roughs are also completely different. Some fairways nowadays are being maintained to the same standard that greens were in the past. For a grass breeder all these new types of management are important to know what specie and/or variety can be used.

Taking the Strain

A grass breeder starts with a collection of ecotypes gathered from nature which he crosses between varieties or a crossing of a variety and an ectoype. This new material gives a lot of variation and it is in the hands of the breeder to select for the best material.

The first selection is done in a turf trial with small plots, mowed as with a lawn - sometimes mowed as a golf green. In these plots the breeder can see what is the best material and in the trials they are always check existing varieties, so the breeder can assess whether the new material is better than the exiting varieties. This process takes three to four years.

If the new material proves to be better, then it will be selected and the breeder will try to make a new variety from the best material.

For plant breeder rights (by law) a new group of plants is a potential variety only when the group of plants is new and does not look too similar to an existing variety.

The group of plants must also contain plants with the same growth habit and, last but not least, the next generation of that new group must show the same aspects and qualities as the first generation. We call this stability of the variety.

At this stage the grass breeder will try to make a combination of the best parent plants between these borderlines. This takes another year.

The first seed of a "new" variety will be used for different trials in different countries. At Barenbrug, we want to see where we can use the variety and what is the value of the variety for the greenkeeper in the different climatic zones.

The material (plants) have to deal with dry summers, wet summers, cold winters etc. In the meantime we will also test on seed yield.

For the end user (greenkeeper) it is important to know that he can buy the variety. The seed company will only start with a variety if it produces enough seed to market it either in some or all-climatic zones.

After three years of testing on our research stations we will produce seed for the first multiplication of a variety. This seed will be used for the official application (STRI and other institutes), storage (Bank of England) of the variety and to start the next multiplication for selling. All the testing and trialing at the STRI etc. will take at least five years, after that time we are able to market the varieties.

All in all, from the beginning until the end it takes about 13-15 years to create a new variety. As it takes a long time the breeders must look into the future and be flexible enough to change some parts of the programmes when there is a demand for new varieties/species as a result of all the environmental changes. I think it must be possible