Dr Stephen Baker, Head of Soils and Sports Surface Science, STRI, Bingley assesses the value of laboratory testing of golf green rootzones...

Reasons for research

In recent years there has been considerable debate about the value of laboratory testing for the selection of materials for golf green construction. Much of the information that has been presented has been anecdotal and perhaps sometimes based on extreme cases. In addition, there is little evidence that detailed measurements have been carried out so that conclusions can be based on meaningful data. The objective of this article is to present the results of two major studies at the STRI where we addressed the issue of comparing laboratory and field measurements to see whether laboratory analysis can be used to predict subsequent performance in the field.

STRI field trial

Results of the first study were presented at the International Turfgrass Society Conference in Australia. This study had two parts, firstly the construction of a series of experimental plots at the STRI covering an area of 34m x 13m and secondly a laboratory programme in which the effects of different moisture levels and compaction procedures were examined.

If we consider first the field trial, this consisted of a suspended water table construction of 250mm of rootzone material, 50mm of coarse sand blinding layer and a 150mm deep drainage carpet of 5-10mm gravel. It included 16 different rootzone materials in 2m by 2m plots each of which was repeated four times.

The rootzones were formed from blends of a sandy loam soil with four different sands in four mixing ratios i.e. 1:1. 1:2. 1:4 and 0:1 (soil:sand by volume). In other words mixing ratio ranged from 1 part soil to 1 part sand mixes to pure sand rootzones. The sands had contrasting grain size characteristics and they included three uniform sands (medium-fine, medium and medium-coarse) and one sand with a wide spread of particles which was therefore susceptible to interpacking. The experimental plots were sown with a fescue-bent seeds mixture in June 1988.

Subsequent management was typical of that for a good quality golf green and wear started in July 1989 using one of the STRI's differential slip wear machines. A vast number of properties of the turf were measured such as changes in grass species composition, ball roll characteristics and the stopping distance of golf balls fired with controlled conditions of velocity, angle and backspin. However, the most important characteristics as far as this study was concerned were water infiltration rates, soil porosity, air-filled pore space and water retention. Infiltration rates were assessed each spring by hammering concentric rings of 300mm and 500mm diameter into the plots and measuring how quickly water entered the turf surface. Porosity and water retention characteristics were assessed at the end of the trial in 1992 from undisturbed cores taken at depths of 10-90mm and 100-180mm.

Samples of the different rootzone materials were submitted to the STRI's Soil Physics laboratory after blending. In the laboratory we examined the effects of two levels of compaction and four moisture contents at the time of compaction. The test procedure was very similar to that used in the USGA test methods except that the two levels of packing energy (18.9 and 47.3kJ per m2) were either side of the compaction energy used in the USGA test (30.3kJ per m2).

Compaction energy and moisture content at the time of compaction inevitably have some effect on the values obtained but the most important factor in the current debate is how well measurements in the laboratory compared with corresponding assessments on the turf plots.

Drainage rates into the field plots inevitably decreased with time because of a build-up of compaction, root blockage of the pore space and accumulation of organic fines but as Fig 1 shows there is a strong relationship between hydraulic conductivity measured in the laboratory and drainage performance in the field. Under United Kingdom conditions it is very rare for rainfall to exceed 15mm per hour and using equation for the data in April 1992 (four years after construction) a drainage rate in the laboratory of 148mm per hour would be required to ensure infiltration rates exceeding the 15mm per hour mark. This value agrees almost exactly with the lower limit of 150mm per hour given in the USGA recommendations for putting green construction.

Relationships between air-filled pore space and capillary porosity (water filled pore space) measured in the laboratory and field are shown in Fig 2. Again the relationships were strong, in other words the laboratory data are very useful for predicting which rootzone mixes are liable to be water retentive and which rootzone materials are likely to be droughty in nature therefore requiring more watering.

Golf greens with sand dominated rootzones

The trial on the STRI experimental plots had the advantage that all the rootzones had exactly the same management and exactly the same amount of wear. The second project examined relationships between laboratory measurements on real golf greens, generally 5-15 years old, which formed part of a survey of sand dominated golf greens financed by the R&A. Again physical properties of the greens were measured using double ring infiltrometers and undisturbed cores.

Figure 1: Relationships between laboratory hydraulic conductivity measurements and field values of infiltration rate measured at the beginning and end of the trial

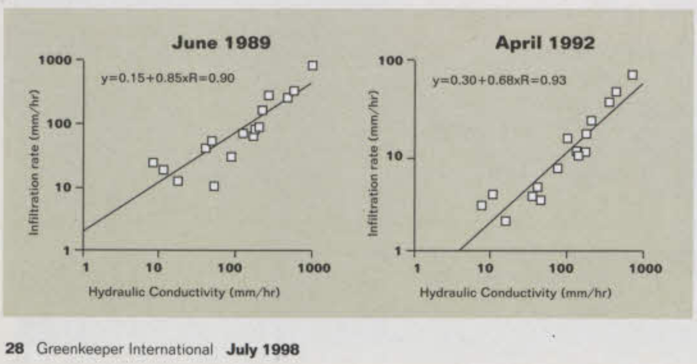
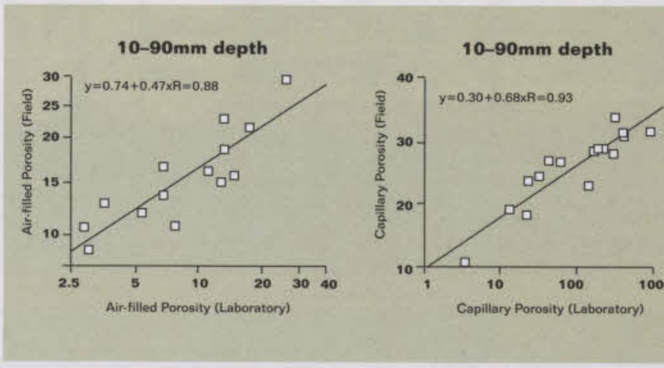


Figure 2: Relationships between laboratory measurements of air-filled pore space and water retention at 40cm tension and corresponding measurements made on undisturbed cores taken from a depth of 10-90mm in the field plots



This time the rootzone material for the laboratory study had to be collected from the established turf using large samples taken by a golf hole cutter.

In this study there were again significant relationships between laboratory and field measurements but compared to the earlier study the relationships were weaker for all parameters except total pore space. The stronger relationship for total porosity probably reflects the greater range of values that occurred in the golf green survey.

Studies elsewhere

The findings of relatively good relationships between laboratory and field measurements under the closely controlled conditions on field trials (where management and wear are standardised) but weaker relationships for real greens has also been found in a number of studies in the United States. This perhaps leads to the conclusion that laboratory measurements can be very valuable in assessing the potential performance of a rootzone for a golf green but variations in management have the capacity to affect performance in the field.

For example a well formulated rootzone mix with the potential to produce a free draining, high quality putting surface may give lower than expected drainage performance because of abuse during construction (eg working in wet conditions), a lack of aeration work or subsequent use of a much finer top dressing.

There are also undoubtedly cases where a rootzone has been tested and approved in a soil testing laboratory but poor quality control has meant that the material delivered to the site bears little resemblance to the material examined in the laboratory.

The quality of laboratory test results

The second main issue that is relevant is the standardisation of test methods and the reproducibility of results from laboratories. Some of alleged variability in rest results may have resulted from the fact that soil properties can quite legitimately be measured using different test procedures. In reality this does not matter as long as results are interpreted taking account of the test method that was used, but it does mean that people must be wary of comparing results from different laboratories. In addition it does provide ammunition for anyone wishing to criticise the whole concept of testing. In this respect the standardisation of methods for the testing of the physical properties of rootzones by the USGA must be welcomed. In the same manner the CEN standardisation procedure taking place within Europe, for which I head the task group on golf, may ultimately help with respect to chemical test methods and other test procedures.

Problems of reproducibility of test results are being addressed through the USGA's Laboratory Proficiency scheme of which the STRI have been members from the outset. Samples are sent to the participating laboratories on a quarterly basis and statistical analysis of the test results provides a mechanism to identify the reliability of the laboratory and to identify if any errors are occurring. Use of a laboratory participating in this scheme is an important step to ensure reliable test results.

Final thoughts

In conclusion, an experienced scientist or agronomist may well have a pretty good idea of the potential performance of a rootzone material just by visual inspection but laboratory test results can be very useful in assessing the physical properties of more marginal materials. Furthermore many developers of new golf greens simply do not have the experience to compare the merits of different rootzones and therefore test results, and their interpreted by a suitably qualified agronomist, is an essential part of ensuring that a good quality product is obtained.