Soil *Chemical Analysis, Results Interpretation, Pitfalls*

Highly respected agronomist, Robert Laycock, offers some excellent advice on how to make the most from the sample analysis you commission

Soils differ in their fertility. This has been known for centuries, and the fact that plants get most of their nutrients from the soil has been known since the 19th century.

Given modern analytical techniques one would think that how the soil influenced turf growth should be fairly easy to work out. Taking a soil sample and sending it off for analysis is routine for many greenkeepers. But, before you get to consider the figures in the results table, it is as well to remember that there are many things that can influence the results.

First of all there is how the sample is taken. I once visited a golf course where the greenkeeper had been applying elemental sulphur to reduce the pH of the rootzone. I took a soil sample and the analysis showed that far from being high, the pH was low.

"There must be a mistake" said the greenkeeper, "One or other analysis must be incorrect!" In fact neither was incorrect. My samples had been taken to the typical rooting depth of the golf green, about 10cm, while the earlier samples had been taken to a 30cm depth. Repeated applications of sulphur had lowered the pH near the surface of the green so that my analysis showed an acidic rootzone while the pH at depth was still high. At the surface of the green the pH was even higher than my 10cm sample had shown and was adversely affecting plant growth, which was one of the reasons why I had been asked to look at the greens. When sulphur application stopped, the quality of the greens turf improved.

The samples taken need to be representative of the whole area of turf and soil should be taken from a reasonable number of places within it. Many golf greens have been in place for decades. They may have had variation within them since the

REFERENCES

1. Escritt, J. R., 1978. The ABC of Turf Culture. Kay & Ward.
2. Houba, V. J. G., Novozamsky, I. and van der Lee, J. J. 1992. Soil testing and plant analysis in Western Europe. Commun. Soil Sci. Plant Anal. 29: 2029-2051.
3. Jones, J. B. Jr. 2001. Laboratory guide for conducting soil tests and plant analysis. CRC Press.
4. Schnug, E., Fleckenstein, J. and Haneklaus, S. 1998. Factors affecting available micronutrient concentrations in soils using Coca-Cola ® as extractant. Commun. Soil Sci. Plant Anal. 23: 1891-6.

beginning and may also have been extended with different soil materials since. Samples should be taken every few metres within the green to overcome this variation.

The time of year when the samples are taken can also affect the results. Most obviously, sampling soon after fertiliser application should be avoided.

Sample transport and storage is less important with soil samples than with plant tissue samples, such as grass clippings, with the exception that the content of soil nitrogen is related to biological activity in the soil, which is of course related to aeration and temperature. This is why nitrogen is often omitted from routine soil analyses, even though it is easy to analyse for. Useful information on turf nitrogen status is best from plant tissue or from soil analysis on a very fresh sample. Biological activity while in transit can also increase the solubility of other nutrient elements as a result of the decomposition of organic matter, further affecting the results.

The aim of extracting nutrients from soil is to mimic the action of the plant in taking nutrients from the soil solution so that the amounts available to them can be assessed by some type of spectrophotometry. The method used to extract nutrients also affects the amount extracted and thus the values in the results table.

The extent of the root system of the plant also affects how much nutrient it can absorb from the soil. Clearly a plant with an extensive root system is better able to take up nutrients than one with a poor root system.

The problem is that replicating the environment around the root hairs of a particular species of plant is very difficult. It changes from time to time and in some cases the plant can change the environment around its root hairs in order to extract a particular element. For example, grasses produce phytosiderophores (a type of amino acid) in a diurnal rhythm. Not only can they do this, but the grass plants can also identify a low level of iron in the soil solution and release more phytosiderophores to proactively extract a greater amount.

A simple chemical soil analysis would not detect that this could occur or estimate how effective it was in releasing iron to the grass plant. The presence of mycorrhizal fungi in association with the roots of some grass species also affects nutrient uptake, particularly phosphorus.

We know that the environment of the root hairs in the soil solution tends to be acidic and it is this that dissolves nutrients from the soil particles, but which extractants best replicate this? If you want to extract all the nutrients from the soil you can use a very powerful acid to totally dissolve all the organic matter, sand, silt and clay particles and analyse the resulting solution. This would tell you exactly what was in the soil but it would not tell you what was available to the turfgrass plants. Conversely, you could extract nutrients from the soil using the simplest of extractant - deionised or distilled water. Undoubtedly, some nutrients would go into solution. However, the true situation is somewhere in between these two. In fact, in an ideal world a different extractant would be used for every plant species and every single plant nutrient that one was investigating.

A review of soil potassium extractants in 1992 2 showed that 13 different soil extractants were in use to extract potassium in soil laboratories around the world. The reasons for this wide range of extractant solutions are to some extent technical, based on the range of typical soil types in the countries concerned but also on historical relationships between countries. Different extractants provide different results. This is important to greenkeepers who may be working abroad and need to interpret soil analysis results obtained locally - BIGGA is an international organisation after all!

In the USA, much research has been done on developing new soil extractant materials and a range of different extractants is used. For example, eight different extractants for phosphorus are used in the USA 3. They all produce different results, which correlate with each other to a greater or lesser extent, allowing for comparisons to be made among them.

Interestingly, it has been discovered that Coca-Cola, because of the strict rules on its manufacture, is a more reliable and stable material in some countries than local water supplies and its acid content means it can be used as an extractant for micronutrients 4 – no I don't drink it!

A common source of soil analysis for greenkeepers are the fertiliser salesmen, who use analysis results as a marketing tool. Beware of these people. If you want independent advice about money matters you should go to someone who is not trying to sell you a financial product, and so with advice about plant nutrition you should not get it from someone who is receiving a salary and possibly a commission based on the amount that they sell. They are inclined to try to sell you as much as possible. They may be nice guys, but at the end of the day they are trying to make a living.

about the author

Robert Laycock has worked in turfgrass research and agronomy for the last 35 years and specialises in golf course agronomy. Regular golf clients include The Belfry, Woburn Golf and Country Club and the London Golf Club and all the Marriott UK golf venues. He is a Chartered Biologist and a Fellow of the Institute of Horticulture and a founder member of the Register of Independent Professional Turfgrass Agronomists.

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At the end of the day, it is the interpretation of the numbers which is the important thing. I came across a case some time ago where one adviser had advised the use of acidifying materials to improve golf green performance while another adviser, advising on the same greens, advised the use of lime to reduce acidity.

In the late 1970s, when I was working at the Sports Turf Research Institute, soil analysis results, as now, would be used to decide which fertiliser should be applied to sports turf surfaces. STRI provided recipes of raw materials, including sulphate of ammonia, superphosphate, bone meal, sulphate of potash and sulphate of iron for greenkeepers to mix up into a fertiliser and apply with a carrier of screened soil or compost. A typical spring fertiliser for fine turf, described by the then Director of the STRI in 1978 had an analysis of 7.2% N: 9.1% P2O5: 4.5% K20 and 2% Fe 1.

In those days, the STRI and the late Jim Arthur held very opposing views on plant nutrition. Using the same soil analyses, STRI were still advising the use of high phosphate fertilisers on golf greens while Jim Arthur, then the R&A agronomist, took the opposite view, saying that zero phosphorus fertilisers were adequate in most situations and that only nitrogen was required for healthy turf growth on most golf greens. Mr. Arthur was dismissive about the use of soil analysis in general while the STRI used them to devise fertilisers which it is generally accepted now were too high in phosphorus.

This rather extreme situation continues today. My advice to greenkeepers is that to some extent it is not the numbers in the soil analysis results table which are important but the advice that you are being given. Various advisers, given the same soil results, could give very different advice as a result of their philosophy of agronomy or their commercial interest - or just the current agronomic fad. The important thing is to find advisers who are knowledgeable, independent and whose advice you trust, based on your experience and the experience of others who have used their services.