Putting soils to the test

In this instalment of Tech Talk, AGCSA environmental agronomist John Geary looks at the integral role soil nutrient testing plays in the development of high quality turf surfaces and the science behind conducting these tests.

Above: Soil nutrient tests play an integral role in assessing the quality of soils to support plant growth while also identifying nutritional deficiencies and providing guidance on fertiliser and amendment needs

Talk to any turf professional or agronomist and all but the most ardent will suggest that soil fertility and identifying the nutritional needs of turf is at the heart of producing a high quality playing surface. The level of fertility affects most, if not all, aspects of the playing surface such as vigour, thatch accumulation, wear tolerance, disease tolerance as well as the ability of turfgrasses to cope with weed and insect invasion.

To help determine the nutritional status, soil nutrient tests play an integral role in assessing the quality of soils to support plant growth while also identifying nutritional deficiencies and providing guidance on fertiliser and amendment needs. Soil nutrient tests also play an important role in providing ongoing environmental monitoring and quality control.

To many practitioners, however, one of the more confusing areas of turf management is the interpretation of soil test results. The AGCSA, through its technical division AGCSATech, provides the Australian golf and greater sportsturf industry with a range of independent diagnostic and analytical services which includes a range of soil nutrient and plant tissue tests.

The analysis of all soil samples sent to AGCSATech is undertaken by Incitec Pivot laboratories with the interpretation of the results carried out by the AGCSATech team. To help gain a better understanding of soil nutrient testing, let's examine the various components that make up a standard AGCSATech soil nutrient report.

SOIL PH

pH is a scale that measures the concentration of hydrogen ions within the soil solution and is used to determine whether a soil is acid or alkaline. The pH of a soil is one of the most important aspects of soil chemistry and it can dramatically influence the performance of a turfgrass species being grown. pH affects the following aspects of a soil;

- Nutrient availability and balances;
- The potential for Al and Mn toxicities;
- The activity of specific microbial populations;
- The quantity of lime or sulphur to alter pH; and
- Turfgrass vigour and persistence.

When undertaking a standard AGCSATech soil nutrient analysis, two pH tests are performed using the saturated paste method. This involves one part soil being mixed with five parts distilled water. This solution is tumbled for one hour followed by about 30 minutes standing/settling time before analysis is undertaken using a radiometer. The results at this point are recorded under the pH (1:5 water) column with readings below 7 classed as acid and reading above 7 classed as alkaline. The same procedure is followed for the pH (1:5 $CaCl_2$) test with the only variation being .001m of calcium chloride is added to the sample upon completion of the initial test which is then re-analysed.

ELECTRICAL CONDUCTIVITY

The salinity of soil, or alternatively water, is measured by determining its ability to conduct electricity which is known as its Electrical Conductivity (EC). The methodology used to undertake the soil EC test is the same as described above for the pH test.

Part of the confusion surrounding the interpretation of EC results is the multiple units which EC can be recorded as, including milliSiemens (mS), microSiemens (µS) and millimhos (mhos), along with deciSiemens (dS) which is generally considered the standard term internationally. It is worth noting that;

1dS/m = 1mS/cm = 1000 µS/cm = 1mhos/cm

Salinity can also be measured as total soluble salts otherwise known as Total Dissolved Solids (TDS) which is measured in units of mg/L which is the equivalent to parts per million (ppm). It is possible to estimate the TDS from the EC reading using the following formula;

EC (in dS/m) x 640 = TDS (in ppm)

AVAILABLE PHOSPHORUS

Testing soil phosphorus levels can be a contentious issue given the multitude of tests that exist such as Mehlich, Bray, Olsen and Colwell. Each has its advantages and disadvantages and given the variability in tests and the results they can generate it is important to know which method is used and why.

AGCSATech uses the Olsen test as its preferred testing method, which was originally developed in North America in the 1950s. The optimum range of between 12 and 20 mg/kg is based on recommendations sourced from Carrow, Waddington and Rieke's publication 'Turfgrass Soil Fertility and Chemical Problems' (page 207).

The Olsen P test uses sodium bicarbonate to extract soil phosphorus. As McKie (2009) states, results should not be seen as an absolute and unequivocal determination but rather should only be used as an estimate of soil-available phosphorus levels. If, however, testing has been undertaken for several years, then the end-user can put more confidence in the results obtained (i.e.: a trend is usually of more value than one isolated individual result.)

AVAILABLE POTASSIUM

The measurement of available potassium is undertaken by a calculation based on the milliequivalent/100g result where;

Potassium (meq/100g) x 390 = Potassium (ppm)
(e.g.: 0.54 meq/100g K = 211 mg/kg K)

Similar to the available phosphorus optimum range, the available potassium optimum range is based on recommendations sourced from 'Turfgrass Soil Fertility and Chemical Problems' (page 218).

EXTRACTABLE CATIONS

The measurement of extractable cations is undertaken by mixing soil with an ammonium acetate solution at a ratio of one part soil to 10 parts solution. Suspensions are clarified by centrifugation and filtration prior to analysis for exchangeable and soluble cations using a spectrometer.

Exchangeable cations such as calcium, magnesium, sodium and potassium are measured in milliequivalents/100g. The sum of these cations can then be used as an estimate of the soil's cation exchange capacity (CEC), or in other words the ability of the soil to retain nutrients. Sand based constructions which contain little in the way of clay particles traditionally display poor nutrient holding characteristics or a low CEC.

BASE SATURATION

Hull (2008) states the theory known as 'Base cation saturation ratio', which has its origins centered on research first conducted back in the 1940's by Bear and Albrecht, suggests there is an ideal ratio or balance of exchangeable cations in the soil and recommendations of fertiliser should be made to adjust the soil to this ratio.

Table 1 outlines this ideal ratio with proponents claiming that the concept of cation balance is important to plant growth and indicate the nutrient supplying capacity of the soil. Many soil scientists however, believe the theory is nothing but a theory, with Whitlark (2009) stating "the percentages and ratios of Ca, Mg and K are simply not important for turfgrass growth, rather it's the amount of these exchangeable cations in the soil which is important."

TABLE 1: IDEAL BASE SATURATION

Calcium	65-85%
Magnesium	10-20%
Potassium	2-7%
Sodium	0-5%
Hydrogen	0-5%
Ratios	Ca/Mg <6.5:1
	Ca/K <13:1
	Mg/K 2:1

CONSISTENCY THE KEY

There is no doubt that regular soil nutrient testing plays an integral role in helping the turf manager understand plant nutritional requirements. It should be noted, however, that there are a number of variables which can influence soil test results.

One such variable is the sampling technique adopted. Consistency is the key and it is important soil samples are representative of the entire area being tested. It is also recommended the sampling depth be a minimum of 100mm deep with a minimum of 500 grams required per sample.

As mentioned earlier it is worth noting that sand-based constructions have poor nutrient holding capabilities and for these soils testing only provides a snapshot of the soil nutrient status. For these types of profiles a number of turf managers prefer tissue testing which has the advantage of determining nutrient levels within the turfgrass plant.

REFERENCES

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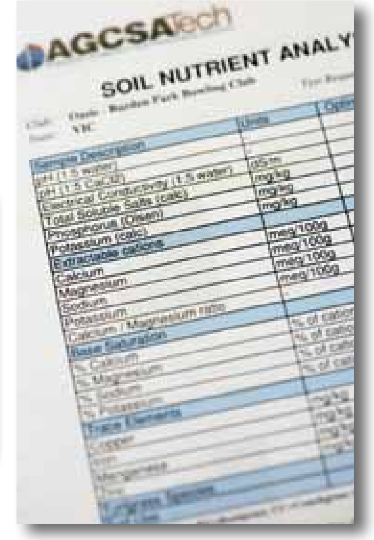
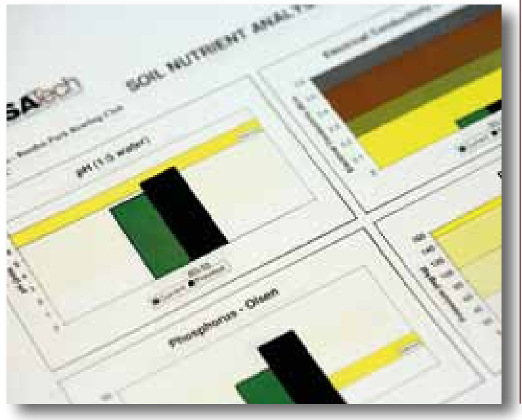


There are many components which make up a standard soil nutrient test including soil pH, electrical conductivity, available phosphorous and potassium, extractable cations and base saturation

Above: It is important soil samples are representative of the entire area being tested and sampling depths should be a minimum of 100mm deep with minimum of 500 grams per sample



Left: Regular testing is beneficial as the turf manager can compare results from previous seasons