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Soil testing: a guide to fertiliser use

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Fertilisers can comprise up to 30 per cent of farm expenditure, so it is important to use the right quantities.

Soil testing is one technique available to provide additional information on which to base fertiliser decisions. It is important to emphasise that a soil test provides only a guide to amounts of fertiliser to use. Other factors such as finance available, the cost of fertiliser, the method of application and the price of the produce, influence the best fertiliser rate.

Soil testing can be used to measure the amount of 'available' phosphorus and potassium in soils as well as acidity (pH) or salinity. There is also a soil test that will give indication of the likelihood of a response to the application of sulphur.

In WA soil tests have not been proven for nitrogen or the trace elements molybdenum, cobalt or manganese. Future research may establish soil tests for these elements and plant testing is the only method to assess these nutrients.

Sometimes fertiliser rates for individual paddocks can be recommended without the use of soil testing. The "Decide" formula used by the Department of Agriculture, Western Australia can be used for phosphorus and information on cropping history and rainfall can be used for nitrogen.

"Decide" uses superphosphate history as one influence on current requirement. If this information is unavailable, or if leaching or transport losses of phosphorus are large, soil testing can be used instead.

With potassium, large amounts can move out of the soil through leaching or plant uptake. History is therefore of little use in predicting the amount of potassium remaining in the soil, and a soil test is the most effective way in assessing the potassium status.

There are four main steps in soil testing: the collection of a representative soil sample; laboratory analysis; the interpretation of the analysis to provide a recommendation for fertiliser usage and the recording of these steps for future reference and relating them to yield.

Planning and record keeping

Good records are an essential part of a soil testing and nutrient management program:

- prepare a map showing all the areas to be sampled and assign each a permanent number to use each time the paddock is sampled
- mark features on the map that could indicate areas that should he sampled separately, e.g. slopes, watercourses, previous paddock boundaries, areas of reduced yield
- for each paddock, maintain a record of the crops grown each year, the results of previous soil tests and the amount of fertiliser applied.

Soil sampling

Sampling often limits the success of a soil test. A hectare of soil 10 cm deep contains about 1,300 tonnes of soil so that a laboratory 10 g sub-sample from a 10 hectare paddock represents only 1 part in 1,300 million! As a consequence, extreme care is needed to ensure that samples are representative.

Nutrient levels in the soil vary as a result of soil type differences and management. Most soils in WA are not uniform and many soil types can usually be found in one paddock.

Where soil differences in a paddock are obvious and where these can be treated differently, it is advisable to sample each area separately.

Even if the paddock has a uniform soil type, stock can spread soil nutrients unevenly through urine and dung. The management of the paddock can also concentrate or spread nutrients through clearing, burning and hay cutting.

Variation in an apparently uniform area can be overcome by combining many sub-samples into a single sample.

Sampling method

Sample cores are taken across the paddock using a special tool designed to regulate the depth of sampling.

Paddocks less than 10 ha

If the paddock is predominantly of one soil type, 40 cores, each to a depth of 10 cm should be taken in a zig-zag pattern across the paddock.

Where there is more than one soil type in the paddock, 20 cores should be taken from each major soil type. Each soil type should be sampled and analysed separately. The cores from each type should be bulked separately and thoroughly mixed, and then sub-sampled to provide a 500 g sample of each soil type for forwarding to the laboratory with the information sheets supplying the necessary details.

Paddocks more than 10 ha

Even in apparently uniform paddocks, some estimate of the variation should be obtained by collecting at least four separate samples each of 20 cores from separate parts of the paddock. Where differences in soil are obvious, 20 cores should be collected from each major type.

Short cuts in sampling such as taking only one or two cores, a handful, or a spadeful of soil will give misleading results.

It is important to avoid contaminating the sample and equipment with fertilisers or other sources of nutrients.

Equipment

Use a sampling tube or “pogo.” Samples cannot be accurately taken with a shovel or trowel. The tube makes it relatively easy to:

- obtain a core of soil
- consistently sample to the proper depth in loose soil by tilting the sampler after vertical insertion to avoiding the loss of soil at the bottom of the sample.

Collect the cores in a clean, plastic bag attached to the top of the sampler by an elastic band or held in place by hand. Do not use containers that have been used for chemicals as chemicals can also contaminate the sample.

Prepared soil sampling kits are produced by a number of manufacturers. These are available from most rural supply stores. If using one of these off-the-shelf kits, read the instructions carefully as they may have specific sampling instructions.

Depth of sampling

In most soils the nutrients are concentrated in the plough layer, so only the top 10cm is sampled. For most annual horticultural purposes the sampler is 20 cm deep. However, in specialist perennial horticultural enterprises such as vineyards, you should consult specific soil testing procedures for the particular crop to avoid meaningless results.

Depth of sampling must be controlled, as in most soils the concentration of phosphorus and potassium decreases rapidly down the profile.

Sampling pattern

The sample must truly represent the area being sampled:

- take at least 5 (preferably more) cores per hectare, covering the entire area
- remember that a hectare is 100 m by 100 m and to take 5 samples diagonally will involve taking samples about 30 metres apart, so a zig zag pattern will be more than this
- avoid fertiliser bands from the previous year and clumps of manure
- note in your records the pattern that you select as repeating sampling in future in the same manner will give a better picture of the trends in your soil.

Time of sampling

The amount of nutrients that can be extracted from the soil varies markedly during the season as a result of plant accumulation, decomposition and changes in soil moisture. When soil samples are collected in spring, a large proportion of available nutrients is still in the plant, and does not return to the soil until after decomposition when the amount available to subsequent crop or pasture increases. Most comparisons are based on mid-summer (January to March) sampling when the soil is dry. Test at the same time of the year to help improve your ability to compare results between years.

Analysis

The analysis of soil samples in the laboratory is usually very accurate. Errors in the soil test are mainly caused by poor paddock sampling techniques or in the interpretation of the analysis.

Analytical services

A number of laboratories handle routine soil testing and plant analysis. The Government Chemical Laboratories analyse a wide range of substances including soil samples. They offer no interpretation or recommendations and these would have to be obtained from advisers of the Department of Agriculture, Western Australia. Other organisations provide their own interpretations.

Calibration and interpretation

Chemical analysis gives the concentration of extractable nutrient. To relate this to fertiliser needs requires a comprehensive field experimental programme relating soil test values to crop and pasture fertiliser needs. This information is available for phosphorus on wheat and pastures, and for potassium on pastures.

The quantity of fertiliser needed is modified by method and time of placement, type of crop or pasture and economic considerations such as cost of fertiliser and the value of the product. As the "Decide" method of phosphorus recommendation incorporates these factors, soil testing used with "Decide" will give the best estimate for phosphorus usage.

Soil testing can be used to define whether a paddock or soil type has enough potassium or phosphorus for growth of pastures. If soils are deficient, the soil test can be a guide to the quantity of fertiliser needed, for details see Farmnotes 74/2001 Potassium for high rainfall pastures and 75/2001 Soil test and phosphorus rate for high rainfall pastures.

No soil test is yet available for predicting the potassium requirements of crops. Because they are deeper rooting than pastures, crops suffer from potassium deficiency only in restricted areas such as the deep grey sands of the West Midlands.

Routine soil testing for copper, molybdenum, manganese, iron, calcium, magnesium and boron is not feasible due to lack of local research or the nature of the nutrient systems.

Although not routinely tested, zinc can be analysed and results assessed by consulting Farmnotes 57/1995 Soil testing for zinc in wheat production, 58/1995 Soil testing for zinc in subterranean clover production and 56/1995 Soil testing for copper and zinc.

Soil pH affects the availability of some plant nutrients. Soils which are acidic may contain relatively high concentrations of manganese and aluminium which reduce plant growth. For details on liming application rates, see Farmnote 70/2000 Looking at Liming – consider the rate.

Liming of soils of higher pH may induce a number of nutrient deficiencies including copper, iron, manganese and zinc.

Measurement of soil salinity is usually provided by commercial laboratories when analysing soil phosphorus and potassium. It is of no direct value in predicting fertiliser needs. It does indicate areas of low productivity which do not warrant the use of expensive fertiliser. A soil test for salinity or total soluble salts can also provide an early warning of potential salt affected areas.

Additional information on soil sampling, analysis and interpretation is available from Department of Agriculture officers and commercial organisations involved in soil testing.

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