DIAGNOSING SANDY SOIL CONSTRAINTS: NUTRITION

FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN AND WESTERN REGIONS

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Crop nutrition for sandy soils

KEY POINTS

- Nutrient supply is a common and important limitation to crop production in sandy soils
- Understanding the extent and severity of nutrient constraints through soil and plant analysis is the first step in working out which nutrients and how much need to be added to achieve yield potential
- Knowing your yield potential, especially if other constraints have been ameliorated, allows you to benchmark the performance of crops and consider the yield gap that might be closed
- Meeting the crop's nitrogen (N) requirement (and other nutrients) is essential to close the yield gap and extract the most profit from soil amelioration

Photos: M. Fraser.

Sceptre wheat, sown 24 May 2022, with district practice fertiliser applied (left) and with an additional 55 kg/ha of nitrogen applied up to GS30.

Sandy soils are often infertile and nutrient deficient because they are highly weathered, low in carbon and have a poor ability to retain and cycle nutrients. Amelioration of soil constraints such as high soil strength, water repellence or acidity increases the yield potential of crops, but the crop's increased nutritional requirements need to be met to realise the new yield potential.

The key considerations when assessing nutrient status of sandy soils are:

- **WHAT ARE THE LIMITING NUTRIENTS?**
  The most common limiting nutrient in sandy soils is nitrogen (N), but there can also be deficiencies of phosphorus (P), potassium (K), sulfur (S), zinc (Zn), copper (Cu), manganese (Mn) and molybdenum (Mo). The methods available to identify which nutrients are limiting include soil and plant testing and in-crop test strips.

- **WHERE ARE THE CONSTRAINTS?**
  Like other constraints, it is critical to understand how nutritional deficiencies vary across soil types within the paddock (for example dunes, mid-slopes and flats). Collect 0-10 cm soil samples from strategic diagnostic zones and send to an accredited laboratory for analysis (see Useful Resources below for details). Where tillage has been used to treat physical and chemical constraints, collect soil samples after amelioration to determine the impact of dilution and/or mixing of the nutrient rich topsoil.

- **HOW SEVERE IS THE CONSTRAINT?**
  The severity of the deficiency, as indicated by soil and plant tests, will inform the amount of fertiliser required to correct it. See Table 1 for a generalised guide of soil test thresholds for sandy soils. Use these diagnostic criteria to assess the severity of nutritional constraints and assign a Sandbox score for each paddock diagnostic zone. Alternatively, consult your agronomist.

TABLE 1. Guidelines of nutrient limitations based on critical values for laboratory soil tests for nitrogen, phosphorus, sulfur, potassium, zinc and copper.

Sandbox Score	Severity	N kg/ha per t target yield	mg/kg Colwell P	mg/kg KCl-S,	mg/kg Colwell K	mg/kg DTPA Zn	mg/kg DTPA Cu
0	Sufficient	> 40	> 18	> 4.1	> 49	> 0.27	> 0.23
1	Marginal	20 - 40	14 - 18	2.3 - 4.1	31 - 49	0.13 - 0.27	0.16 - 0.23
2	Deficient	< 20	< 13	< 2.2	<30	< 0.12	< 0.15

[1]Soil test thresholds for N, P, K, S are derived from https://bfdc.com.au/interrogator/frontpage.vm and for Zn and Cu from Peverill et al. (1999). Note that soil testing for manganese and molybdenum availability do not have reliable thresholds.

Addressing deficiencies

When deciding how best to address nutrient deficiencies after amelioration, it is important to know the new yield potential you are targeting. Crop yield potential is largely driven by rainfall and can be calculated using long-term average rainfall records. According to Sadras and Angus (2006) the potential yield for wheat is;

- Potential yield (kg/ha) = 22 × (crop water-use - 60) *1.12

The crop water use is estimated as the growing season rainfall (April-October mm) plus 0.25 x summer rainfall (December to March mm). The 1.12 multiplier assumes that the grain yield is reported at 12 per cent moisture content (Hunt and Kirkegaard, 2012).

The profitability of commercial crops is usually optimised at about 80 per cent of the yield potential (Hochman et al, 2012). This is because the cost of extra inputs to achieve the last 20 per cent of yield exceeds the value of the grain. So, the yield potential needs to be multiplied by 0.8 to determine the attainable or target yield.

The difference between your actual yields and the attainable yield is termed the 'yield gap'. This gap is caused by soil constraints as well as weeds, pests, diseases and suboptimal agronomy.

Ameliorated sands have fewer constraints, greater potential and attainable yields, and a higher N requirement compared to the site before amelioration.

Of course, crop yield potential depends on seasonal conditions, especially rainfall. Potential and attainable yields can be estimated before sowing using long-term average rainfall data (Table 2), but these need to be reviewed during the season to inform post-emergent N applications.

TABLE 2. Estimates of yield potential, attainable yield, and nitrogen (N) requirement for attainable yield based on long term rainfall at sites in SA and Victoria. Examples of actual and yield gaps are also included.

Site	Yield Potential (t/ha)	Attainable Yield (t/ha)	Total N requirement for Attainable Yield (kg/ha)	[A] Actual Yield (t/ha)	Yield Gap (t/ha)
Buckleboo	3.1	2.5	100	1.4	1.1
Bute	5.6	4.5	180	3.6	0.9
Koolonong	3.2	2.6	104	1.3	1.3
Murlong	4.5	3.6	144	0.4	3.2
Pinnaroo	4.0	3.2	128	1.9	1.3
Sherwood	7.4	6.0	240	0.9	5.0

[A]Yield specific to the constrained sand, not the whole paddock

Nitrogen requirement

The nitrogen (N) requirement or demand for a cereal crop at 11% protein is usually estimated as;

- N requirement (kg/ha) = attainable yield (kg/ha) x 40.

This N demand can be met from the mineral N pool in the soil at the start of the season (ie ammonium and nitrate tests), from mineralisation during the growing season (i.e. the release of N from soil organic matter), and from fertiliser or other N containing amendments (e.g. composts, manures etc.). Further information on estimating your N requirement is available from Unkovich et al. (2020).

An estimate of the N requirement for the attainable yield at key sandy soils sites is shown in Table 2. This scenario represents all the yield gap being closed. It is possible that an amelioration treatment will initially allow the crop roots to access nutrients in deeper layers (for example leached N) and the fertiliser requirement does not change. However, with sustained increases in yield, the crop will eventually require a higher level of inputs. Where the amelioration does not reliably close all the yield gap, the attainable yield and associated N requirement should be recalculated.

USEFUL RESOURCES

Back Pocket Guide: ***Soil and plant testing for profitable fertiliser use***
grdc.com.au/soil-plant-testing

GRDC fact sheet: ***Soil testing to determine fertiliser applications***
grdc.com.au/soil-testing-to-determine-fertiliser-applications

GRDC fact sheet: ***Soil testing for crop nutrition*** **(Southern Region)**
grdc.com.au/GRDC-FS-SoilTestingS

GRDC fact sheet: ***Soil Testing for Crop Nutrition*** **(Western Region)**
grdc.com.au/GRDC-FS-SoilTestingW

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MORE INFORMATION

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