Results of the soil treatments at the Lillecrapp's farm

The South East Natural Resources Management Board (SE NRM Board) has been implementing an Enhancing Soil Health project during 2010 - 2013, with funding provided by the Australian Government Caring for our Country program and the SE NRM Board.

As part of this project, the SE NRM Board is supporting demonstration sites on the Lillecrapp family's property at Joanna. A demonstration farm is not a scientific trial; rather it tries to measure things that are happening in working farm situations.

The Lillecrapp family has been applying a lot of different treatments to the soil on their farm over the last decade. These treatment sites are being used by the Enhancing Soil Health project to test soil conditions such as carbon content and acidity levels following the treatments

THE LANDSCAPE

The land at the Joanna demonstration farm is an undulating plains landscape, comprising a variety of soils including sand over clays, loam over clays, red clay loams over calcrete, and deep sands. The soils range from moderately fertile (red clay loam) to very infertile (sandy surfaced).

WHAT ARE WE MEASURING?

A variety of treatments on the farm that can potentially influence soil pH, soil hardness and / or soil fertility are being measured. These treatments include:

- Surface liming, and
- Ripping / mixing the soil profile using a clay delving machine, a spader machine, and a ripper.
- No till cropping,
- Various grazing regimes,
- A range of fertiliser treatments

Various measurements have been taken over a 12 month period at the demonstration sites and these have included:

1. Soil sampling at different depths (0-10cm, 10-30cm and 30-40cm) to test for pH, **aluminium (Al)**, total organic carbon (TOC), cation exchange capacity (CEC), **phosphorus (P)**, **potassium (K)** and **nitrogen (N)**
2. Soil properties (texture, colour, pH, horizon depth)
3. Penetrometer tests
4. Yields from pastures or crops
5. Plant tissue testing

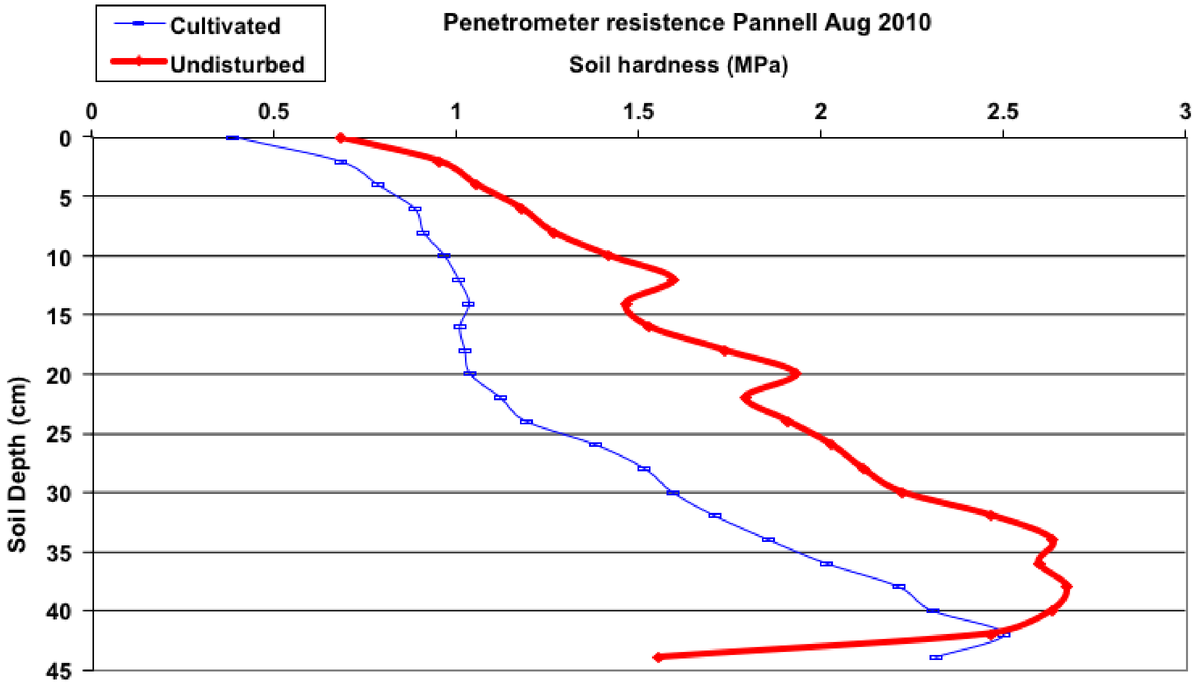
THE RESULTS TO DATE

Physical

The soils with strong texture contrasts (all the paddocks except one) featured structureless surface soils over clays of variable qualities. Some of the clay subsoils were sodic and coarsely structured, while others were non-sodic and relatively friable. All the clay subsoils were likely to perch water above them to some degree. Some of the sand over clay soils had strongly bleached sub-surface layers with ironstone gravel present. This feature commonly inhibits root growth into the sub-soil.

A soil penetrometer was used to measure the effect of the various treatments on soil hardness. The measurements of the paddocks showed that the cultivation of the soil, whether by ripping, spader or delver, resulted in a significantly softer soil to a depth of 40cm than that found in undisturbed paddocks. This is illustrated in Graph 1 below.

Graph 1

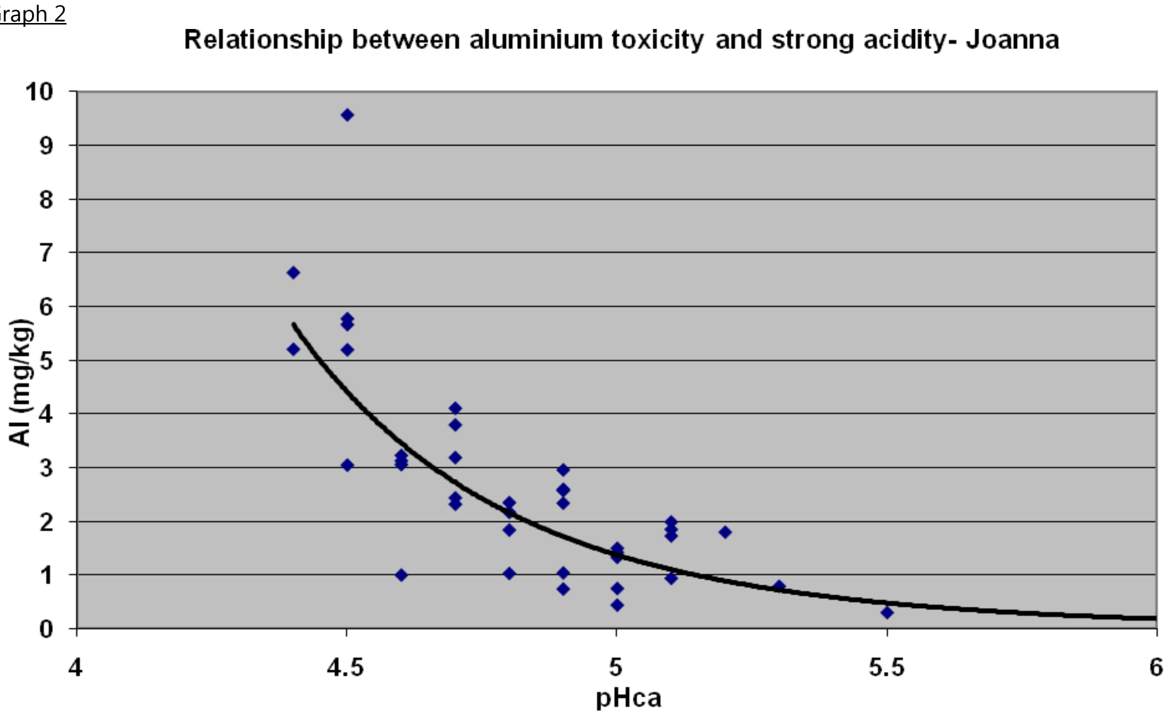


Chemical

Some useful soil chemical relationships have been observed on the Joanna Demonstration farm. There was a relationship between pH and extractable aluminium (Al). The aluminium measure here (in parts per million or ppm) represents the soluble aluminium in the soil. Soluble aluminium is toxic to plants and affects fine root hair development, resulting in short and stubbly root growth.

Soil layers with high soluble aluminium are sometimes referred to as chemical hardpans due to the way that they block root growth. As illustrated in Graph 2 below, as the soil pH declines and becomes acidic, aluminium becomes increasingly more soluble. A pH_{ca} of 5 represents a useful threshold below which aluminium becomes increasingly problematic, with an aluminium content above 2ppm likely to affect sensitive plants.

Graph 2

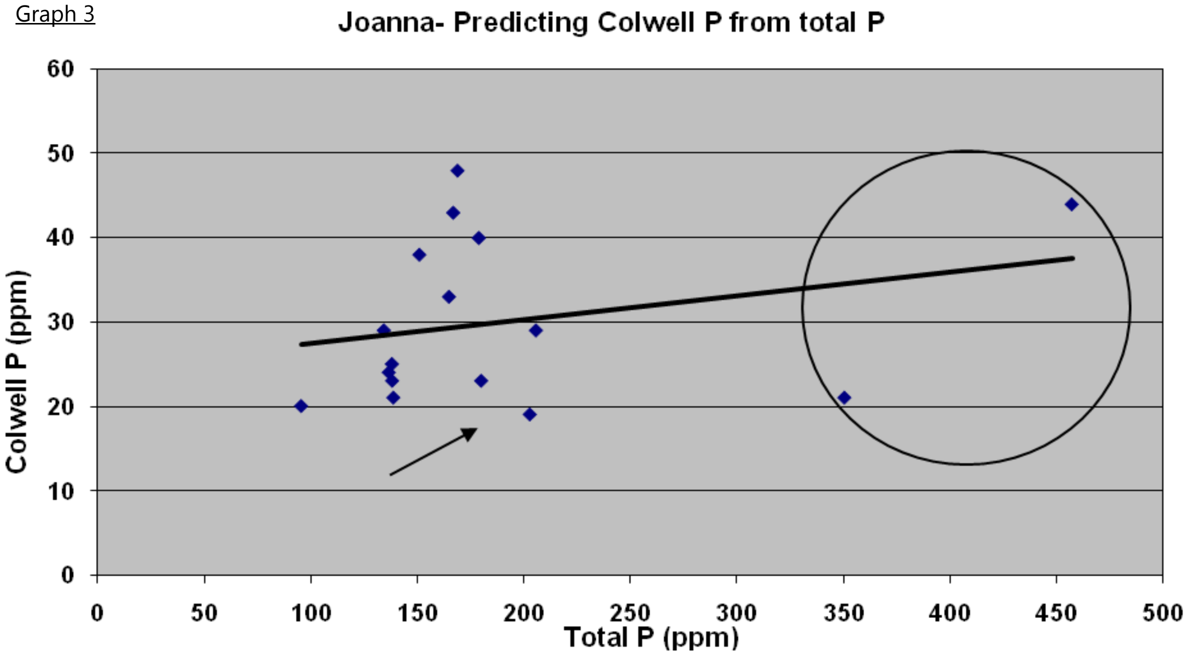


Phosphorus

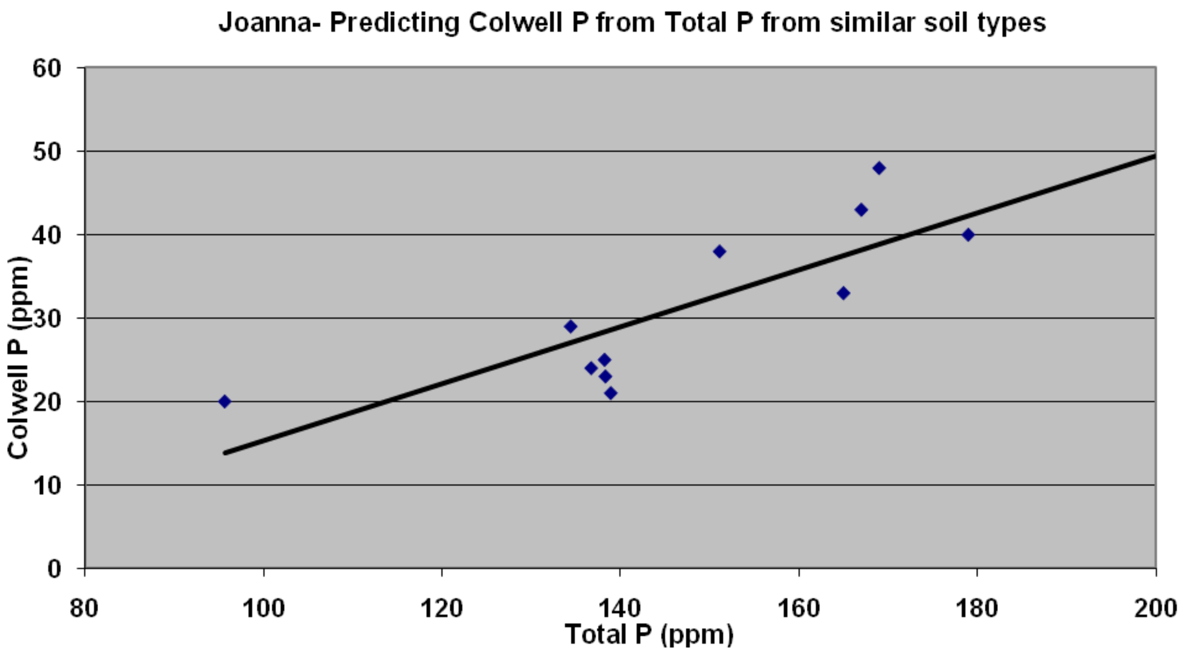
Colwell extractable phosphorus provides an indicator of soil phosphate that can be rapidly released to the soil solution where plants can access it. Numerous field trials have been used to calibrate the Colwell phosphorus measurement, and on red gum soils used for dryland cropping and pastures, a critical level of around 25 ppm has been established as the point above which plants will not be limited by phosphorus.

Using Graphs 3 and 4 below, it may be possible develop a phosphorus balance for a paddock to predict when the availability of phosphorus crosses this critical threshold as phosphorus is either added through fertiliser or removed in crops. As can be seen on the graphs, the relationship between Colwell phosphorus and total phosphorus is highly sensitive to soil type, and one needs to be sure that the soil types being compared have similar properties.

Graph 3



Graph 4



BIOLOGICAL

The pasture yields did not show any strong indicators of treatment differences. The highest yield was achieved by one of the control paddocks, with 9 tonnes/ha of dry matter produced between May and November 2010. The soils between paddocks were quite variable, particularly in depth to clay and this is likely to confound any small treatment effects.

The delved and spaded paddock resulted in the crop becoming quite yellow, and this may have been indicative of a nitrogen deficiency. The dilution of surface nutrients and organic matter with highly infertile sub-surface soil often causes nutrient issues that should be addressed if best results are to be achieved.

Strong soil acidity also has a direct negative impact on soil biology, and can reduce nodulation of legumes, particularly on lucerne. In the South East, the red gum soils found south of Frances have a strong susceptibility to becoming strongly acid, and of the 9 demonstration paddocks, all of them had a layer with a pH_{ca} value of less than 5. Once a soil has received sufficient lime to neutralise existing strong acidity, lime should be applied in the order of 100-150kg/ha/year to match the acidification rate of agricultural production on these soils. Soils can become very difficult to fix once acidification has been allowed to proceed to a point where plant yields are affected.

The clay delved paddock before and after working in the clay with the spader.

OTHER SOIL NUTRITION OBSERVATIONS

Nitrogen and sulphur showed up as being deficient in some of the plant tissue tests. It was difficult to determine whether these results were directly influenced by the soil treatments or whether they were more a product of soil type and paddock fertiliser history. It is possible that the mixing of the soil with the spader diluted surface nutrition enough to induce the deficiencies.

Colwell extractible potassium appeared to be low in most of the soil tests on the sandy surfaced soils. Sandy soils are problematic for potassium management unless the clay layer is shallow. The clay layer can often supply adequate potassium levels if sufficient root growth develops to that depth.

If you are interested in finding out more about the Enhancing Soil Health Project please contact Natural Resources South East by phone on 08 8735 1177 or by visiting the South East Natural Resources Management Board's website **www.senrm.sa.gov.au**