# Results of the soil treatments at the Peuckers' farm

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

As part of this project, is the assessment of paddocks on the Peuckers' farm to investigate a range of soils to determine what makes some more productive and resilient than others. This will be done by assessing different treatments types, including irrigation, clay spreading and delving, to determine their effect on soil properties. This assessment is not a scientific trial; rather it tries to measure things that are happening in working farm situations.

The Peuckers have been applying different treatments to the soil on their farm over the last few years. The Enhancing Soil Health project will test soil conditions such as carbon content, fertility, density and acidity levels under different paddock treatments.

## THE LANDSCAPE

The land at the Mingbool Demonstration farm is mostly in the Young Land System which consists of a poorly drained sand plain to the north of the Forest Ridge land System. Dominant soils include highly leached podsols, thick sand over clays, deep sands and some smaller areas with heavy soils including peats. The Forest Ridge in the south of the property is dominated by shallow loam and sandy loams over calcrete with some deeper sand.

## WHAT ARE WE MEASURING?

A variety of treatments on the farm that can potentially influence soil pH, fertility and soil density. These treatments include:

- Surface liming,
- Mixing the soil profile using a clay spreading and delving machine,
- Different pastures species
- Use of pig effluent and chicken manure

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. Bulk density and penetrometer tests
4. Yields from pastures or crops
5. Plant tissue testing

Paddock Treatments assessed included:

Pad 1 – Lucerne paddock - irrigated, some pig effluent applied

Pad 2 – Cropped and clay spread/potatoes - some effluent

Pad 3 – Not clay spread, has had dolomite and chicken compost applied

Pad 4 – Comparison of delved and not delved (all has been clay spread now), delving aims to bring up P rich coffee rock layer, dolomite and gypsum 2010 + some chicken manure 2008

Pad 5 – Loamy soil phalaris, dolomite 2008, some chicken manure, periodically hay cut

Pad 6 – Irrigated willow paddock, irrigated, some pig effluent

A deep sandy podsol with coffee rock over clay at depth

## THE RESULTS TO DATE

**Physical**

Sandy soils are often the most vulnerable to the development of hard pans and compacted layers.

Figure 1 below shows the bulk densities under 5 different paddocks included delved (del) versus control (C)

As a general rule, soil density becomes an issue for root growth around 1.6 gms/cm$^3$. The lucerne, irrigated lucerne and control (no delving) paddocks all had subsoil layers close to or at this level. The delved area is well under the 1.6 gm/ cm$^3$ threshold as is the loamy soil over clay. Delving has reduced the bulk density.

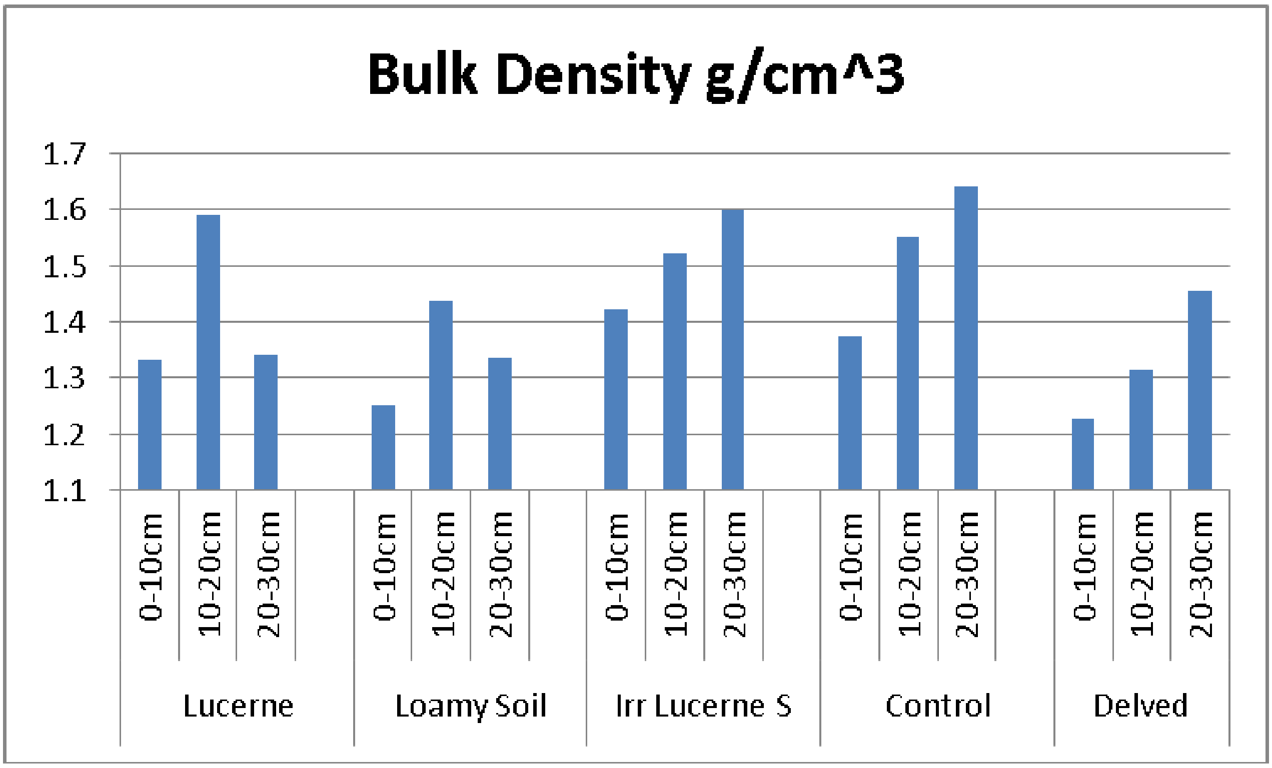


**Fig 1 –** Bulk Densities of paddocks/ treatments

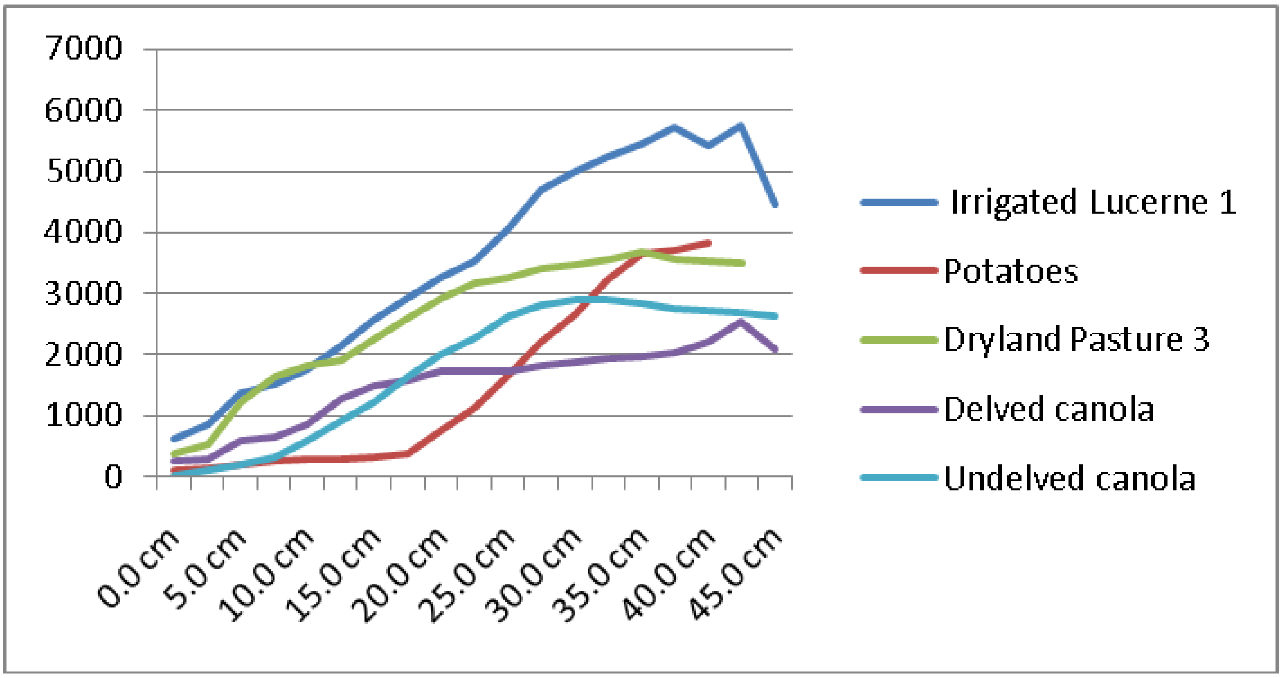


**Fig 2**– Penetrometer resistance to soil depth by paddock treatment/ use

Soil physical strength was also measured using a penetrometer during winter when the soil was wet. As a generalisation, the strength of the soil from penetrometer resistance is considered restrictive for root growth when the level passes about 2500 to 3000 kPa. The highest level was detected under the irrigated lucerne and the lowest under the delved canola. Resistance was greatest at about 30 to 50cms in depth.

**Chemical**

There were some useful soil chemical relationships observed at the Mingbool Demonstration Farm.

**Acidity**

pHCa and Exchangeable Al are shown in Figure 3 below for all paddocks. 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.

Al increases sharply when soil pH falls below pHCa 5.0. When examining paddocks individually, acidity was only an issue in those paddocks not irrigated and in most cases acidity is now lowest in the subsurface layers. This is in part because soils have been limed and surface pH increased on paddocks 4 and 5. pHCa 5.0-5.5 seems to be a good target on these soils. Subsoils levels need to be addressed as well.

Most layers in the irrigated paddocks are now between pHCa 6.0 to 7.0.

Strong soil acidity also has a direct negative impact on soil biology, and can reduce nodulation of legumes, particularly lucerne which is considered sensitive.

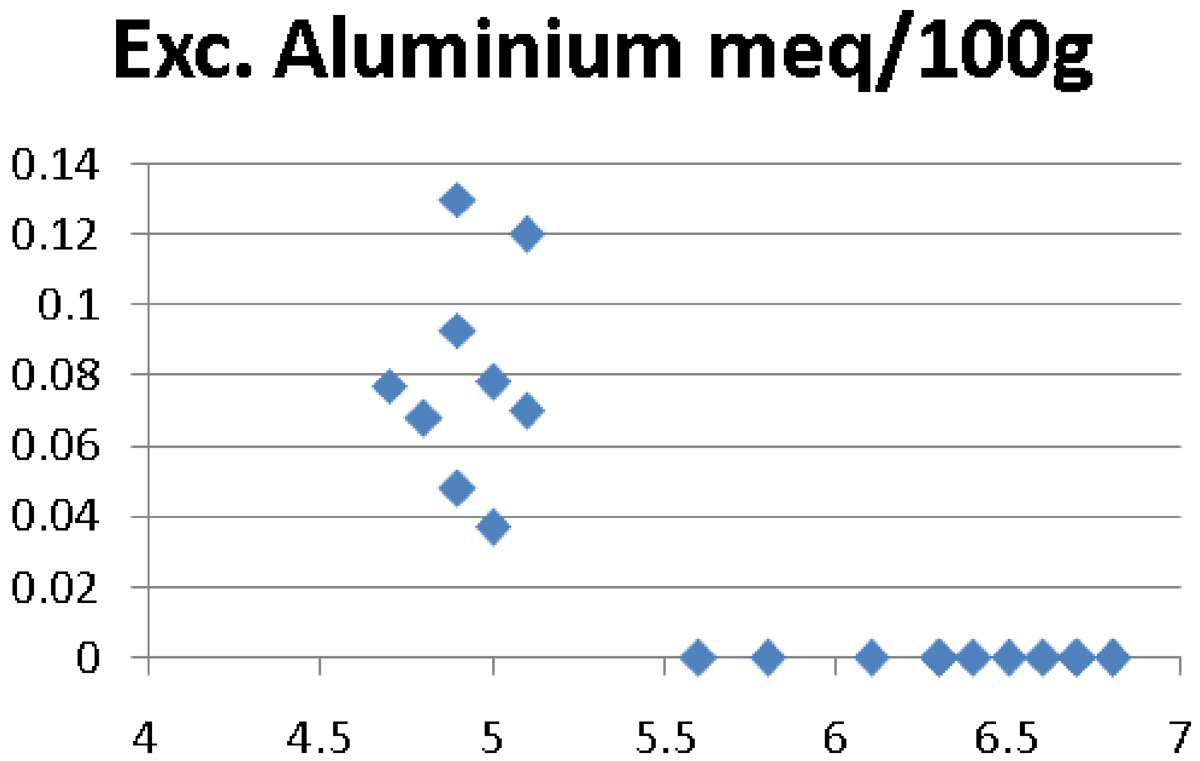


**Fig 3**– Exchangeable Al versus pHCa

**Phosphorus**

Colwell extractable phosphorus provides an indicator of soil phosphate, which 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, although on sandy leaching soil there is still some debate about critical levels. The Phosphorus Buffering Index (PBI) has been developed to use in conjunction with the Colwell P test. PBI supports Colwell P analysis by providing a measure of "tie up" and leaching potential.

High PBI levels (greater than 150-200) indicate a strong potential for "tie up" and a significant proportion of P applied will be unavailable to plants. A very low PBI (below 40) indicates that there may be potential for phosphorus to leach (these soils generally have low Colwell P levels as well).Other indications of leaching, which are evident on the sandy soils, are where the Colwell P is high in the 10-20cm and 20-30 cm layer. In paddock 4, an analysis of the iron rich layer (coffee rock) at around 50cm indicated it had a Colwell P of 274ppm indicating significant leached P had got to this layer and was fixed to the **iron (Fe)** here.

In Figure 4 above, the PBI level varied from 5 to 20 on the sandier soils to around 100 on the loamy soils. The critical Colwell P, adjusted for the PBI as per the soil testing fact sheet, would change the critical Colwell P levels as per the following which indicates critical/target levels for the different paddocks.

The clay spreading has increased the PBI slightly in the surface layer. Using these modified Colwell (from PBI) 0-10cm the Willow irrigated paddock (P6, 12ppmP) and the loamy paddock (P5, 22ppmP) came out as low while the other paddocks were either right on the critical level or above indicating good P histories.

**Chicken Compost and Pig Effluent**

Several paddocks have had chicken compost or pig effluent applied. Without more information it is hard to determine how effective this has been.

| PBI | Adjusted Critical Colwell P for pastures | Paddocks Categorised by PBI |
|---|---|---|
| <15 | 23 (20-24) | Deep sands |
| 15-35 | 26 (24-27) | Sand clay spread |
| 35-70 | 29 (27-31) | |
| 70-140 | 34 (31-36) | Loamy soil phalaris |

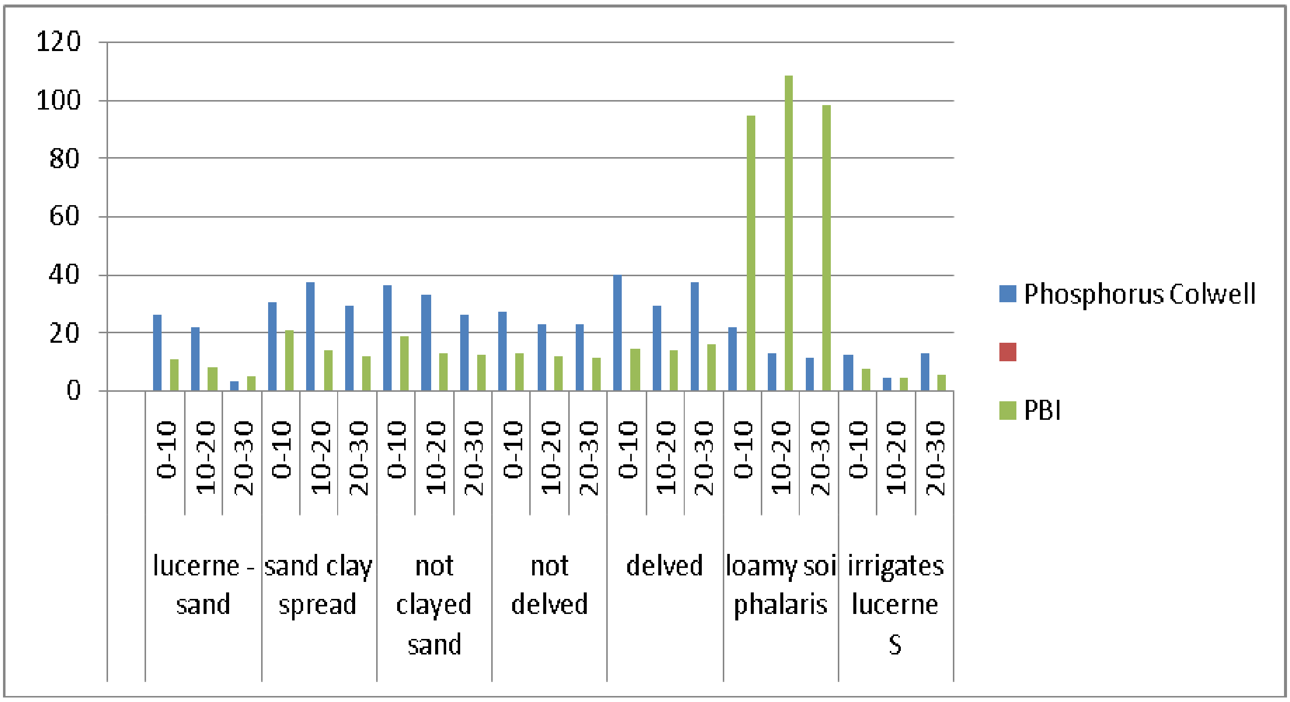


**Fig 4 –** Colwell P and PBI by soil type and depth

Table 1 below identifies typical available nutrient content (%) of various manures at 50% moisture, double figures for dry weight (from Glendinning, J S (2000)):

| Source | N | P | K | Organic Matter |
|---|---|---|---|---|
| Chicken | 0.8-2.6 | 0.6-2.0 | 0.4-1.2 | 30-35 |
| Pig | 0.6-1.2 | 0.5-0.8 | 0.4-1.0 | 15-20 |

Table 1 – Nutrient content in manures (%)

Using a product at 1.5%P, you would need about 600kg/ha to get same P as single super at 100kg/ha. This would also give you up to 15-20 kg of N and 6 kg of K, although significant amounts of N in manures (up to 50%) can be volatised.

*Manures and effluent will be released more slowly than most fertiliser depending on the rate of breakdown of manures which in these sandy soils is an advantage.*

**Potassium**

Potassium levels were consistently low in surface areas on sandy soils, even when clay spread and even though some fertiliser K has been applied (around Colwell K 40-90ppm). The loamy paddock had better K levels, at 139ppm. Critical levels are around 100-120ppm for sandy soils and 120-140ppm for loamy soils. In recent times a 5:1 fertiliser has been used regularly. Plant tests of the canola paddock, including both the delved and un-delved sites, indicated K to be well below the adequate range. This analysis suggests K is limited in several of the sandy soil paddocks and the addition of clay has not increased it enough. The loamy paddock is also getting close to critical levels particularly if cut for hay.

**Nitrogen (N) and Sulphur (S)**

Large variations were observed when looking at total available N and S to 80cms, see Figure 5 below. Interestingly, the highest N was under lucerne (a legume), the loamy phalaris paddock and where the delving had occurred. (delving may have caused some mineralisation).

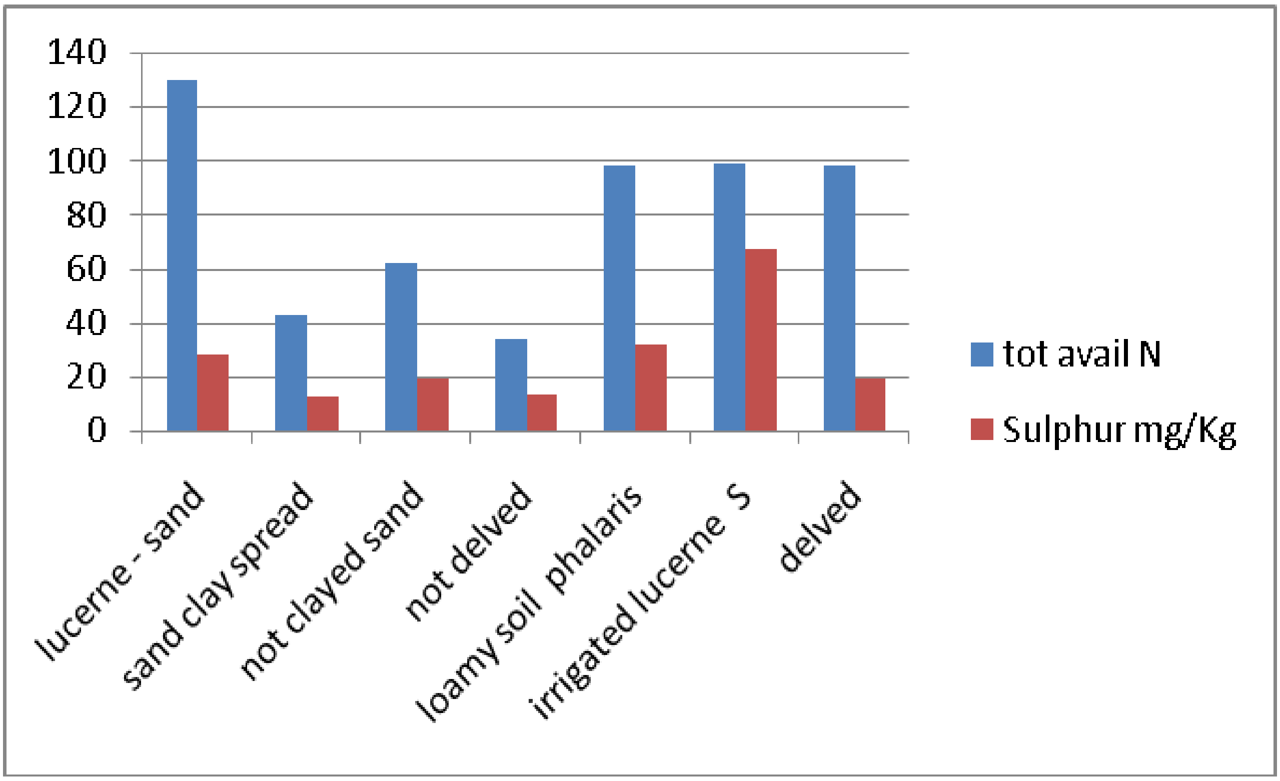


**Fig 5** – Total Available N and S to 80cms

**Carbon**

Interest has grown in the amount of carbon soils hold and whether management can affect it. Figure 6 below highlights organic carbon levels by paddock/ treatment. The highest levels of organic carbon occurred in paddocks with finer textured soils (loamy phalaris) and paddocks which have been under long term irrigated pastures (eg Lucerne). In comparison, cropped paddocks were generally lower in organic carbon levels. Levels of carbon great then 2 – 2.5 would generally be considered good for sandy soils.

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

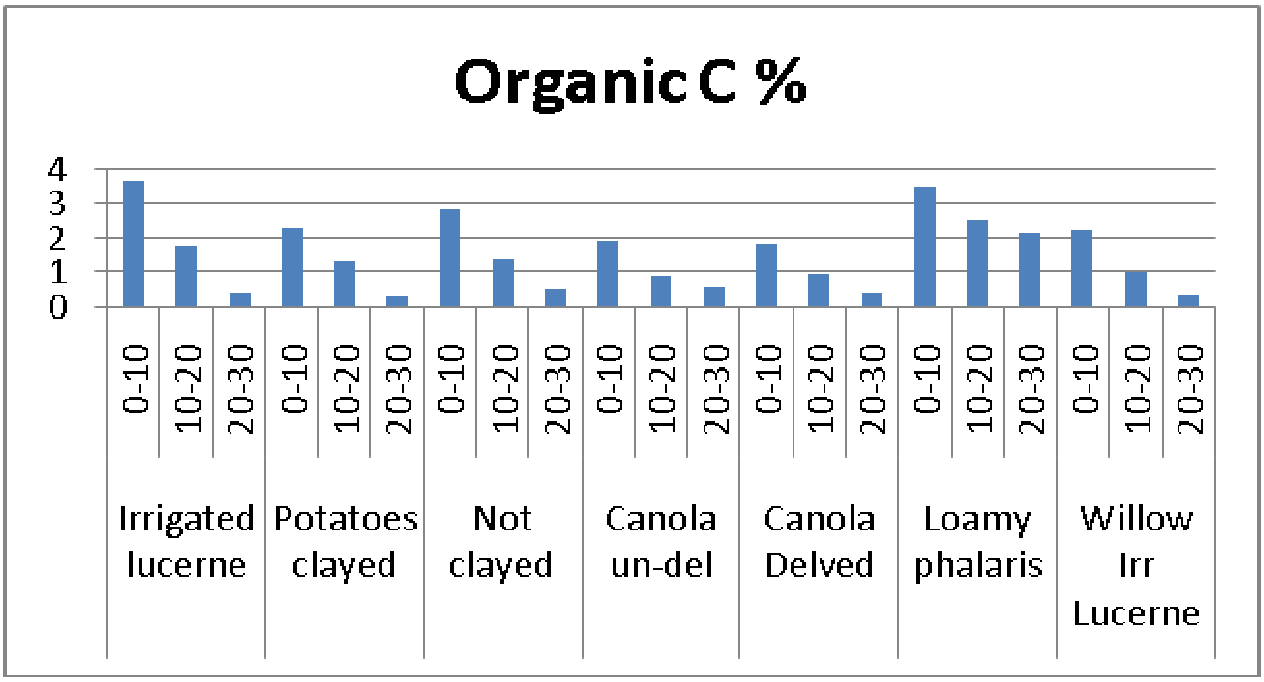


**Fig 6** – Carbon levels by paddock and depth (cm)

**Other Nutrients**

Soil testing was undertaken for trace elements using the EDTA method. While noting, there are limiting factors when testing for trace elements, and recognised critical values are yet to be established. However for the purpose of this project, "ball park" target figures for trace elements were used.

It was identified there were low levels observed for copper in the loamy phalaris paddock and the willow irrigated lucerne paddock, for zinc in the loamy phalaris paddock and 'marginal' levels for manganese in the delved canola paddock (See soil test interpretation guide for levels).

Plant tests undertaken for the willow irrigated lucerne paddock came back as 'marginal' for potassium and copper. No low manganese or zinc was observed in the plant tests in the canola and willow lucerne paddocks.