More to claying than clay

GRAEME JENNINGS

'Claying', incorporating clay into non-wetting or otherwise inhospitable sandy soils, may have greater benefits than previously recognised.

Research led by Rural Solutions SA Senior Consultants Amanda Schapel and David Davenport aims to identify, quantify and maximise the results from claying.

One of the benefits being explored is the potential to increase soil organic carbon.

Increases in plant growth are usually observed following claying and this increased plant growth could be expected to lead to higher soil carbon levels, Amanda said. However, it is becoming increasingly clear that this is far from the only mechanism at play, with differences in the type and amount of clay and how it is incorporated also influencing outcomes.

"Increasing the clay content of sandy soils can significantly improve crop performance but results are inconsistent. The reasons for this variability are not clear but there are indications that the amount of clay applied and the depth and evenness of incorporation are at least as significant as the characteristics of the clay or the sand targeted for improvement.

AMANDA SCHAPEL.

DAVID DAVENPORT CHECKING CROP GROWTH IN A 'CLAYED' PADDOCK.

"Claying is an expensive process and we want to identify the modification practices that will maximise the economic returns farmers can achieve from investing in claying.

"We are working to determine the clay-related factors that directly influence crop productivity and what changes to soil organic carbon occur after addition of clay to sandy soils. We also aim to quantify the potential for increased carbon build up after claying and to identify how crop and paddock management can be modified to improve soil carbon levels, crop performance and farm economics," she said.

Part of Amanda's work will be used in her PhD studies on the relationship between clay and carbon content in the soil, but the scope of the research project is far wider than that. The primary aim is to identify the factors driving improved production outcomes and provide growers with good, science-based advice on which soils are most likely to benefit from claying and the most appropriate claying technique for each soil.

Amanda is optimistic that at least some of this practical information, including a better understanding of the significance of clay chemistry in claying outcomes and the factors that can influence the level of economic benefit from the procedure, will be available by the end of this year.

Claying is an expensive process – we want to identify the modification practices that will maximise the economic returns.

"We are looking at what growers can do to improve the return from claying. The economics are affected by much more than how far the clay has to be carted or how deep the deposit is below the surface. How the paddock is managed after spreading is also significant. For example, growing and incorporating a green manure crop might improve incorporation of the clay, reduce clod size and rapidly increase soil carbon content, all of which appear to improve the performance of following crops.

AMANDA SCHAPEL HARD AT WORK TAKING SOIL CORES.

"The economics can also change if adding clay makes it possible to adopt higher-value or more intensive cropping rotations. Claying can change the soil characteristics enough to make a paddock suitable for a more profitable crop than could have been grown before the soil was improved. Being able to successfully grow a good crop of canola, for example, instead of barley, could have a significant impact on the profit potential of a paddock."

According to David Davenport, when clay spreading of sandy soils was first undertaken in the South East more than 30 years ago, primarily to overcome the phenomenon known as 'non-wetting', the focus was on modifying the top 10 centimetres of the soil.

"More recently, claying has been reported to improve crop yields by 20 to 130%, increase soil fertility, reduce frost damage in wheat and improve soil structure, with farmers reporting greater increases in production where clay is incorporated deeper than 10 centimetres," he said. "However, there has been little formal research into the impacts of clay addition at depths greater than 10 centimetres.

"This is potentially an important issue, as there are about 2.8 million hectares of sandy soils in SA cropping districts including the South East, the Mallee and Eyre and Yorke Peninsulas.

"Some of these soils are deep sands. Others are 'texture contrast' duplex soils with varying depths of sand over clay or limestone. They all typically have low fertility, poor water-holding capacity, are low in organic carbon and are frequently acidic. Many are also susceptible to water repellence and have high wind erosion potential. Modifying these soils by adding clay has the potential to reduce or eliminate many of these limitations.

"Up to two million hectares of those soils contain or are reasonably close to clay suitable for claying. Where clay is not available, incorporation of nutrients and organic matter may provide significant benefits."

The findings from the claying research, which is supported by the Advisory Board of Agriculture, the Department of Environment, Water and Natural Resources (DEWNR) and Caring for our Country, will provide the foundation for the Primary Industries and Research SA (PIRSA) 'New Horizons' project. It is estimated this new initiative to 'apply advances in soil science and management', could increase broadacre agricultural production in SA by $800 million a year.

The starting point for the current research was information from SA Department of the Environment, Water and Natural Resources (DEWNR) State-wide surveys of soil characteristics undertaken as part of an on-going program to monitor soil condition. This program, headed by Tim Herrmann, manager of DEWNR's Sustainable Soils unit, also provided SA soil data for the national Soil Carbon Research Program (SCaRP).

The research team built on the DEWNR data with an audit of 60 'clayed' sites. This audit revealed a high level of variation in soils modified by the addition of clay.

"There were large differences in soil carbon levels from paddock to paddock and within paddocks but no clear indication of the reasons for that variability," Amanda said. "The data are being further analysed to determine trends but detailed analysis of two sites suggests that differences in the rate of clay applied and the depth of incorporation could be contributing factors."

DELVING CAN BE HIGHLY EFFECTIVE IN THE RIGHT CONDITIONS.

Trials comparing different claying treatments with un-treated controls on the properties of Roger Groocock, at Wirrega, in the South East and Terry Young, at Ungarra on Eyre Peninsula revealed clear differences in carbon levels under different clay modification treatments but no method appeared to consistently increase soil carbon stocks more than the others, Amanda said.

At the South East site, carbon levels were highest in paddocks where clay had been delved from a layer deeper in the soil profile or carted in and spread. At Ungarra the spaded site, where a spader was used to incorporate clay from a sub-soil layer into the topsoil, had the highest soil carbon levels.

At both sites the greatest increase in soil carbon occurred where clay was incorporated into bleached sub-surface soil layers, with the best treatments having twice the carbon level of untreated control soils.

"Growers and researchers have realised the white, 'bleached' sandy layer found immediately under the topsoil in many of these soils can significantly limit root growth and crop production and have found that deeper incorporation of clay and organic material in soils with these 'bleached', often compacted layers can increase soil carbon levels and improve crop yield potential," David said.

He believes these bleached A2 horizons may be as great an impediment to production as non-wetting topsoil, with

PRACTICAL ISSUES TO CONSIDER

The depth of topsoil above a clay-rich subsoil determines which clay addition technique is most appropriate, said David Davenport.

Soils with a clay layer more than 70 cm below the surface can be modified only with clay spreading. Clay from a horizon within 60 cm of the surface can be brought to the surface through delving, depending on the machinery available.

However, if the topsoil depth is less than 30 cm a spader may be a better option as spading distributes clay more evenly and delving shallow clay layers may result in too much clay being brought to the surface, he said.

Spading is also an excellent option to improve incorporation of clay on delved and clay spread sites and can provide additional benefit through incorporation of organic material, fertilisers and soil ameliorants such as lime.

CLAYING PART OF A BIGGER PICTURE

Claying is part of a bigger soil protection and improvement picture for Tim Herrmann, Department of the Environment, Water and Natural Resources (DEWNR) Sustainable Soils manager.

Tim and his team, who monitor soil condition across the State and provide financial and hands-on support for soil-related research projects and other initiatives, were involved in some of the preliminary work that led to the current research into claying methods and benefits.

Tim believes improving productivity of soil by claying to improve water-holding and nutrient holding capabilities, among other things, could be the next step in improving SA soils and reducing State-wide erosion risk, which has reduced significantly over the past decade.

Periodic monitoring of more than 5,000 sites across SA shows that the period for which agricultural soils in SA are adequately protected against wind or water erosion has increased from 276 days in 2003 to 332 days in 2013, an improvement Tim attributes largely to changes in cropping practice such as adoption of no-till and stubble retention.

The sustainable soils team has also identified sub-soil acidity as a compounding issue with the potential to limit crop productivity in many soils.

GROWER TERRY YOUNG CHECKS A CANOLA CROP IN A 'CLAYED' PADDOCK.

WORTH THE EFFORT: A HEALTHY CROP ON A CLAYED AND SPADED SAND DUNE.

the very low fertility levels in these layers appearing to be a significant factor. Compaction and low water holding capacity may also have roles in limiting productivity.

Amanda agrees, noting that many sandy soils considered to be candidates for claying often have high water levels in deeper soil horizons because roots do not penetrate through infertile, compacted layers.

"In soils where this layer of bleached sand is broken up and mixed with clay and the previous top soil, plant roots can be found throughout the blended upper layer, right down to the underlying clay layer at the bottom of the root zone," she said.

This increases root mass in the top 10 to 30 cm of soil, which has consistently resulted in higher yields in most trials.

The researchers have also found that roots are concentrated in and around clay 'clods' in treated soils.

"When comparing clay clods ranging from one to two millimetres to greater than 10 centimetres across we have found that the smaller clods have two to three times the carbon concentration and root mass of the larger clods," Amanda said.

"This has important ramifications for claying methodology because the size of clods is influenced by the chemical and physical characteristics of the clay, the methods used to spread and incorporate it and factors such as moisture levels when it is spread and incorporated."

Timing is also a factor.

"Claying in spring when there is more likely to be some moisture in the soil can make the clay softer and easier to work with," Amanda said. "However, too much moisture can result in the clay smearing instead of breaking up into small 'clods', which give the best results.

"If claying is done too close to seeding, particularly if a spader is used for the incorporation, the soil will not have time to settle and stabilise. This will make it hard to control seed depth and placement and achieve good seed–soil contact, which may reduce crop establishment and performance.

"Clay rate, incorporation depth and clod size all appear to affect the end results but there could also be other factors at play," David said. "We have found that adding organic matter during clay incorporation appears to further increase crop performance and soil carbon levels.

"Incorporating clay can double root mass compared with untreated control areas. Adding clay plus organic matter can treble root mass."

Given the large area that could benefit from clay modification, up to 30% of the area under agricultural production in SA and a higher percentage in WA, claying appears to offer an opportunity to increase food production without increasing the area being cropped, he said. There is also a significant opportunity to address NRM issues commonly associated with these soils.

A SPADER CAN BE USED TO BRING SHALLOW SUB-SOIL CLAY UP INTO THE TOPSOIL AND TO IMPROVE. THE SPREAD AND INCORPORATION OF SPREAD OR DELVED CLAY.