COVER CROPS AND SOIL AMENDMENTS TO IMPROVE SOIL HEALTH AND YIELD

Julie Finnigan, Serve-Ag Tasmania

Today's sophisticated potato production systems bear little resemblance to the hand dug spuds of the early 1800s.

Mechanisation, remote sensing, molecular testing for disease, variable rate irrigation and fertilisation, and other developments mean we have more control than ever over the growing environment. Yet, despite these advantages, growers are finding it harder to get the yields they once did.

This may be due to disease pressure, fewer chemical options and difficult weather conditions. Continual cropping can deplete organic matter and soil biology, destroy structure and reduce resilience. In some cases, the pressure to find fresh ground means growers are using increasingly marginal soils.

Yet, according to Julie Finnigan from Serve-Ag: "Healthy soils are the cornerstone of productive and sustainable farming systems. We need these soils to keep producing food for generations to come."

Julie presented some highlights from Serve-Ag's research on Tasmanian potato crops, looking at some of the short- and long-term options available to growers to improve their soils and sustainability.

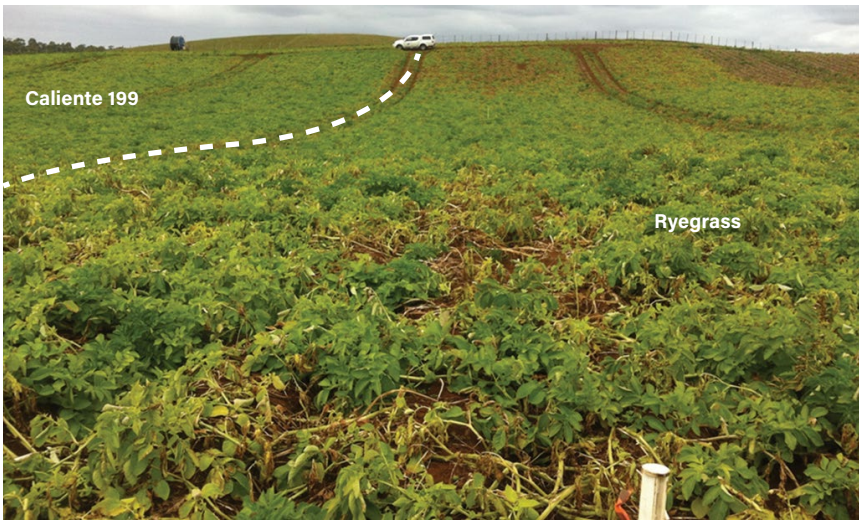

Figure 16. Potato crop growing on a field previously cover cropped with Caliente 199 (left side) or Ryegrass (centre). Note the early die off on the high bank sown to ryegrass, as well as the increased pink rot in the lower lying, wet area in the foreground. *- J. Finnigan*

COVER CROP, CAN DO

Cover crops can serve many purposes. They can help condition soils, suppress nematodes and disease, scavenge nutrients and suppress weeds.

"Many of our growers have found biofumigants to be a really big winner, especially if they outgrow weeds and volunteer potatoes," observed Julie. "A lot of these plants have really strong root systems. By improving soil structure, they not only limit the need for tillage, but make tillage easier, reducing fuel use."

Better soil structure also improves water infiltration, making irrigation more efficient.

For example, a Tasmanian trial compared yield in areas of the paddock sown with either ryegrass (the grower standard) or Caliente 199. Reduced water infiltration at the top of the bank sown to ryegrass resulted in early plant death. At the low, wet end of the paddock there was noticeably less pink rot where Caliente 199 had grown (Figure 16). As a result, yield increased from 67.4 T/ha to 74.8 T/ha, representing a 8:1 return on investment.

When brassica cover crops are macerated, sulphur compounds (glucosinolates) inside the plants react with enzymes to form gaseous isothiocyanates (ITCs). These are natural soil fumigants, demonstrated

to be active against nematodes, as well as suppressing diseases such as *Phytophthora* spp., and *Sclerotinia*.

Effectiveness depends on the variety grown, as glucosinolate content varies considerably. Factors such as plant maturity, soil moisture and how quickly macerated plants are incorporated into soil also affect the amount of ITC released (Figure 17). According to US data, around 80% of ITCs are released in the first 20 minutes after maceration, with high soil moisture and warm temperatures optimising conversion.

Julie is not the only one who is a fan of brassica cover crops; similar results have been reported by Queensland and NSW researchers, as well as overseas. For example, a study by Agriculture and Agri-Food Canada found that mustard cover crops could significantly reduce potato early dying complex (PED) as well as improve soil health. PED in Canada is caused by a combination of disease (*Verticillium dahlia*) and root lesion nematodes (*Pratylenchus penetrans*), both of which can be suppressed by ITCs.

Some biofumigants (e.g. Caliente 199™, Nemat™) can host club root, so if potatoes are rotated with a brassica crop this is an important consideration. In contrast, Terranova oil seed radish is not susceptible to clubroot so may be more appropriate in this situation.

CONDITIONING SOIL

One of the big problems with sandy soils in South Australia, Tasmania and other areas is that they can become very hydrophobic. This reduces water infiltration into the mounds and mound stability.

Serve-Ag has done a number of trials with the Oro-Agri product Transformer. Derived from cold pressed citrus, the product aims to increase water infiltration by dissolving the waxy coating that has formed on soil particles. This increases irrigation efficiency, enabling more uniform wetting of the root zone. It can be applied in-furrow or through fertigation.

Figure 17. Brassica cover crops such as Caliente are best finely macerated and incorporated before the plants bloom, as this is when active compounds and organic mass are highest.
- J. Finnigan

"We have found major benefits in terms of improved mound structure on sandy soils. The improved water infiltration reduces slumping as well as wetting and drying within the mounds. The result is healthier plants with better root growth and fewer green and misshapen potatoes," said Julie.

"In one of our trials in Tassie, we got an increase of 7.8T/ha from applying a total of 7L/ha Transformer. This represents a return on investment of around 15:1."

In a South Australian processing potato trial, Transformer was applied as an in-furrow treatment, blanket spray or both. Although total yield was similar to the control, the percentage of marketable potatoes was nearly doubled (Figure 18). The product can remain active in the soil for up to eight months and does not negatively affect soil biology.

BIOLOGICAL SOLUTIONS

As previously noted, there is an increasing variety of biological products entering the marketplace.

Serve-Ag has trialled a number of these of which the Sumitomo product EndoPrime is a standout. EndoPrime contains four species of arbuscular mycorrhizal fungi (AMF).

Mycorrhizae colonise the root systems of plants, helping them to extract water and nutrients from the surrounding soil. The fungi cannot survive without their host plant, which

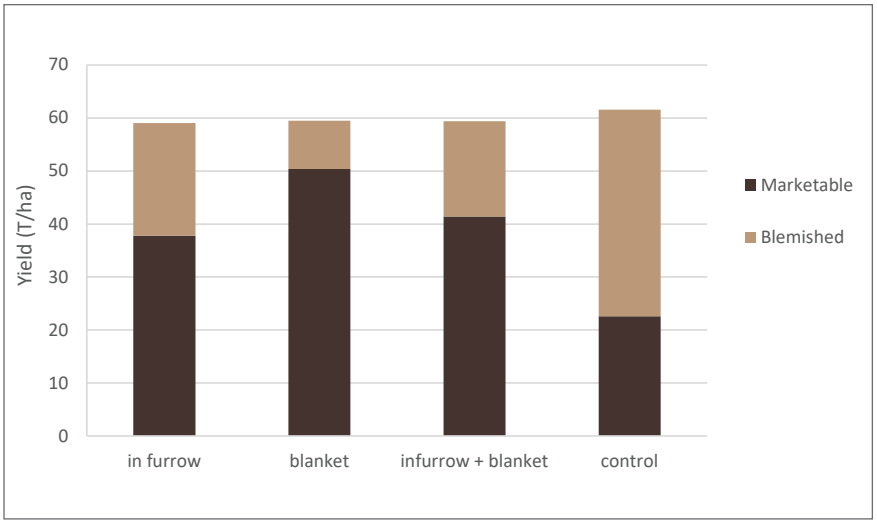

Figure 18. Marketable and total yield of processing potatoes grown in South Australia with the soil conditioner 'Transformer' applied in-furrow, as a blanket spray, or both

supplies them with carbohydrates. Symbiosis between mycorrhizae and plants is one of the oldest relationships on earth, having existed for at least 400 million years.

AMF live inside the roots, and can increase the effective root zone by up to 50 times (Figure 20).

Julie has been impressed by the effects on yield. "We applied EndoPrime at 150g/ha in-furrow on heavier soils at two sites in Tasmania, as well as a site in South Australia. In all cases, we had a significant increase in yield. The gains were mainly by a shift from small to larger tubers, with more in the valuable premium size range." (Figure 19)

"This represents a return on investment of something like 17 to 33 to one. It's not pixie dust, it's good stuff, with excellent longevity and really easy to apply," commented Julie.

Julie has seen major improvements in yield and packout from using biofumigant cover crops, soil conditioners and a number of biological stimulants. These are natural and sustainable options for improving plant performance, not only for the current crop but for ones that follow. As Julie suggests, growers need to look at the data and decide what will work in their situation. However, so far, the results seem very promising indeed.

Figure 19. Compared to the controls (left), plants treated with EndoPrime (right) had more even tuber sizing. *- J. Finnigan*

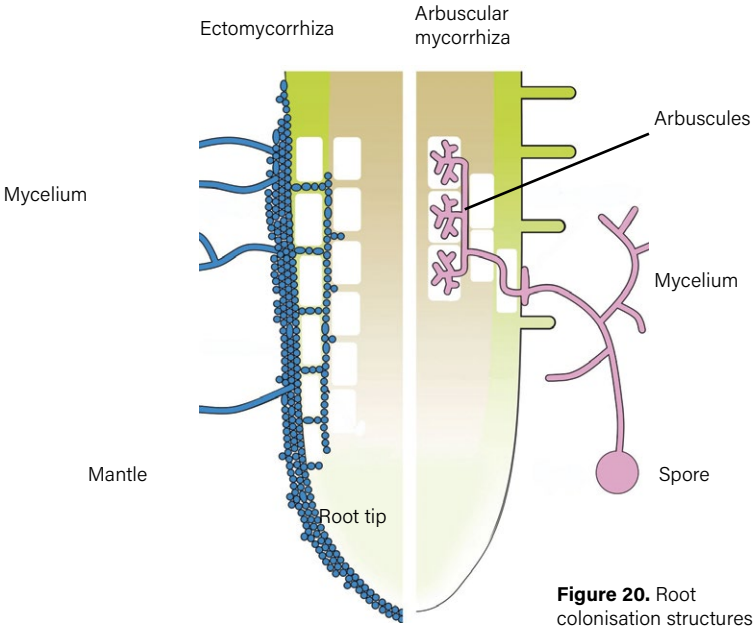

Figure 20. Root colonisation structures in ectomycorrhizal and endomycorrhizal fungi *- P. Bonfante and A. Genre*