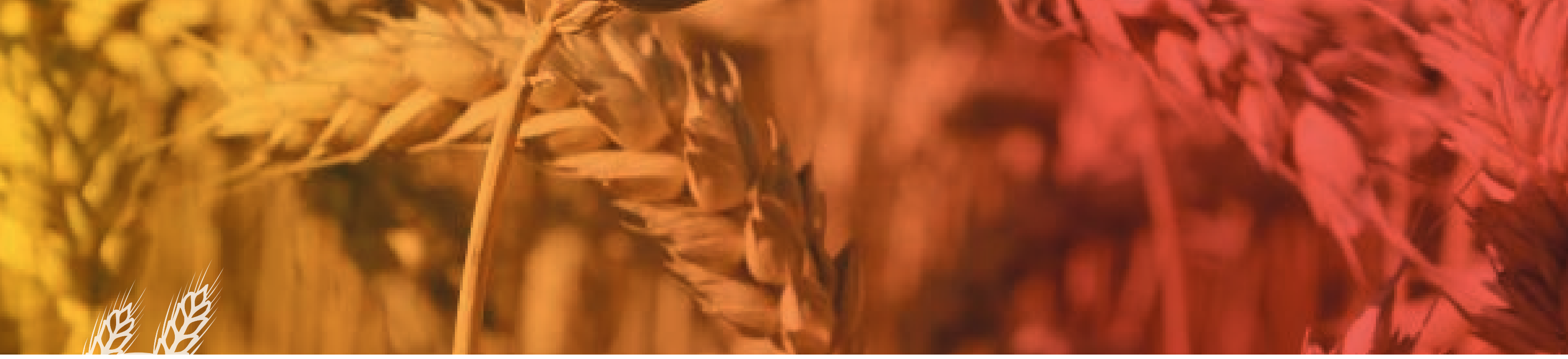
Grains Research & Development Corporation

AgGrow AGRONOMY + RESEARCH

GROWING PROFITABLE CROPS ON SANDY SOILS IN SW NSW

A guideline collating recent research outcomes and management practices for profitable cropping systems on sandy soils.

INDEPENDENT AGRONOMY ADVICE + CUTTING EDGE RESEARCH



RECOMMENDATIONS WITH CURRENT KNOWLEDGE

- Carefully plan a cropping rotation that takes a holistic approach to getting the best out of your sandy soils. Plan to maximise crop biomass on sands and maximise soil cover.
- Grow crop types and varieties that perform well on sands, including wheat, barley, lupins and field peas. Avoid 18 month fallows on these soil types if possible.
- Consider utilising variable rate technology in seeders and spreaders to increase seed and fertiliser inputs. The yield benefits are significant.
- Use higher seeding rates with cereals on sands compared to heavier soils. The effect of higher seeding rates in other crops is unknown.
- Be careful with seed burn when using starter fertilisers such as MAP/DAP at rates over 50 kg/ha.
- Consider topdressing urea early in the season at rates over double those required on heavier soils.
- In areas where manures are available, apply manure on your sands for an expected 2-3 year benefit.
- Plan your pre-emergent and knockdown herbicide use carefully. Some products are very risky to use on sands.
- Cultivation in some cases can increase yield, however the benefits can be quickly outweighed by increased erosion risks and poor crop establishment due to sand blasting.

WHAT DEFINES A SANDY SOIL AND HOW COMMON ARE THEY IN SW NSW?

Sandy soils are typically classified as having greater than 75% course particles (sand) in their texture. Many sands in SW NSW exhibit both fine and course sand particles, in addition to very fine silt particles that often concentrate between larger sand particles and on top of compaction layers.

These sands are found commonly on mallee country, and are very rarely evenly spread across a paddock. This is because of the way they were originally formed during historic wind erosion events.

Sandy soils are scattered right throughout SW NSW cropping belt, however are very common between Ardlethan in the east and Cobar in the north west, and in this area can contribute up to 30% of the cropping landscape.

CHARACTERISTICS OF SANDY SOILS IN SW NSW.

The sandy soils found in SW NSW are quite different to those found in WA, VIC and SA. They do however share some similar properties.

Typical characteristics of sands in SW NSW;

1. Texture – The sands in this region are often 75% sand, and 25% silt, with very little clay in the top soil, figure 1. The silt usually sits very tightly both between the sand particles and also on a concentrated layer at between 12-15cm, before the soil texture begins to change with depth. As the depth of profile increases, so does the silt and clay content, however on some sandy rises even at depths of 2m there is very little clay found in the texture. This makes sands highly prone to water and wind erosion.

Figures 1 and 2: Typical sandy soil texture (left) and layout in the landscape (right).

2. pH – All sands in SW NSW are inherently acid in nature. Acidity has progressively become a greater issue as cropping history increases, a similar story with all cropping soils. It is common to measure pH ($CaCl_2$) as low as 4.3 in the top 10cm, with exchangeable aluminium levels commonly greater than 5%. 80% of sands soil tested by Ag Grow Agronomy have a soil pH 0-10cm less than 4.8 $CaCl_2$. The small compacted silt layer can often be even lower in pH than at the surface, before the pH starts to increase to depth. By 30cm most sands are back to pH 5.5 $CaCl_2$, and by 50cm can be as high as pH 6.5 $CaCl_2$.

   Some sands with calcareous sub surfaces may be quite alkaline at depth. This highly acid subsurface layer can greatly impact on crop growth, causing roots to run horizontally along the concentrated silt layer, figure 3.

Figure 3: The effect of subsoil acidity on canola roots in sandy soils.

3. Organic Matter (OM) – All sands are extremely low in organic matter and as a consequence have very low microbial activity. Soil tests commonly measure less than 0.5% OM, which is the lower detection level for many soil test providers. This low OM level impacts on nutrient mineralisation, biological activity, and also breakdown of herbicides within the soil particles.

4. Moisture holding properties – Sands in SW NSW infiltrate water very quickly and are therefore unlike the non wetting sands in WA and SA. They typically store about 40-100mm of plant available water (PAW), however that is dependent on the subsoil properties. Some sands that sit over clay subsoils can store much higher PAW numbers, and 120-140mm is not uncommon.

Importantly, sands allow the majority of the stored water to be accessed by crops, and local research has measured up to 95% of soil water can be extracted by a healthy cereal crop. This impacts on the way that the crop can finish in a tight season, and also the way that both a crop and weeds can establish with very little rainfall.

5. Nutrition – Sands are often very low in most key nutrients including nitrogen, phosphorous, sulfur and potassium. Zinc is also extremely low on sands, with soil tests less than 1ppm common. Yield responses to Nitrogen and phosphorous are almost guaranteed, whilst other nutrients such as sulfur, potassium and zinc tend to be less reliable, probably because of variable subsoil properties between sands.

Because of the free draining nature of sands, nutrients tend to readily leach through the profile beyond the root zone. Even highly stable nutrients such as phosphorous have been shown to leach to depth on sands.

6. Weeds – Sands are often the weediest part of most cropping paddocks, figure 4. This is because of the ability of weeds to germinate on small rainfall events (as opposed to the heavier soils within the paddock), low crop competition through lower than desired biomass production, and retained subsoil moisture after harvest as a result of poor performing crops.

Common summer weeds that are a problem on sands include skeleton weed (figure 5), fleabane, black grass, feathertop rhodes grass, spiny burr grass etc. Common winter weeds on sands include brome grass, ryegrass, black oats, spiny emex etc. Most weeds however found in the region grow well on sands.

7. Diseases – Sands commonly host a very different plant disease spectrum compared to heavier soil types. This is most likely due to lower levels of microbiological activity, fertility and crop vigour on sands compared to the heavier soils.

The most common soil borne disease on sandy soils is rhizoctonia, however this disease is commonly found in conjunction with other root diseases such as pythium and common root rot, and the nematode pratylenchus neglectus.

Figures 4 and 5: Prolific weed growth on the sand in the background, whilst the heavier soils are clean from weeds (left), the thickness of a skeleton weed root at depth (right).

MANAGEMENT PRACTICES TO MAXIMISE PROFITABILITY AND SUSTAINABILITY ON SANDY SOILS IN SW NSW.

Over the past 15-20 years, there has been a lot of effort researching better ways to grow crops on sands. In recent years, Ag Grow Agronomy along with many clients have undertaken more formal research evaluating various management factors that impact on crop performance on sandy soils. This has led to 4 main management factors being identified that make a difference to crop performance.

Importantly, any management practice that increases biomass (often measured by NDVI) increases yield. This is totally the opposite to what has been found on the heavier soils within this region.

a) Cultivation/ripping/spading: Over the past 20 years the farming system has moved quickly to a zero or no till system, where cultivation has been either eliminated or minimised. Adoption has been rapid on sands in order to reduce erosion, and has been measured at over 90% no till for Ag Grow clients.

Many trials have evaluated the place for various forms of cultivation, including ripping deep with narrow points (leaving stubble intact), deep ripping to 50cm, full cultivation, and even spading, figures 6 and 7.

Figure 6:and 7 Ripping trial at Rankins Springs 2015 (left) and Spading trial at Rankins Springs 2015 (right).

In summary, any disturbance of the silty sub layer at 12-15cm by ripping and cultivation often results in an increase in crop performance, however is not without its down side. The major hurdle is sand blasting (figure 8) of the following crop resulting in poor crop establishment, uneven soil finish, and wind and water erosion.

Figure 8: The outcome of sand blasting on cultivated sands. Emergence on the heavier ground in the background is much better.

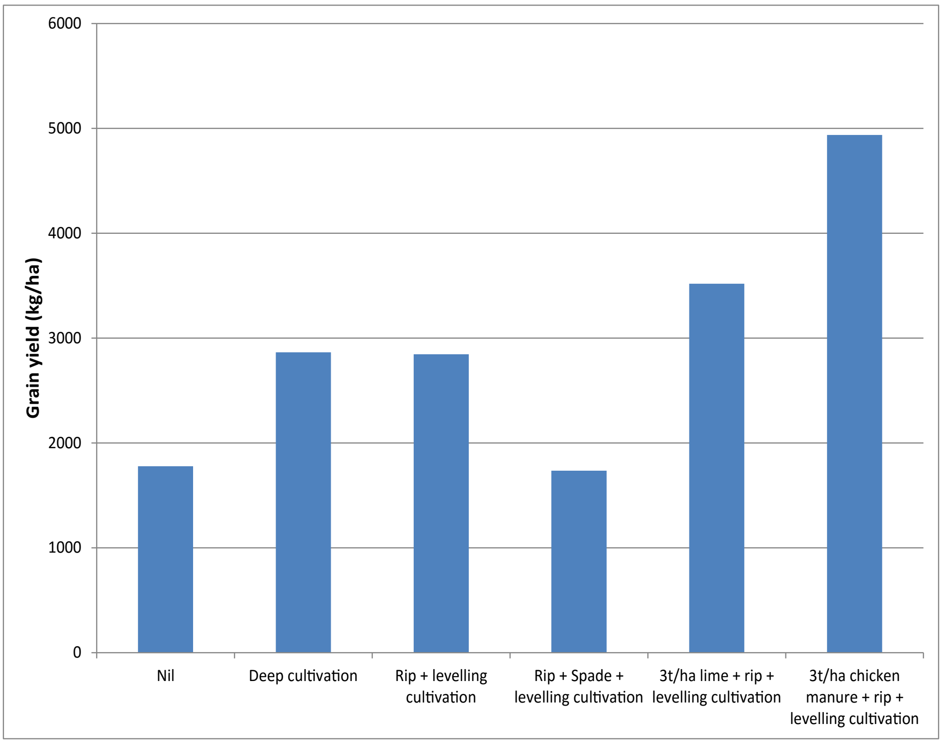
Trials in 2015 showed the value of cultivation, especially when it was coupled with manure or to a lesser extent lime, figure 9. This trial was replicated 3 times, with plots 60m x 12m, and performed with commercial equipment. Treatments were applied on 2nd April, and paddock sown 29th April. Results show that adding a deep cultivation (20-30cm) increased yield by about 1 t/ha, figure 10. Deep ripping to 50-60cm gave no extra yield benefit. Adding 3 t/ha lime and incorporating with a deep cultivation increased yields by an additional 1.6 t/ha compared to the control, but amazingly adding 3 t/ha chicken manure and incorporating with a deep cultivation increased yields by 3.1 t/ha.

Assuming chicken manure at $10/m delivered on farm, $5/m spreading costs, 3m/t, and 3 t/ha target rate (all by contract), applying 3 t/ha manure will cost $135/ha in this region. With wheat at $220/t on farm, the results of this trial suggest you spend $135 to make $682, a 500% return on investment!

This result is much higher than what has been historically expected in previous trials evaluating similar cultivation and manure comparisons.

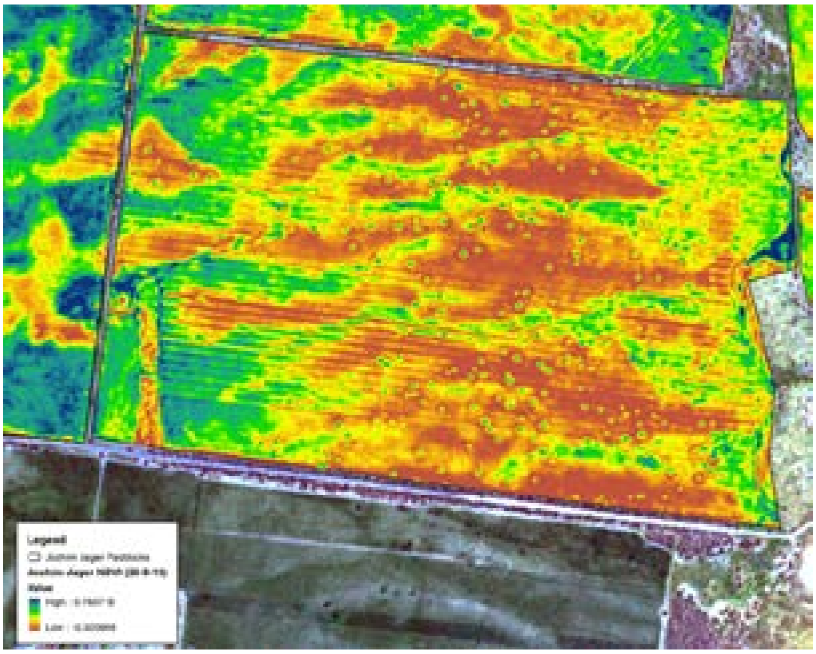
Figure 9: Trial at harvest showing rip + cultivation + manure (left) vs nil (right).

Figure 10: Effect of cultivation, ripping, manure and lime on yield in a trial at Rankins Springs 2015.

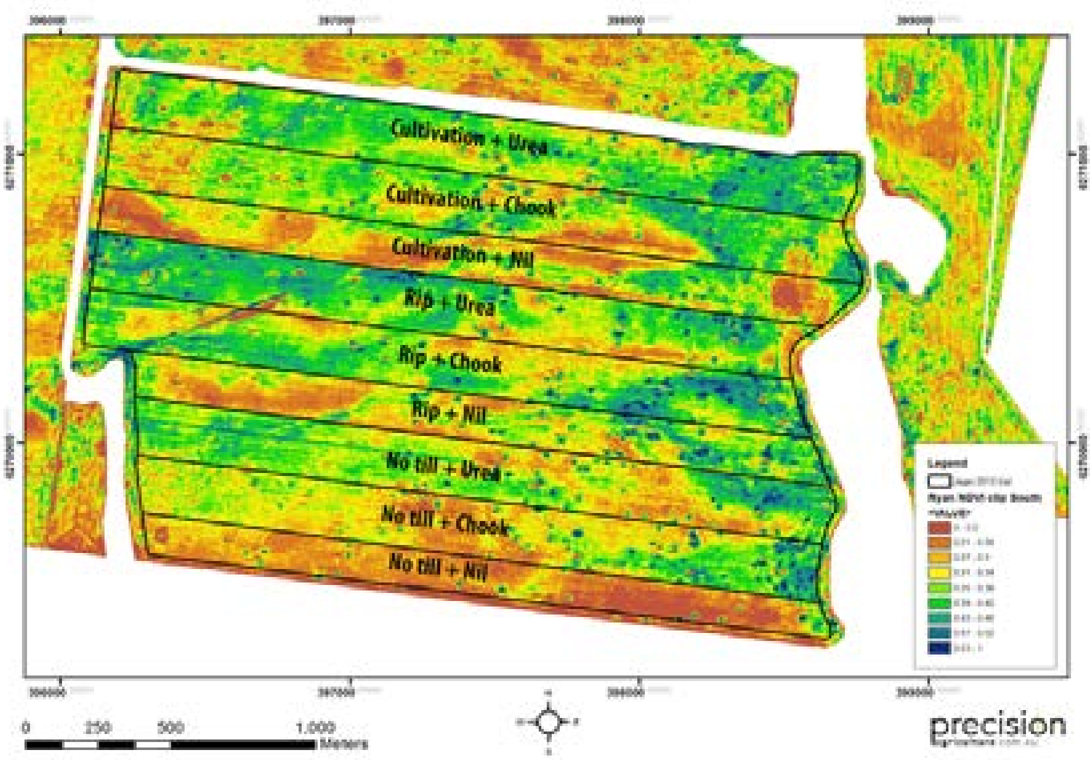


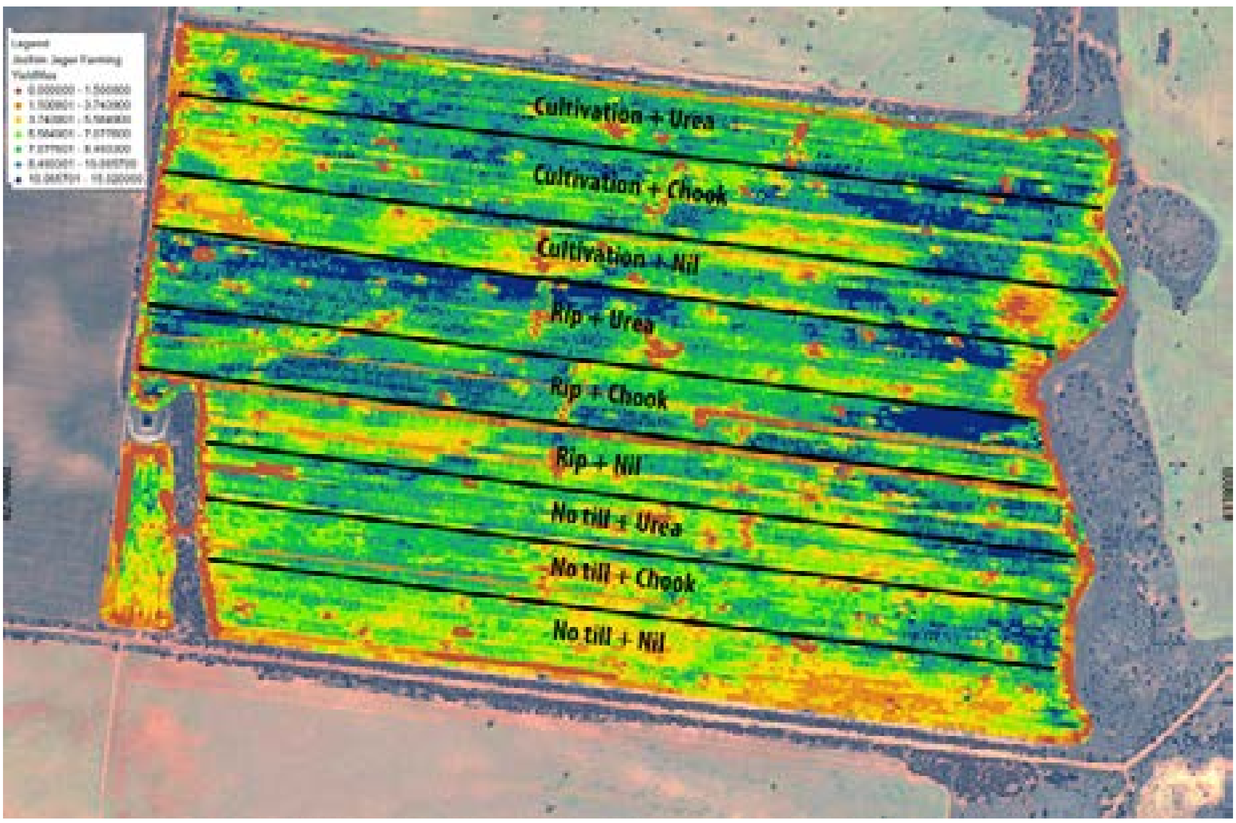
Another paddock scale trial conducted in 2012 (Sandy Soil responses to different nitrogen fertilisers and cultivation) showed similar trends, however yield increases were much less given it was a much drier season, figure 11. In this trial there were three cultivation treatments (nil, ripped with knife points to 15cm, and conventional full cut disturbance) and three fertiliser treatments (nil, 100kg urea and 2 t/ha chicken manure). Cultivation added another 300-400 kg/ha yield, and urea and manure about the same.

Figure 11: The paddock chosen in 2010 for the large scale tillage and nutrition trial.

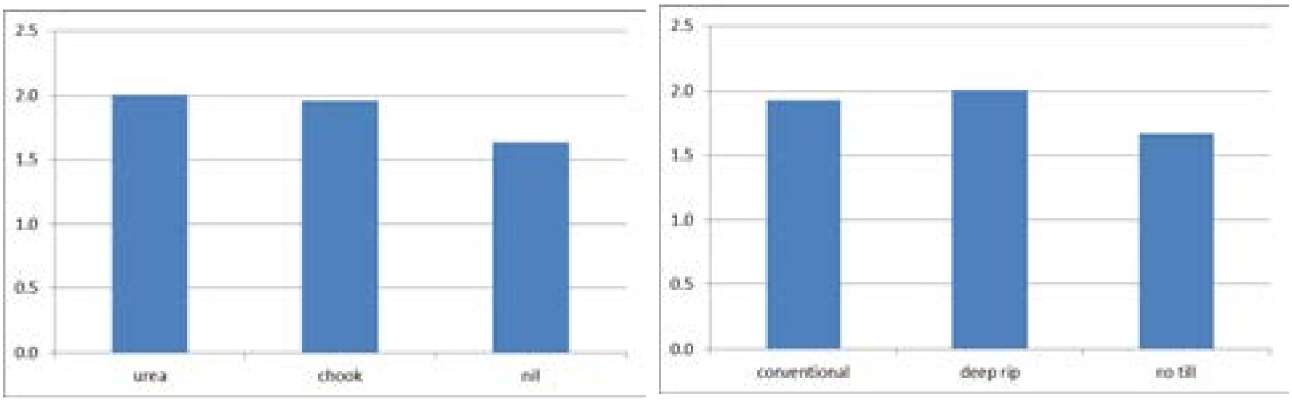


Figures 12 and 13: The treatments overlaying an NVDI image at peak biomass (above) and yield map (below) in the paddock trial 2012.





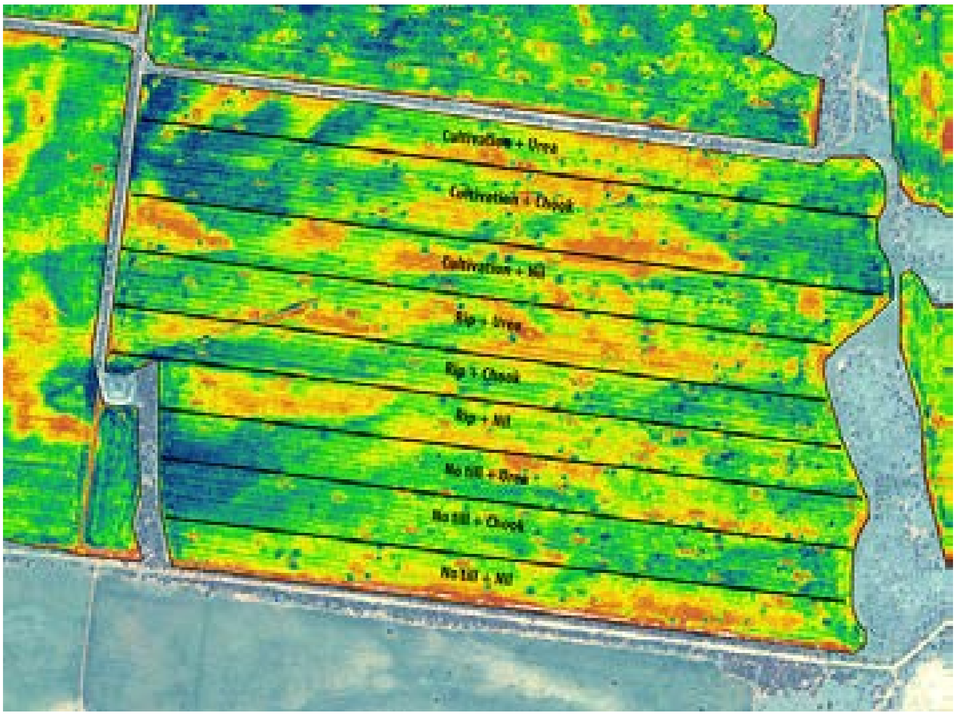
Figures 14: The effect of nutrition and tillage in a trial at Merriwagga 2012.



The NDVI and yield response in the second season was also interesting. There was a second year effect of chicken manure, particularly in the no till treatments, and yield increases of 300-500 kg/ha on the sands were common.

In 2015 (4 years after treatments were applied), there were still obvious effects of cultivation and manure, where the no till treatments are now performing better than where the paddock was cultivated, figure 15.

Figure 15: The effects of the trial can still be seen 4 years after treatment.



b) Nutrition: It is obvious that sands are less fertile and hence require more fertiliser for productive crop performance. The benefits of manure have been well explained above. Nitrogen and Phosphorous fertilisers are also very important.

The sandy soil project evaluated various crop nutrition treatments as highlighted below in figures 16 and 17. In this trial, MAP was applied with the seed, however all other treatments were either predrilled just prior to sowing or spread and incorporated by sowing (manure).

Generally, the higher the NDVI at flowering the higher the yield. This trial did highlight the sensitivity to higher rates of MAP with the seed, as shown by the lower NDVI and yield of 100 kg MAP versus 50 kg MAP, figure 16. This was as a result of crop burn, and is commonly observed on sands.

This trial also highlighted the value of nitrogen and phosphorous in conjunction with each other. It also showed no benefit of either Sulfur, Potassium or Zinc. Manure was again a standout treatment, which would likely offer several years of increased yields. Yields in this trial were limited by an extremely dry finish to the season.

Figure 16: The effect of various nutrition treatments on NDVI in a trial at Rankins Springs 2015.

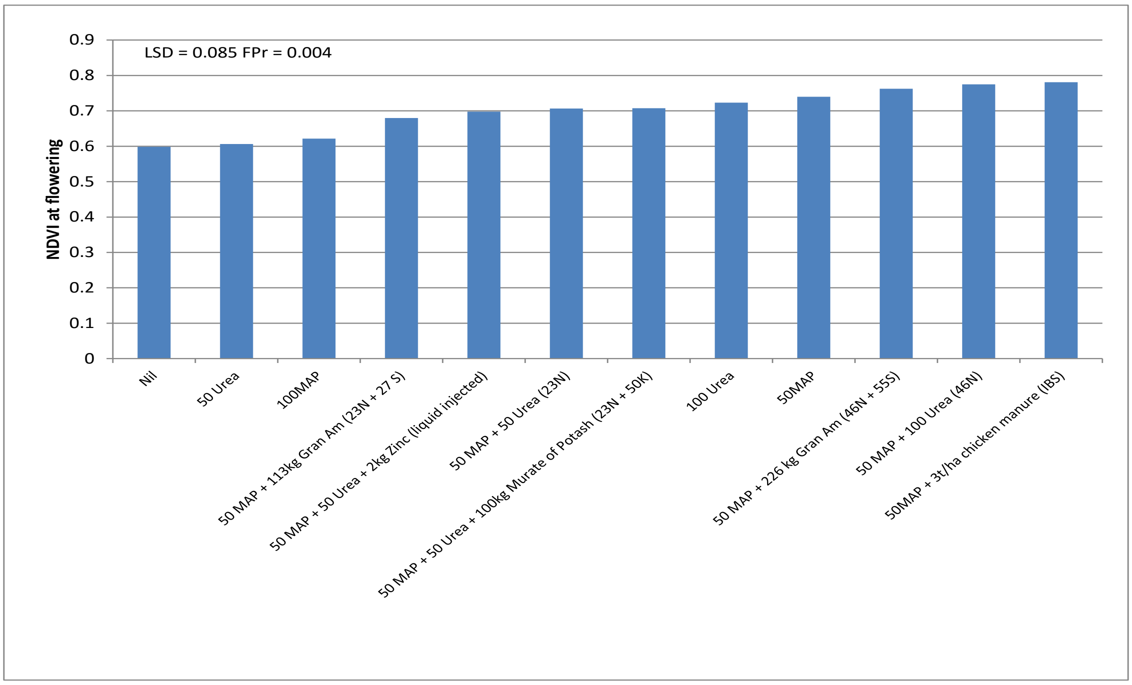
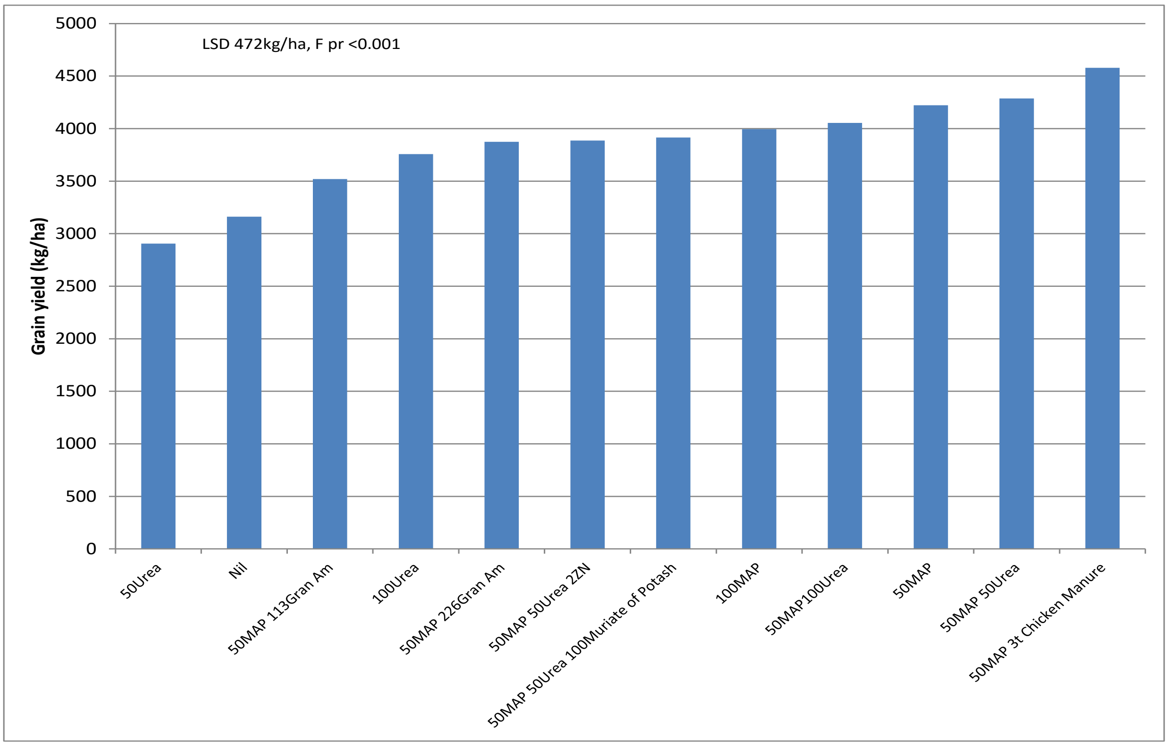


Figure 17: The effect of various nutrition treatments on grain yield in a trial at Rankins Springs 2015.



c) Variety and seeding rates: 2015 was the first real varietal evaluation performed specifically on sands in the region.

As shown by figure 18, there is a major difference between varietal performance on sands. This is most likely as a result of acid soil tolerance, table 1, however is not the complete answer. Bellaroi is not tolerant of acidity, and as such performed very poorly. Suntop rates as moderately tolerant, however was a standout performer in this trial, figure 19. The higher rated varieties Corack, Ventura and EGA Gregory performed well, however were well behind Suntop. All barley varieties (which are not usually tolerant of acid soils) perfomed exceptionally well.

The addition of 3-6 t/ha lime did increase yield in Bellaroi, however made no difference in Suntop, and in both cases would be deemed commercially unviable due to economics.

Seeding rates have been evaluated commercially for a few years using farmer equipment, and there is a general agreement that NDVI and consequently yield increase with higher seeding rates.

In this trial, yield increased consistently as seeding rate increased, which was unexpected. In recent farm trials using seeding rates over 80 kg/ha has tended to reduce yield due to the crop burning off. It is generally excepted that increasing seeding rates from the flats (average 20-40kg) to the sands is a no brainer, however the rate that provides the most reliable yields on sands needs further investigation.

Figure 18: The effect of various varieties and seeding rates on grain yield in a trial at Rankins Springs 2015.

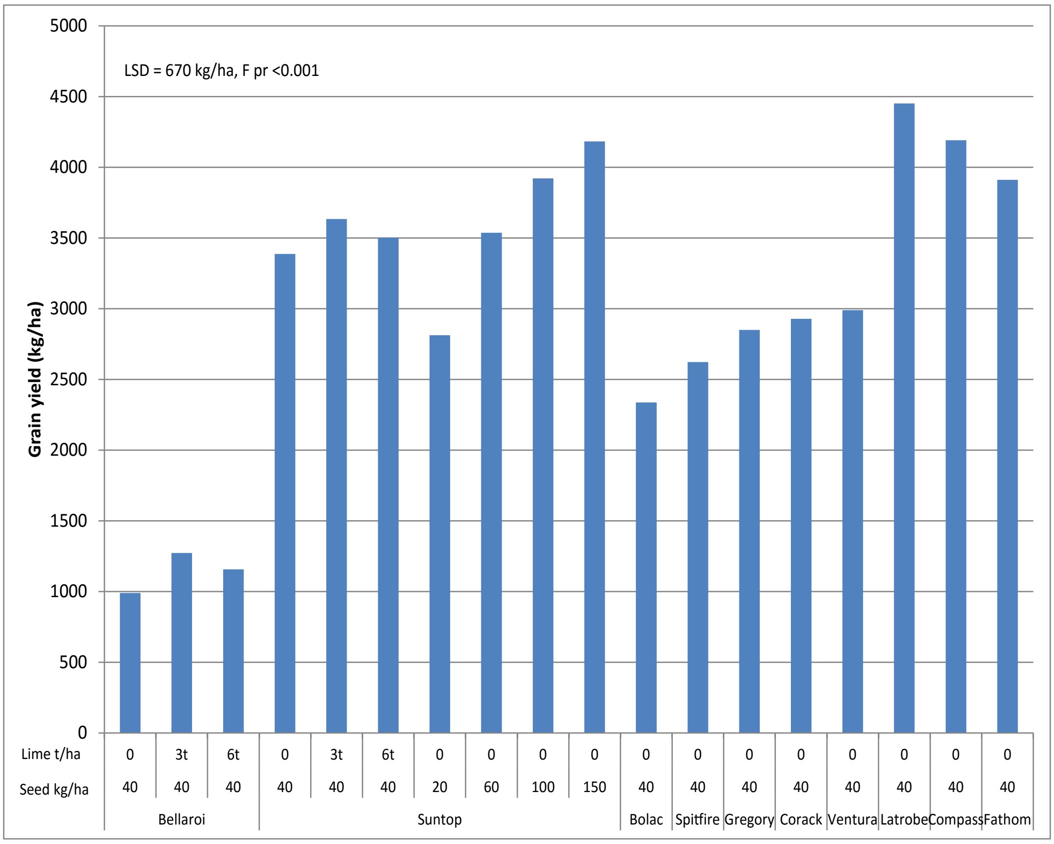


Table 1: Varietal acid soils tolerance

Variety	Acid soils tolerance
Gregory	Tolerant
Ventura	Tolerant
Corack	Tolerant-Mod Tolerant
Suntop	Mod Tolerant
Spitfire	Mod Tolerant - Mod Intolerant
Bolac	Mod Intolerant
Bellaroi	Very Intolerant

Figure 19: Suntop at 40 kg/ha (left) versus Bellaroi at 40 kg/ha (right) in a trial at Rankins Springs 2015.

d) Influence of herbicides on sands: Using herbicides on sandy soils has many issues. This is because sands are very low in microbial activity reducing their ability to break down herbicide residues, they are free draining allowing herbicides to enter the root zone of plants, and they are often sprayed regularly as a result of the way weeds germinate on minimal moisture.

A trial in 2015 measured the effect of various knockdown and pre-emergent herbicides on NDVI and yield on a sandy soil. The treatments were sprayed on 28th April, and incorporated by sowing using a commercial Morris contour drill on 30cm spacing's into good soil moisture. Note no weeds were present at the time of application.

All pre-emergent products were registered for this use. Two treatments containing the knockdown herbicide 2,4-D LV Ester and Glyphosate 540 were used at higher than label rates to test the concept that these products can be quite damaging to crop growth and yield on sands. This proved to be true, and whilst these results are due to a practice not recommended, this needs further investigation.

Some pre-emergent herbicides did have an impact on grain yield as shown in figure 20. 2L Triflur X®, Boxer Gold® at 2.5L IBS and Boxer Gold® at 1.5L EPE all reduced yield in this trial. This is commonly observed commercially, and fits within expected results. We did not evaluate 2.5L Boxer Gold® EPE as previous trials highlighted yield reductions on sands. Note this trial was replicated 3 times however not statistically randomised, and as such no statistical analysis was performed.

Logran® unexpectedly had very little effect on yield. This is not the case with commercial observations, and as such this product should be avoided on sands.

Sakura® seemed to provide a slight increase in yield, probably because it provided some control of brome grass, which was present at low levels in this trial.

Figure 20: The impact of pre-emergent herbicides on grain yield in a trial at Rankins Springs 2015.

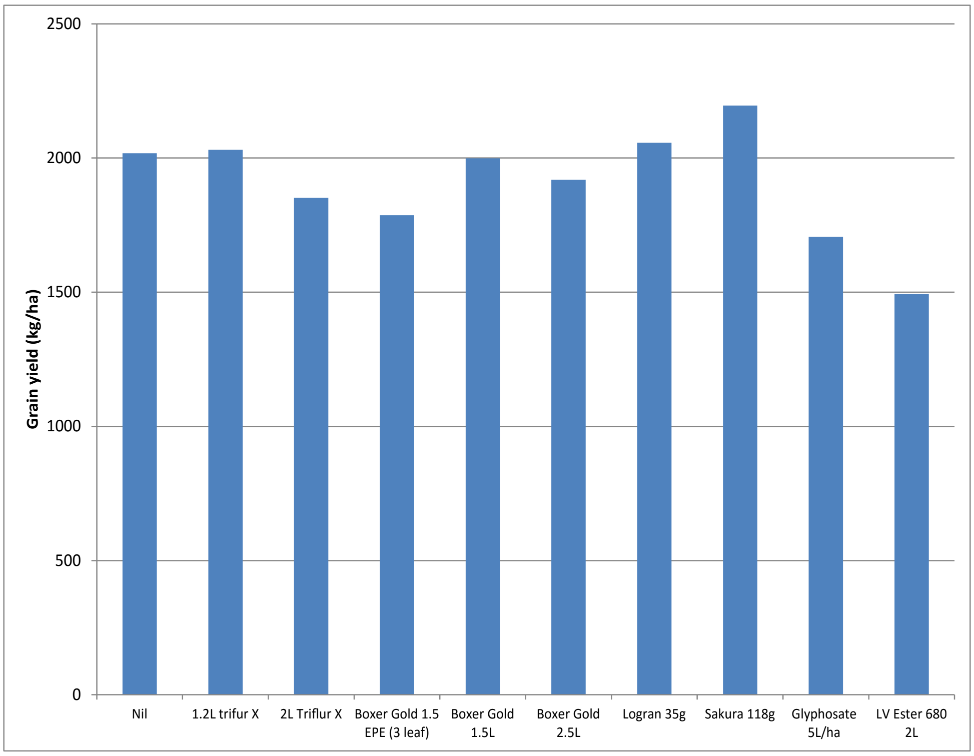


Figure 21: The effect of 2 L/ha LV Estercide 680 at sowing (IBS) in a trial at Rankins Springs 2015

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Figure 22: The effect of 5 L/ha Glyphosate 540 at sowing (IBS) in a trial at Rankins Springs 2015

Figure 23: A typical wheat plant affected by Logran® damage on a sandy soil. Plants exhibit bleaching and limp middle leaves, similar to that of Zinc deficiency.

ACKNOWLEDGEMENTS

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