Lentil agronomy on variable sandy soils – Rudall, Eyre Peninsula (2025)

Summary

Lentil performance at Rudall was primarily driven by soil type and landscape position. While a wide range of establishment and nutrition strategies were tested, there was no consistent treatment response across the whole site, with responses highly dependent on soil type.

Key Findings

- Yield ranged from 0.37 to 1.07 t/ha
- Soil type had a significant effect on yield ($P < 0.001$)
- Treatment effects were not significant overall ($P = 0.29$)
- A significant soil type × treatment interaction ($P = 0.02$) was observed
- Mid-slope soils were the highest yielding and most responsive zone
- Sandy soils were the lowest yielding and least responsive to inputs

Location and Seasonal Context

Location: Rudall, Eyre Peninsula

Soil type: Highly variable paddock including sandy rise, mid-slope sandy loam and heavier calcareous flat

Seasonal conditions: Dry start with crops sown into marginal moisture, good winter rainfall supported crop growth, drier than average finish to the season, but under cooler conditions. These conditions allowed lentils to establish across all soil types and enabled good winter/ early spring growth that allowed clear identification of underlying soil and nutritional constraints.

Trial Objective

To determine the key constraints to lentil establishment and yield across a variable soil landscape, and to assess the relative importance of:

- Nitrogen supply and nodulation (SOA and organic sources)
- Phosphorus rate and placement
- Trace elements
- Establishment strategies (sowing rate and depth)

Trial Design and Site Characterisation

Trial design

The trial was established across a landscape gradient (sandy rise → mid-slope → flat), with treatments targeting (each seeding row running for 120m) x 3 reps.

Baseline MAP (50kg/ha) was applied in all treatments (apart from the liquid P treatment).

As the trial ran for 100+m up the sand hill we broke it up into 10m sub-plots and then categorised the soil into flat, mid-slope and sand. This meant that we ended up with 12-16 reps of each treatment depending on where they were in the landscape – analysed with a spatial analysis.

Treatment Description:

1	Control: Lentil seed rate 50 kg/ha (placed 5 cm deep). Fertiliser: 50 kg/ha MAP placed below seed
2	Seed rate 1.5 x (75 kg/ha). Fertiliser: 50 kg/ha MAP placed below seed
3	Shallow Seed placement (2 cm): 50 kg/ha seed. Fertiliser: 50 kg/ha MAP placed below seed
4	Seed rate 50 kg/ha. Fertiliser Phosphoric Acid @ 25 L/ha (11.3 kg/ha P)
5	Seed Rate 50 kg/ha. Fertiliser 50 kg/ha MAP with the seed
6	Seed Rate 50 kg/ha. Fertiliser 100 kg/ha MAP with the seed
7	Seed Rate 50 kg/ha. Fertiliser 100 kg/ha SOA
8	Seed Rate 50 kg/ha. Fertiliser 50 kg/ha MAP + Foliar 3L ZMC+Mo x 2 applications
9	Seed Rate 50 kg/ha. Fertiliser 50 kg/ha MAP +Foliar: 10 L/ha of (8.3% N, 6.0% Ca, 2.67% Mg, 2.67% Zn, 1.0% B, 0.67% Cu, 0.67% Mo) plus EDDHA Fe (6%) @ 4kg/ha. x 2 applications
10	Seed Rate 50 kg/ha. Fertiliser: Phosphoric Acid @ 50 L/ha (22.6 kg/ha P)+ Dynamic Lifter 1 t/ha (36 kg/ha N and 10 kg/ha P)

Gamma radiometric mapping

Gamma radiometric mapping clearly delineated three production zones:

1. Low K / high Th zones: sandy rise
2. Intermediate zones: mid-slope
3. Higher K / distinct signatures: heavier flat soils

These patterns aligned closely with observed soil texture and productivity. Radiometric mapping provided an effective tool for defining management zones within the paddock.

Soil characterisation

Soil testing confirmed strong variation across the landscape:

Sandy rise

- Low organic carbon
- Low nutrient reserves
- Low water holding capacity

Mid-slope

- Moderate fertility
- Fewer physical and chemical constraints

Flat (calcareous soils)

- High pH (alkaline)
- High calcium and background nutrient levels
- Elevated salinity and boron

Measurements collected

- Grain yield (machine harvest)
- Soil chemical analysis
- Plant tissue nutrient analysis (flowering)
- Gamma radiometric mapping

Above: Jake Giles presenting the Rudall lentil on challenging soil trial site to the Rudall/Tuckey Ag Bureau members in spring 2025.

Summary of constraints

Zone	**Primary constraint**	**Secondary factors**
Sandy rise	Water + low fertility	Low organic matter
Mid-slope	Nitrogen and emerging P limitation	Higher yield potential
Flat	Nodulation/chemical constraints	High pH, salinity

Above: Rudall site prior to harvest 2025.

Yield Results

Soil type strongly affected yield and was the primary driver of lentil performance at the site.

Soil Type	Yield (t/ha)
Heavy	0.65
Mid	0.90
Sandy	0.54
P	*<0.001*
lsd	*0.16*

Treatment main effects were not significant overall.

Treatment	Yield (t/ha)
Control	0.74
Sowing rate x1.5	0.68
2cm sowing depth	0.69

Liquid P	0.69
MAP with seed	0.67
x2 MAP with seed	0.73
SOA	0.71
Traces	0.70
Trace elements x 2 Application	0.71
x2 Liquid P and Organic N	0.65
P	*0.29*
lsd	*0.07*

Average yield across all soil types ranged from 0.65 t/ha for treatment 10 to 0.74 t/ha for the control. The overall treatment effect was not significant. This indicates that no individual treatment consistently improved yield across the whole site.

Treatment responses differed by soil type.

Soil type	**Heavy yield (t/ha)**	**Mid yield (t/ha)**	**Sandy yield t/ha)**
Control	0.70	0.85	0.67
Sowing rate x1.5	0.70	0.83	0.50
2cm sowing depth	0.61	0.94	0.51
Liquid P	0.66	0.87	0.54
MAP with seed	0.62	0.89	0.51
x2 MAP with seed	0.62	0.99	0.59
SOA	0.74	0.96	0.44
Traces	0.63	0.93	0.53
Trace elements x 2 Application	0.60	0.91	0.61
x2 Liquid P and Organic N	0.62	0.86	0.47
P	*0.02*		
lsd	*0.21*		

The soil type × treatment interaction was significant, meaning that treatment response depended on the part of the landscape in which the crop was grown.

Heavy soil

Yields ranged from 0.60 to 0.74 t/ha. Responses were relatively small, with SOA and the control among the higher yielding treatments, but most treatments performed similarly.

Mid-slope

Yields ranged from 0.83 to 0.99 t/ha. This was the highest yielding and most responsive part of the paddock. The strongest yields were recorded with:

- double MAP with seed (0.99 t/ha)
- SOA (0.96 t/ha)
- 2 cm sowing depth (0.94 t/ha)

- trace elements (0.93 t/ha)

Sandy soil

Yields ranged from 0.44 to 0.67 t/ha. This was the lowest yielding environment. The control was the highest yielding treatment (0.67 t/ha), while increased sowing rate (0.50 t/ha), 2 cm sowing depth (0.51 t/ha), MAP with seed (0.51 t/ha), SOA (0.44 t/ha) and double liquid P and organic N (0.47 t/ha) all performed poorly.

Integration of Yield, Soil, Tissue and Radiometric Data

Combining the yield analysis with the radiometric, soil and tissue data helps explain why treatment responses differed across the landscape.

Sandy rise

- Yield: ~0.37–0.67 t/ha
- Lowest yielding zone

Key observations:

- Increasing sowing rate reduced yield
- Nutrient additions (P, N, trace elements) provided little or no benefit
- Control treatment was often among the highest yielding

Supporting evidence:

- Radiometrics identified this as a distinct low productivity zone
- Soil tests indicated low organic carbon and buffering capacity
- Tissue tests showed relatively low N status, but yield did not respond to inputs

Interpretation

Sandy soils imposed an inherent yield penalty driven by low water holding capacity and poor nutrient buffering. This constraint could not be overcome with increased inputs in 2025. Higher plant populations likely increased competition for limited water and additional nutrients did not translate into yield due to moisture limitation.

Mid-slope

- Yield: ~0.83–0.99 t/ha
- Highest yielding zone

Key observations:

- Strongest response to management
- Yield increased with:
    - higher MAP rates (with seed)
    - SOA
    - shallower sowing depth
    - trace elements

Supporting evidence:

- Radiometrics indicated intermediate, more productive soils

- Soil tests showed fewer physical and chemical constraints
- Tissue tests showed improved N status with treatments

Interpretation

The mid-slope represented the primary opportunity zone where inputs translated into yield. Notably, the response to higher P suggests nutrient removal may be exceeding supply in higher yielding areas. This is one of the few zones where input optimisation is likely to be profitable.

Heavier Flat (Calcareous Soil)

- Yield: ~0.60–0.74 t/ha
- Intermediate performance

Key observations:

- Modest and inconsistent treatment response
- No clear benefit from increasing nutrient inputs

Supporting evidence:

- High pH, elevated Ca, salinity and boron
- Tissue tests showed generally adequate nutrient concentrations

Interpretation

Constraints on the flat are likely chemical (high pH, salinity, boron) rather than nutritional. This suggests that root function and nodulation may be restricted, and increasing fertiliser inputs alone is unlikely to resolve these constraints.

Summary of Results

The Rudall trial showed that lentil performance was primarily determined by soil type and landscape position, with treatment effects secondary and dependent on the environment in which they were applied.

The GenStat analysis confirms three key points:

1. **Soil type was the major driver of yield**
   Mid-slope soils produced significantly more grain than both heavy and sandy soils.
2. **There was no single best treatment across the whole paddock**
   Overall treatment effects were not significant.
3. **Treatment response depended on soil type**
   Some treatments improved yield in the mid-slope, while similar treatments gave little benefit, or reduced yield, on sandy soil.

These findings reinforce that lentils are highly sensitive to both soil water holding capacity and nutrient supply, but that the dominant constraint shifts across the landscape.

Key Findings

- Soil type had a significant effect on lentil yield, with mid-slope soils outperforming both heavy and sandy soils
- Treatment effects were not significant across the whole site
- Treatment response varied significantly with soil type
- Sandy soils had an inherent yield penalty that was not overcome by increased inputs
- Increasing sowing rate reduced yield on sandy soils
- Mid-slope soils were the most responsive part of the landscape
- Higher phosphorus inputs improved yield in some mid-slope areas, suggesting emerging nutrient depletion in higher yielding zones
- Flat soils were likely constrained by high pH and associated chemical effects rather than simple nutrient deficiency
- Gamma radiometric mapping aligned well with observed production zones and was useful for interpreting treatment response

Implications for Growers

- Lentil management should be zone-specific, not paddock-average
- Sandy soils represent consistently high-risk environments
- Increasing sowing rate on sands reduced yield in 2025
- Mid-slope soils are the best targets for fertiliser investment
- Calcareous soils require different strategies beyond nutrient addition
- Radiometrics + soil testing are valuable tools for targeting management

Future Research and Extension

- Define phosphorus requirements in higher yielding lentil zones
- Evaluate zone-specific sowing strategies
- Extend use of radiometric mapping for decision-making in variable paddocks

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