More profitable crops on highly calcareous soils by improving early vigour and overcoming soil constraints.

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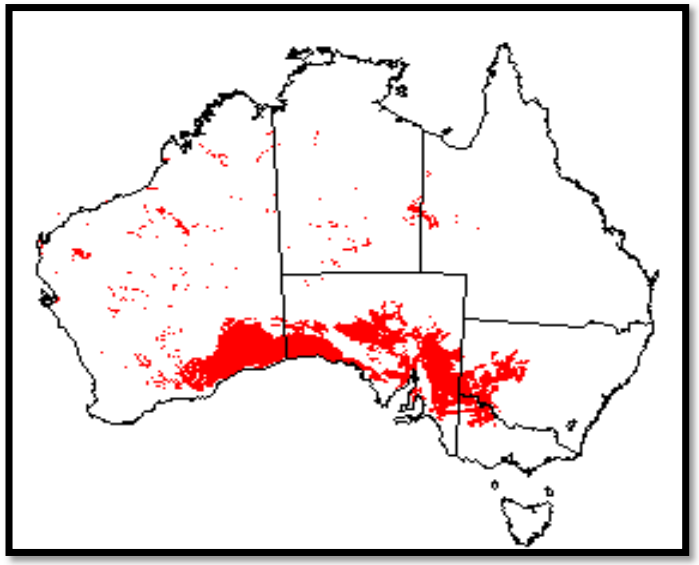
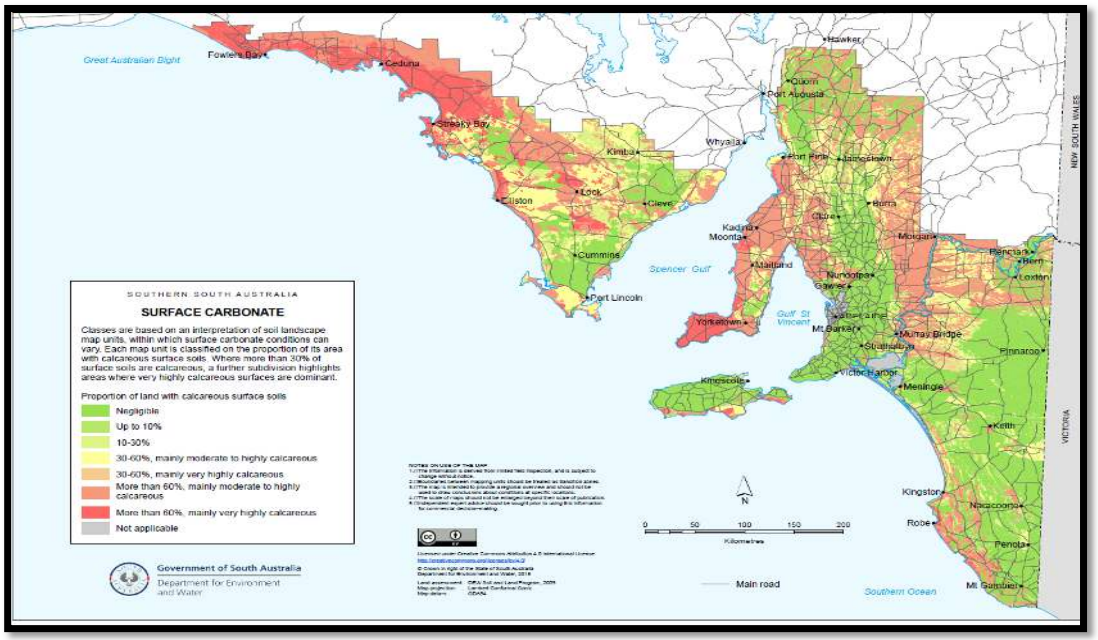
Calcarosols



Occupy about 60% of the cropping soils in south-eastern Australia

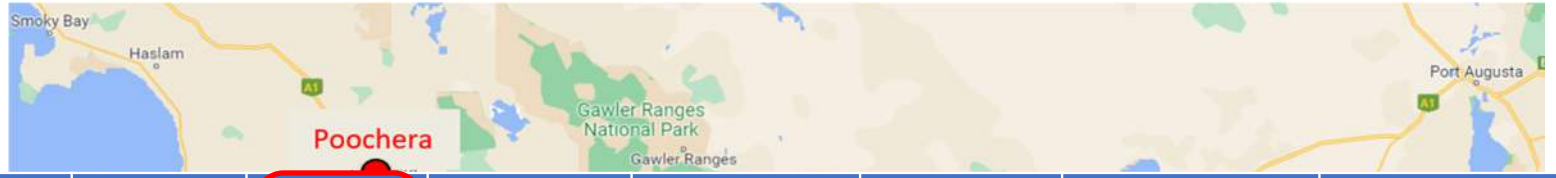
- 1 M ha - very highly calcareous
- 2.5 M ha - highly calcareous
- 800,000 ha - calcareous



Constraints

- Phosphorus nutrition is a challenge
- Micronutrient supply
- High levels of sodium, boron
- High pH
- Fertiliser toxicity at seeding
- Low soil microbial activity
- Poor soil moisture retention
- Rhizoctonia

EP trial sites: Minnipa, Poochera, Port Kenny (2021 – 2023)



Site (crop)	Depth	pH	Colwell P	Nitrate N	Exch Na	Boron	MED (0-5 cm)	Carbonates
	cm	$CaCl_2$	mg/kg	mg/kg	mg/kg	mg/kg	molar	%
Minnipa	0 - 10	7.9	36	45	0.5	2.7	0	15
	60 - 80	8.5	<10	18	10.7	24		40
Poochera	0 - 10	7.9	31	33	40	2.1	0	40
	60 - 80	8.4	<10	25	665	9.1		50
Port Kenny	0 - 10	7.9	45	52	127	2.2	1.2	75
	60 - 80	8.4	<10	19	524	9.6		82

Strategies (2021 – 2023)

TOPSOIL

- Typical practice – control
- Upfront urea (N)
- Phosphorus + TEs
- Fungicide
- Sweep cultivation
- Wetter
- Carbon-coated minerals - CCM
- High seeding rate
- Microbial seed coating

SUBSOIL

- Typical practice - control
- Deep ripping (DR)
- DR + Neutrog (5t/ha)
- DR + CCM (5t/ha)
- DR + granular fert
- DR + Phos acid/TEs
- DR + inclusion plates (IP)
- DR + IP + Neutrog

Impact on plant population

- **Topsoil**
- Higher seeding rate increased plant population.

- **Subsoil**
- Deep ripping with inclusion plates < lowest plant population

- Deep ripping without inclusion plates also reduced plant numbers at all sites

Flowering shoot dry matter - SUBSOIL

- Biomass not affected by subsoil strategies at Minnipa and Poochera.
- Port Kenny - CCM and Neutrog had more biomass than typical practice.
- Ameliorating compaction did not improve flowering biomass at all site.

Flowering shoot dry matter - TOPSOIL

- CCM and the combination strategy consistently yielded more biomass.
- Port Kenny - high seeding rate increased biomass by 22 % compared to the control
- 20% reduction in biomass at Poochera from the use of '***SE14 wetter***' and '***seed coating***'

Cumulative (2021 – 2021) change in cereal grain yield (t ha^{-1}) - Subsoil

Treatments	Minnipa	Poochera	Port Kenny
Deep_rip	-0.3	0.3	-0.2
DR_carbon-coated minerals	-0.2	1.6	0.4
DR_granfert_carbon-coated minerals_match	-0.5	0.8	0.1
DR_granfert_NEUTROG_match	-0.5	0.8	0.5
DR_Inclusion_plates	-1.0	0.1	0.1
DR_Inclusion_plates_NEUTROG	-0.2	1.1	1.1
DR_Neutrog	-0.1	1.4	0.6
DR_Phos_acid	-0.3	0.9	-0.1
DR_Phos_acid_TEs	-0.5	0.8	0.1
Cumulative yield (t/ha) - Typical practice	***7.7***	***6.0***	***5.8***

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Cumulative (2021 – 2022) change in cereal grain yield (t ha^{-1}) - Topsoil

TOPSOIL	Minnipa	Poochera	Port Kenny
Broadcasted_urea	0.1	0.5	0.1
Carbon-coated minerals_500kg/ha	0.9	2.0	1.0
Continuous_P	0.7	0.7	0.5
Fungicide_bandedN_phosacid_TEs	0.2	0.9	0.3
Fungicide_GranNP_TEs	-0.1	0.4	-0.4
Granfert_N&P_carbon-coated minerals_match	0.3	1.0	0.4
High_seedrate_fungicide_bandedN_phosacid_TEs	1.1	1.5	1.3
Phosacid_TEs	0.7	1.0	0.3
SE14_Wetter	0.1	-0.1	-0.3
Seed_coating	-0.4	0.1	-0.8
Sweep_cultivation	0.1	-0.2	0.1
Cumulative yield (t/ha) - Typical practice	***6.5***	***5.2***	***6.1***

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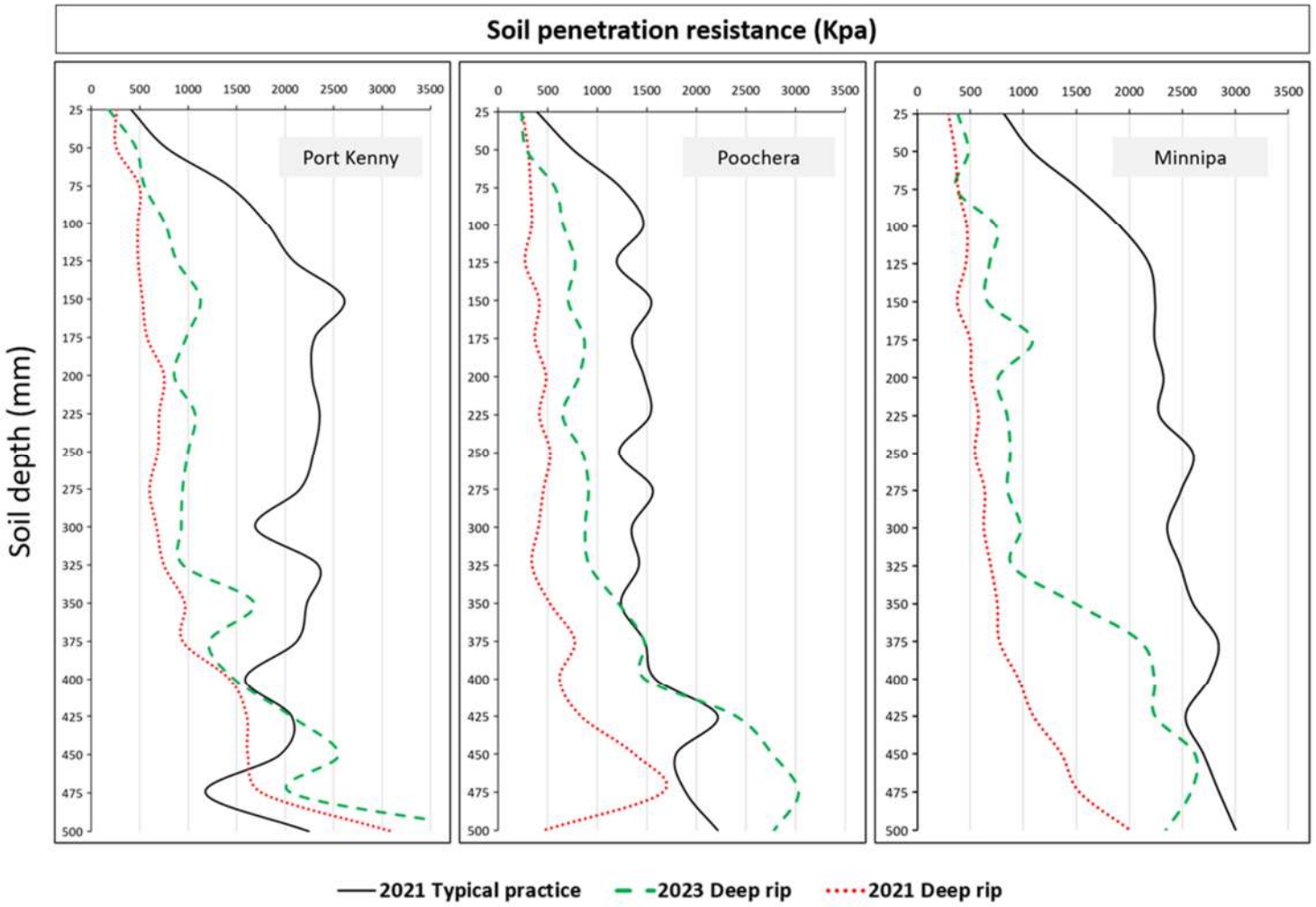

Soil strength

- Compaction is not severe in these soils
- Signs of re-compaction of the ripped treatments (dotted green line)

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Recommendations

- ✓ Crop responses to subsoil strategies are smaller and less likely in highly calcareous soils. **Focus on short-term topsoil strategies.**
- ✓ Increasing seed sowing rate is an effective strategy to improve plant population, crop biomass and grain yield.
- ✓ **Carbon-coated minerals** proved to be an effective strategy to improve early crop vigour, biomass and grain yield.
- ✓ Deep ripping has proven to be less effective.

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- ✓ **Carbon-coated minerals** proved to be an effective strategy to improve early crop vigour, biomass and grain yield. **Not commercially available on the market**
- ✓ Deep ripping has proven to be less effective. **Focus on identifying and understanding the underlying subsoil constraints.**

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