Effects of Novel Soil Amendments on Nutrient Leaching in a Sand

<u>Richard Bell,</u> Simon Yeap and Karthika Pradeep

23 July 2025

SOILSWEST

Murdoch University

SOIL CRC

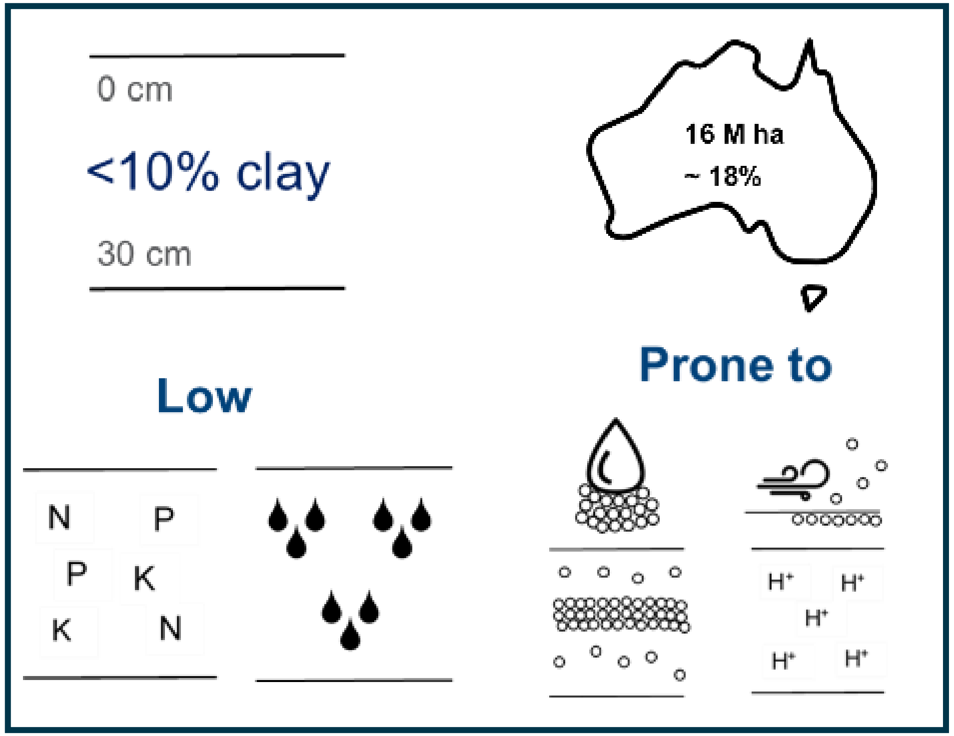
Performance through collaboration

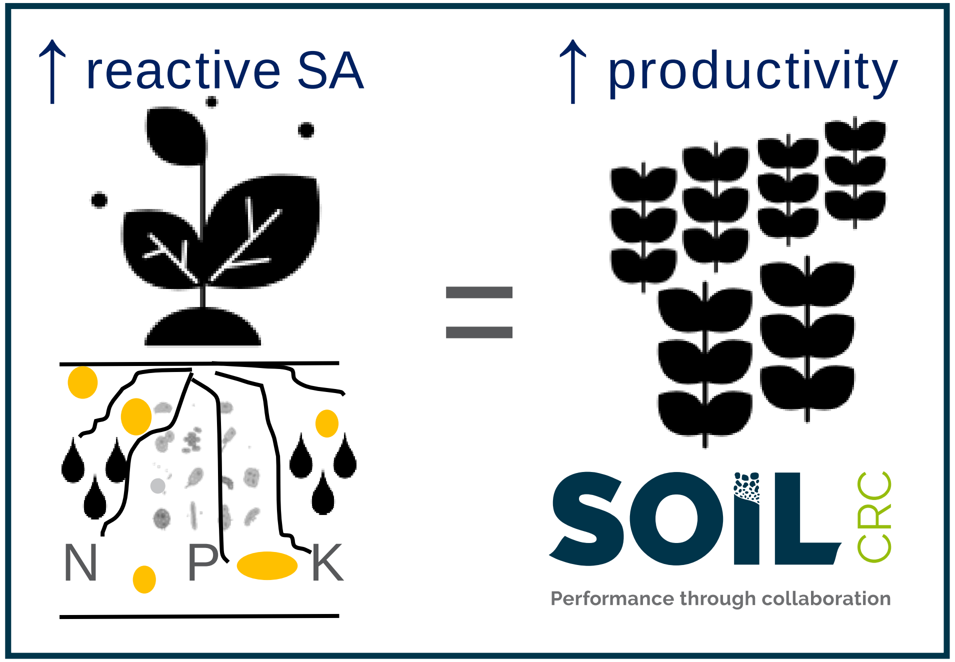
Sandy soils often have multiple limitations

- these need to be addressed before an increase in productivity and OC can be expected

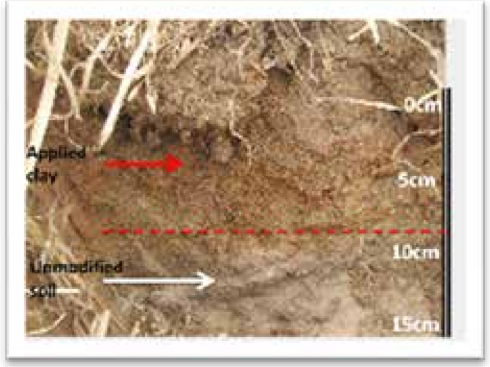
High performance sandy soils = increase reactive surface area with added clay and / or organic material

Design by Amanda Schapel





SANDY SOIL AMELIORATION TECHNIQUES



SOIL CRC
Performance through collaboration

LITERATURE REVIEW

19 Sandy Soil Constraints
Organic and Clay Amendments to Improve the Productivity of Sandy Soils

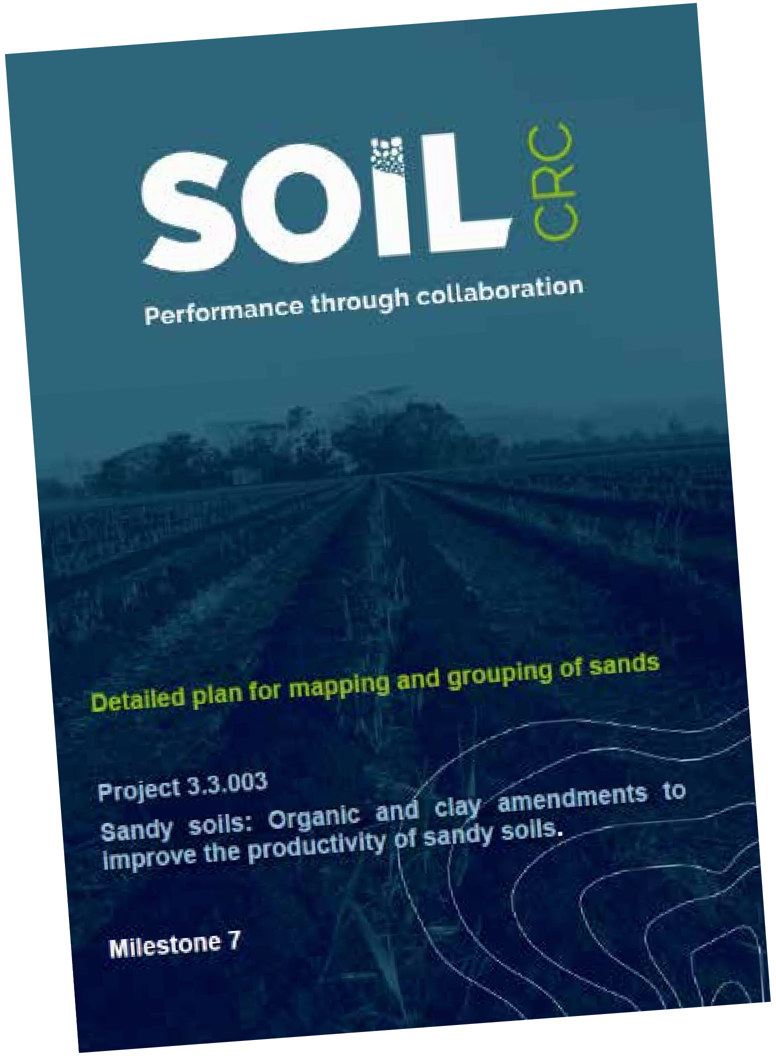
Amanda Schapel[1], Richard Bell[2], Simon Yeap[2,3], and David Hall[4]

Topics Covered

- Characterising sandy soil
- Production influences
- Challenges to sandy soils and how they can be overcome
- Review sandy soil amendments (organic amendments and clay) and effects on yield and OC
- Novel products identified- industrial waste, minerals, organic, super-absorbent and micronised polymers

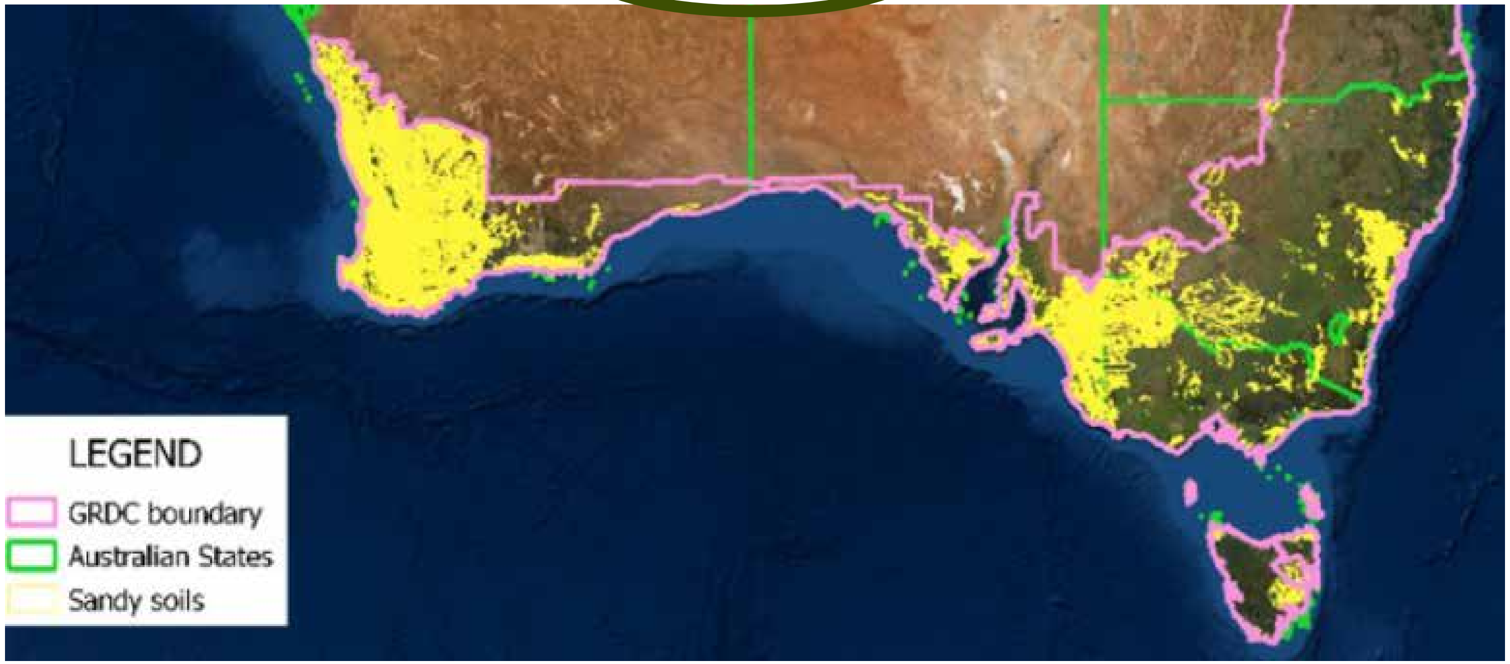
SOiL CRC
Performance through collaboration

MAPPING AND GROUPING OF SANDS



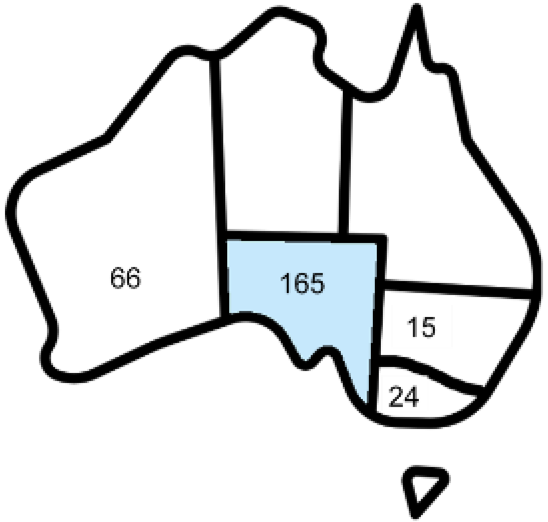
Nathan Robinson and Rick Pope, Federation University Australia

State	Area (ha) of sandy soils in agricultural land	% of agricultural land in state
Western Australia	10,611,418	51.3
South Australia	2,479,772	22.8
New South Wales	1,867,352	4.1
Victoria	864,944	6.9
Tasmania	215,526	17.7
National	16,039,012	

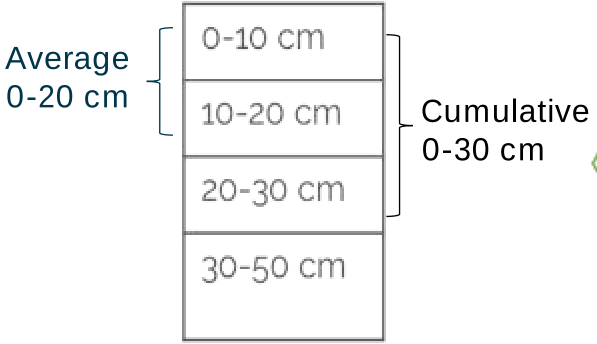


META-ANALYSIS

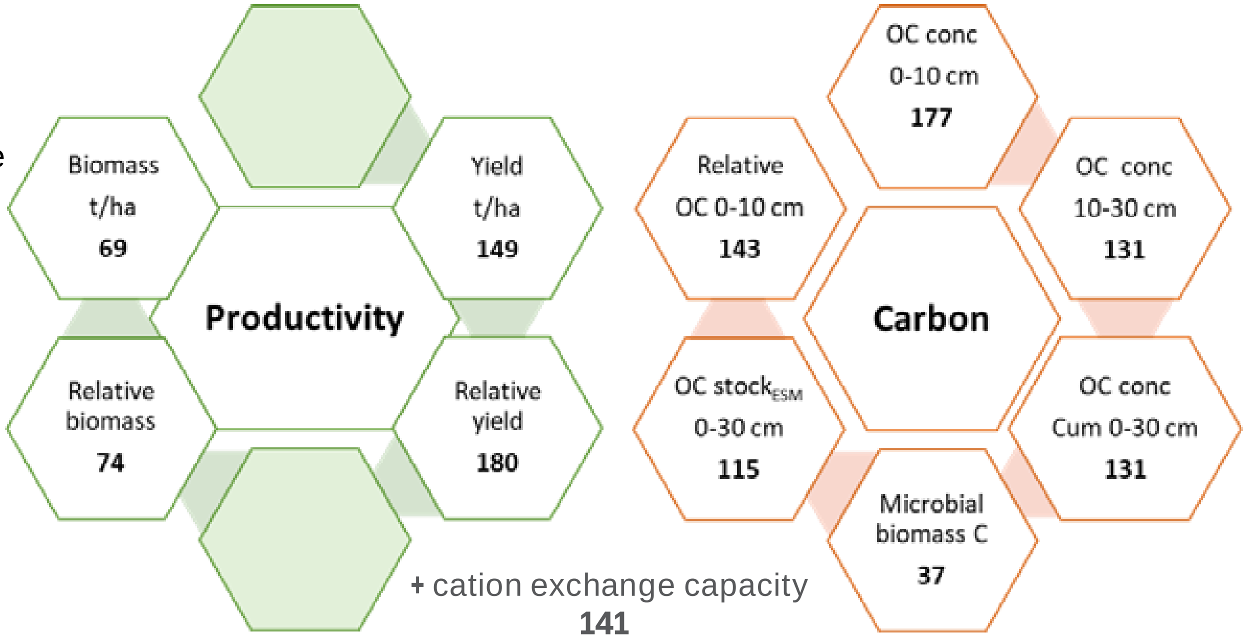
89 projects - 270 records



Soil depths



Key variables assessed



Analysis

- Linear regression, coefficients recorded where $P < 0.05$ for 180 variables
- Top 10 factors for key variables – ‘influencing factors’
- Grouped data for influencing factors

SOIL CRC
Performance through collaboration

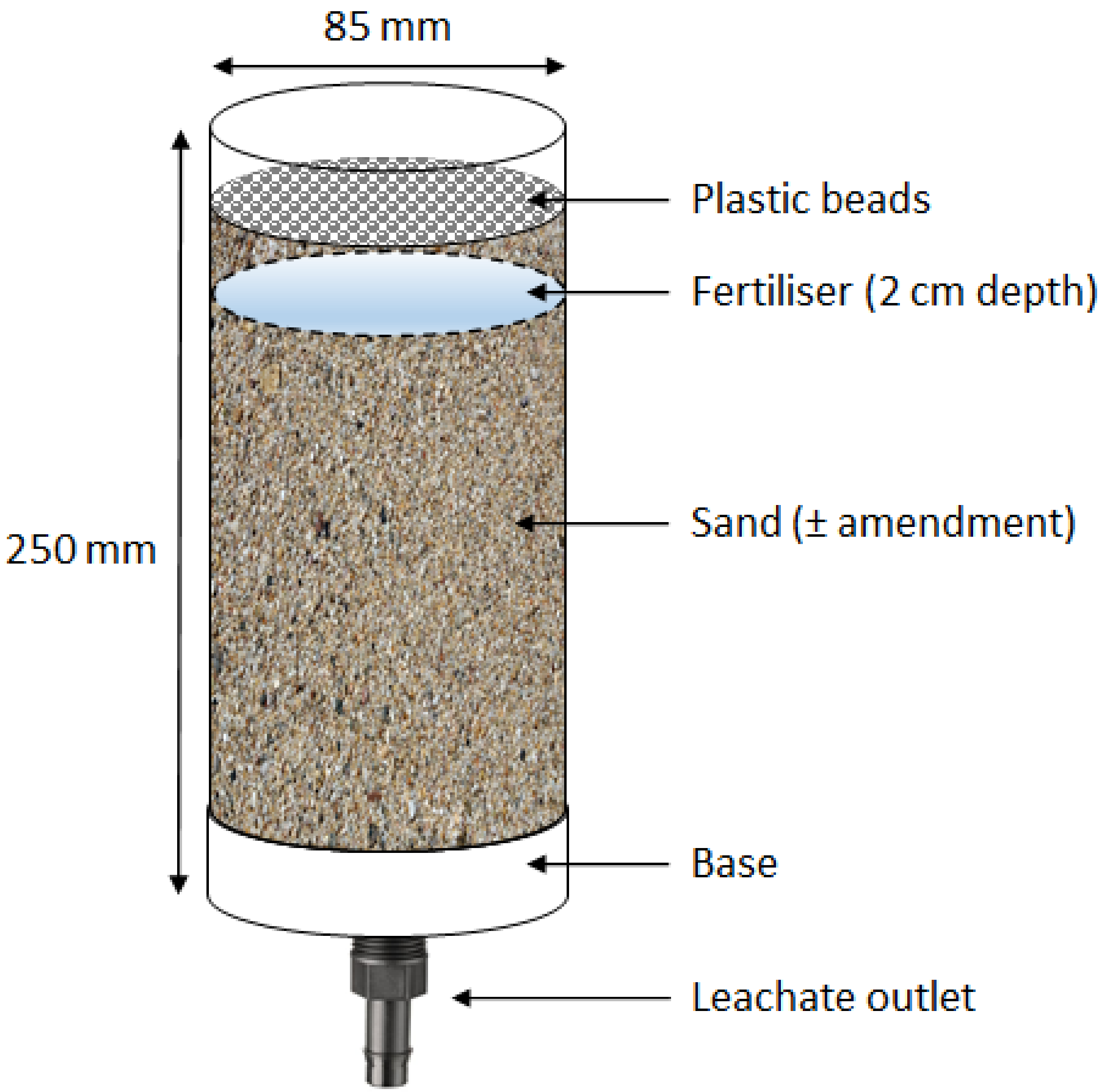
[OFFICIAL]

What novel amendments can improve properties of sands by suppressed leaching?

COLUMNS

- 2 irrigation regimes:
  - low (33.4 mm), high irrigation regime (42.8 mm).
- 10 irrigation events every 4 days, equivalent to the 25th (334 mm) and 75th percentile (428 mm) of annual rainfall at Meckering

- Granular fertiliser at 2 cm depth
- 50 N, 21 P, 58 K, 5.0 Mg, 41 S, 0.4 Zn, 0.1 B, 0.3 Mn, and 0.1 Cu mg/kg
- soil bulk density -1.6 g/cm³



AMENDMENT TREATMENTS

- Sand control
- Compost pellets (from Carbon Ag Solutions WA)
- Compost ground
- Zeolite rock (4-6 mm; Zeolite Australia, NSW)
- Zeolite ground
- Spongolite (0.5-2 mm; Southern Spongelite Industries, WA)
- Rescapye (sodium acrylate/acrylamide copolymer; MIBA Rescaype AB, Sweden).

- Compost, zeolite, and spongolite applied at equivalent to 20 t/ha,
- Rescaype applied at recommended rate of 10 kg/ha.

Meckering sand

Sand 96 %
Silt 3 %
Clay 1%

Properties	Soil	Zeolite	Compost	Spongolite
pH ($CaCl_2$)	6.7	6.2	7	4.5
Organic carbon (g / kg)	0.64	<0.5	51.6	1.3
Min-N (mg / kg)	13	31	204	8
Colwell P (mg / kg)	10	3	952	3
Colwell K (mg / kg)	24	634	8974	444
S (mg / kg)	1.9	4	6501	579
B (mg / kg)	0.15	0.1	6.4	2.39
Cu (mg / kg)	0.56	0.26	11.6	2.08
Fe (mg / kg)	11.6	5.8	41.4	20
Mn (mg / kg)	3.3	4.82	117	0.62
Zn (mg / kg)	0.77	0.44	151	0.88
Ex. Ca (cmol(+) / kg) $^{\Delta}$	1.51	9.38	73.9	1.64
Ex. Mg (cmol(+) / kg) $^{\Delta}$	0.2	1.95	17	6.22
CEC (cmol(+) / kg) $^{\Delta}$	1.8	17.3	124	30
Ex. Na (%)	1	29.8	9.7	69.7
PBI	15	21.6	137	70.4

$^{\Delta}$ Exchangeable cations (not pre-washed).

SOIL CRC
Performance through collaboration

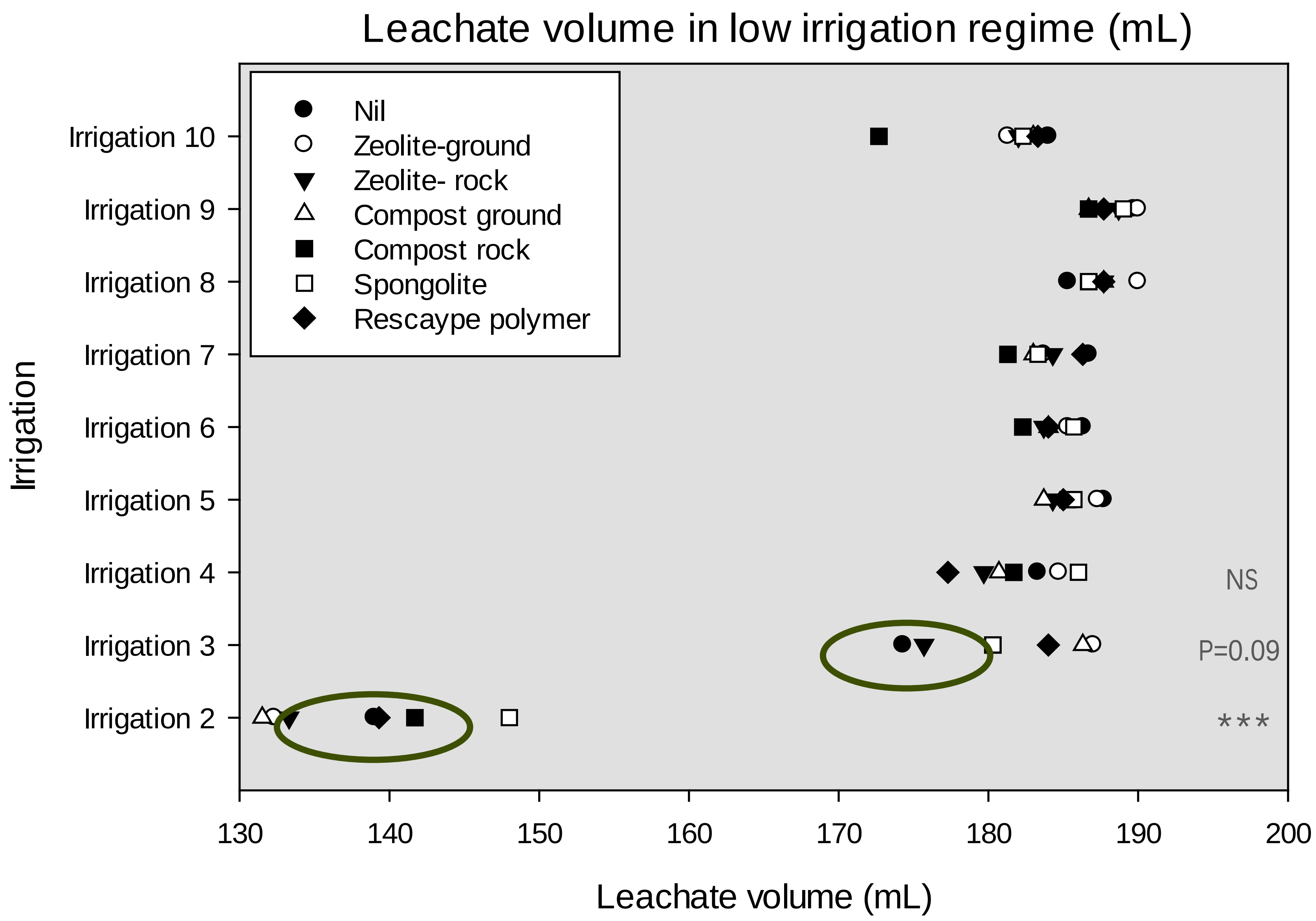
Properties	Soil	Zeolite	Compost	Spongolite
pH ($CaCl_2$)	6.7	6.2	7	4.5
EC (dS / m)	0.04	0.06	7.6	4.6
Organic carbon (g / kg)	0.64	<0.5	51.6	1.3
Min-N (mg / kg)	13	31	204	8
Colwell P (mg / kg)	10	3	952	3
Colwell K (mg / kg)	24	634	8974	444
S (mg / kg)	1.9	4	6501	579
B (mg / kg)	0.15	0.1	6.4	2.4
Cu (mg / kg)	0.56	0.26	11.6	2.2
Fe (mg / kg)	11.6	5.8	41.4	20
Mn (mg / kg)	3.32	4.8	117	0.6
Zn (mg / kg)	0.77	0.44	151	0.88
Ex. Ca (cmol(+) / kg) $^{\Delta}$	1.51	9.4	73.9	1.6
Ex. Mg (cmol(+) / kg) $^{\Delta}$	0.2	2.0	17	6.2
CEC (cmol(+) / kg) $^{\Delta}$	1.8	17	124	30
Ex. Na (%)	1	30	10	70
PBI	15	22	137	70

$^{\Delta}$ Exchangeable cations (not pre-washed).

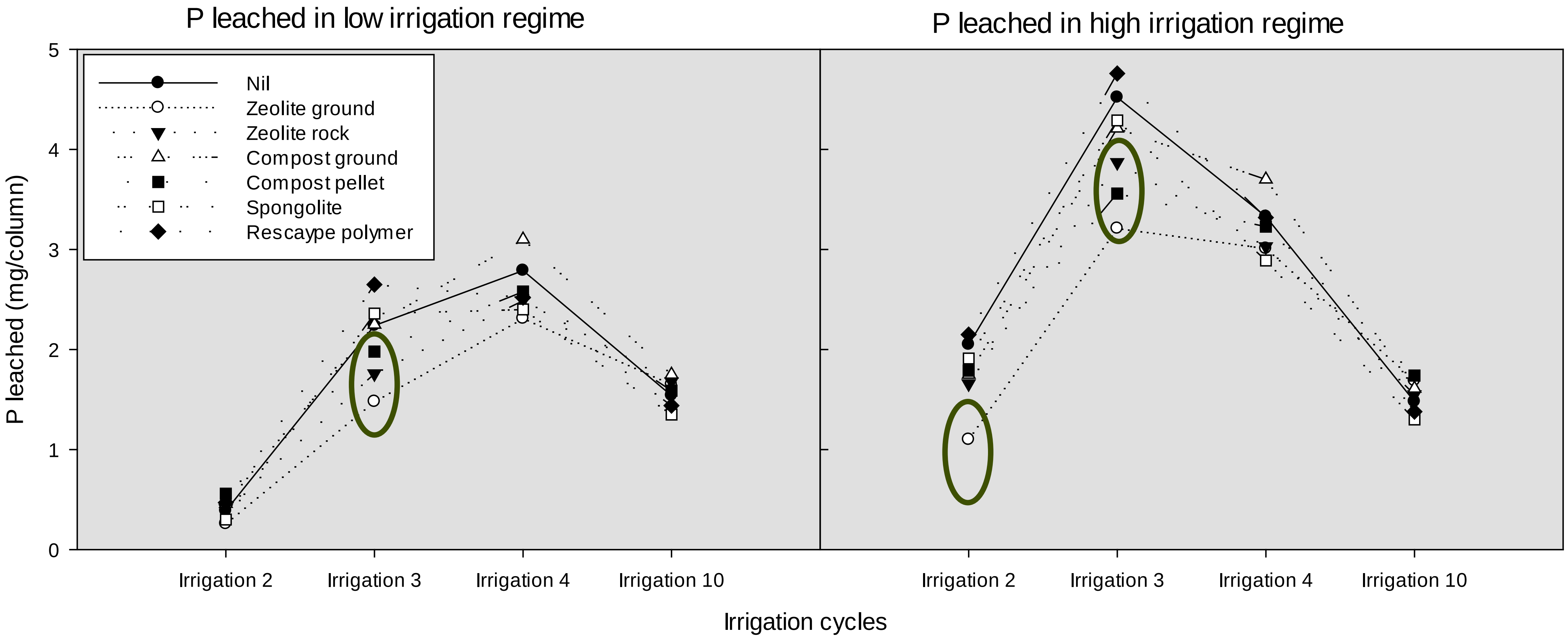
SOIL CRC
Performance through collaboration

[OFFICIAL]

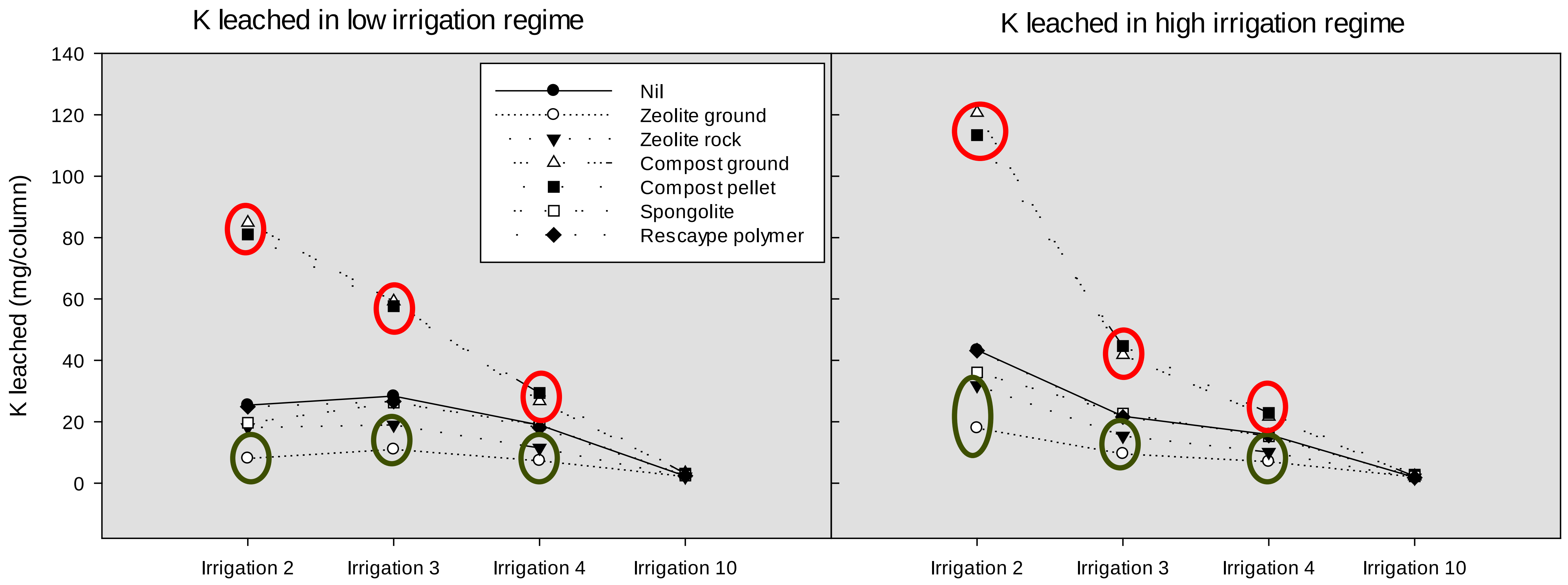
Leachate volumes



P LEACHED OVER TIME



K LEACHED OVER TIME



Performance through collaboration

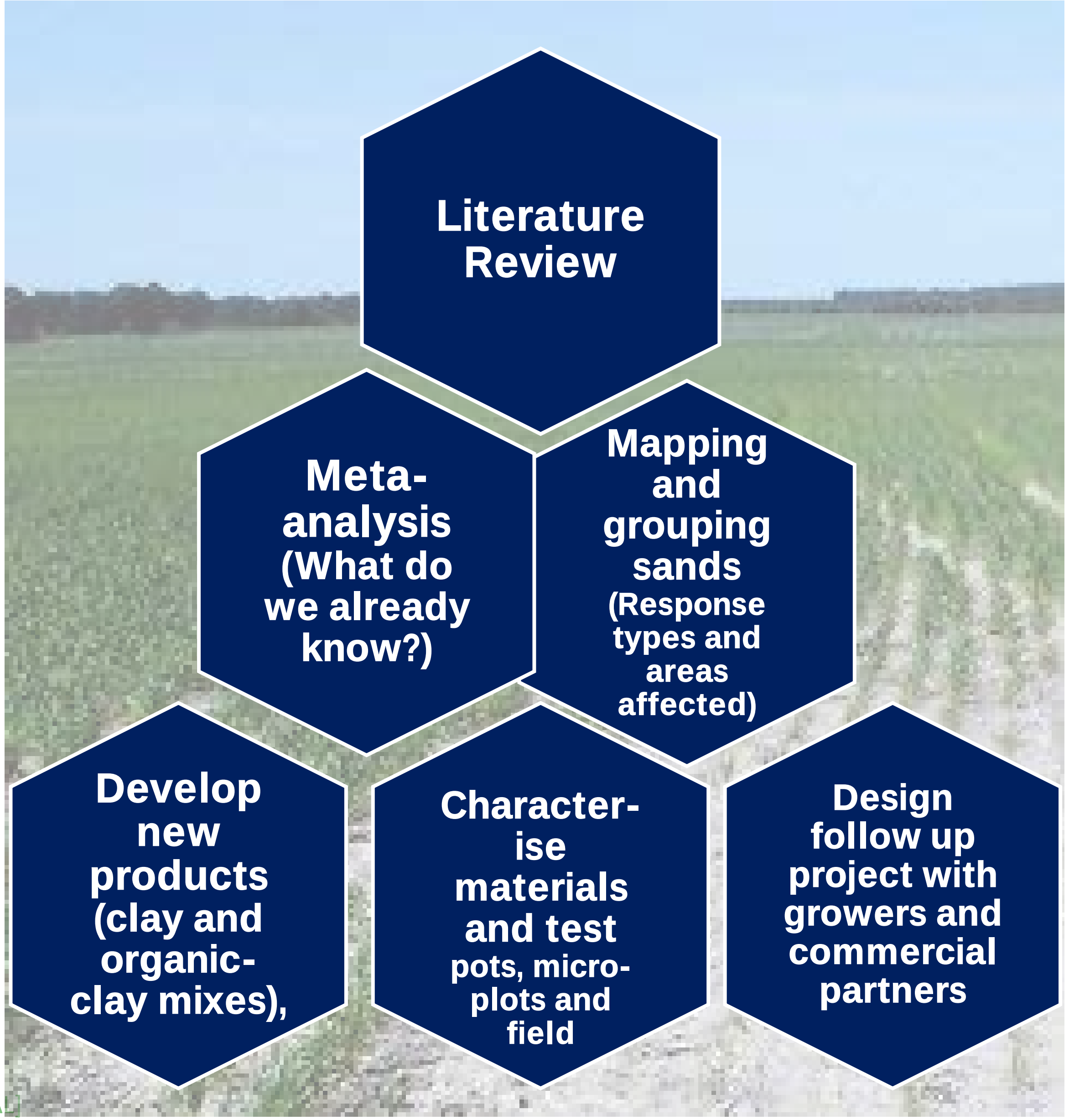
[OFFICIAL]

CONCLUSIONS

- **Zeolite most promising for water retention, and decreased leaching of cations and P**
- **Compost had mixed effects, lowering leaching volumes <u>but</u> increasing loss of N, K, Ca, Mg, S**
- **Hydrotalcite – promising for P retention in other studies**
- **Bentonite – product may have high Na, B**
- **Polymer – no benefits under adequate water supply**
- **Field evaluations in long term experiments underway**

SOIL CRC
Performance through collaboration

PROJECT ACTIVITIES



How do we permanently increase the reactive surface of sandy soils?

- **Literature review**
  - **What can we learn from previous work on addition of organic matter and clay to sandy soils?**
  - **What novel products have been used in Australia and globally**
- **Meta-analysis will assess current benefits**
- **Select and evaluate novel products**

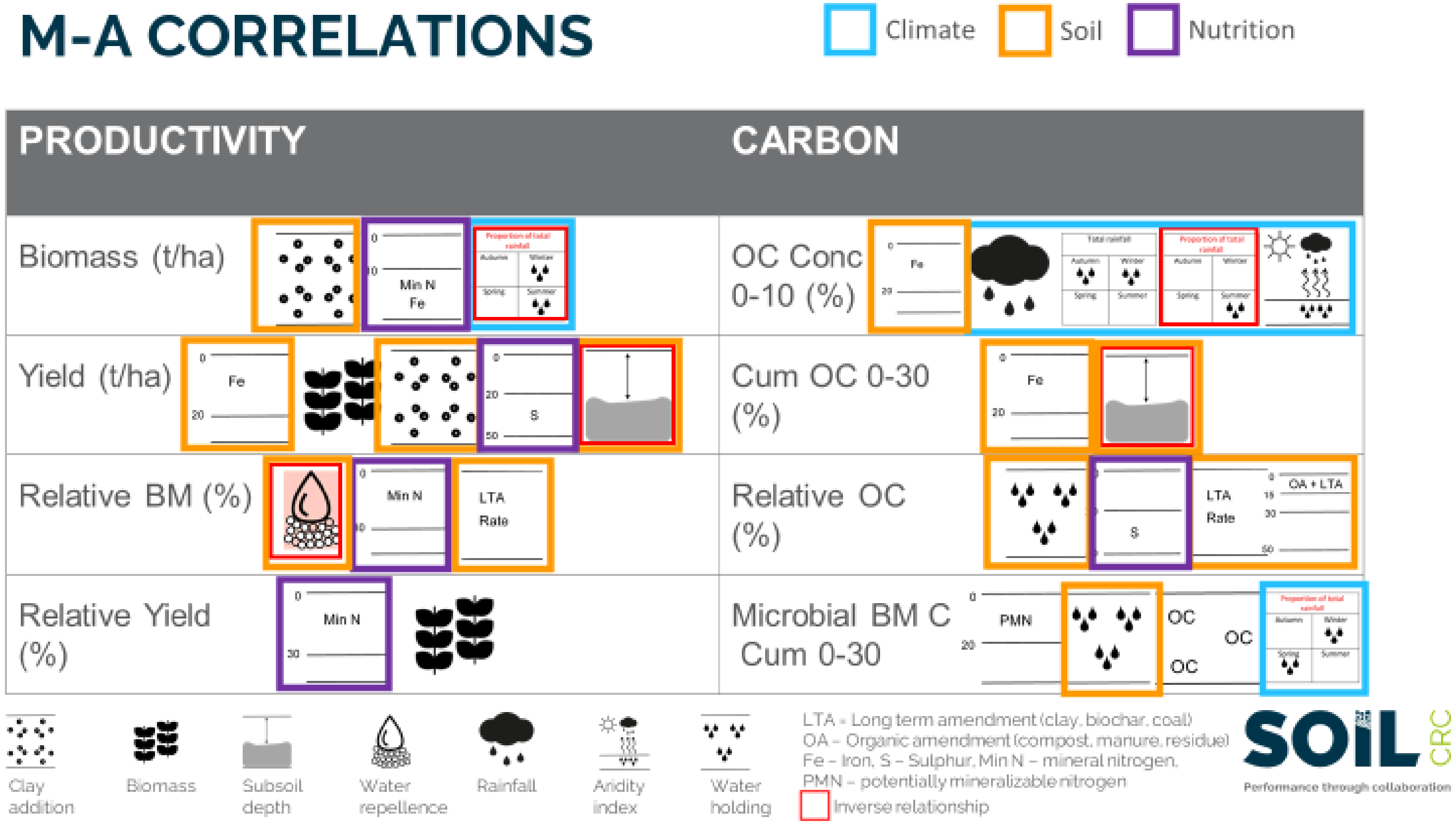
SOIL CRC
Performance through collaboration

META-ANALYSIS

Amanda Schapel SARDI, Richard Bell Murdoch University

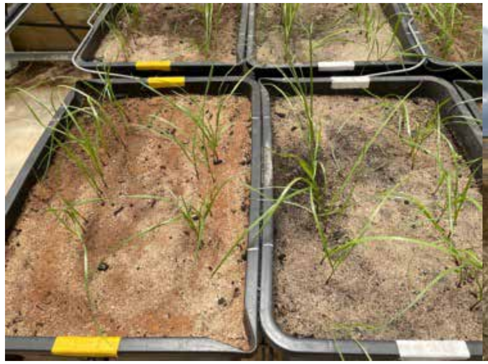
- long-term assessment of clay and organic amendments in relation to the productivity and carbon concentration of sandy soil
- examine the factors that influence productivity and OC

https://www.youtube.com/watch?v=mrbxSXmX5Q8&t=8s&ab_channel=SoilCRC



STRATEGY FOR BUILDING SOIL ORGANIC CARBON AND CO-BENEFITS IN DEEP SANDS

- **Add compost / biochar (e.g. FOGO-based products)**
- **Add clay (to stabilise carbon in sands)**
- **Incorporate to depth (to store more carbon than topsoil)**
- **Grow biomass (to provide continuous carbon inputs)**
- **Minimum soil disturbance (to slow decomposition of soil carbon)**
- **Maintain soil cover (lower soil temperature)**



L CRC
collaboration