Case Study 3 - West Midlands Group, Evolving Soils Project.

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Interpretation of lab data and graphical results for Paddocks 3, 2 and 1 (reported on in order of sampling).

Paddock 3!

At the time of soil sampling paddock 3 (used for grazing/pasture) we collected 49 sub samples from 0 - 30 cm, which were thoroughly combined, and a portion sent to the lab for testing. This paddock is historically known to be salty and was in a flood plain area that had a significant amount of natural and manmade gullies to direct water flow.

The samples were collected in a grid pattern over most of the paddock as best we could whilst traversing and avoiding gullies too deep to cross!

The soil texture was sandy.

Figure 1 P3 Soil Data Graph

The pH levels are fine at 5.91. Paddock 3 has a low CEC at 3.33 consistent with sand. Organic Carbon and Total Carbon levels are good at a midrange level.

Phosphorous (P) levels are low at 13mg/kg. PBI is extremely low (5) indicating potential for plant available P (higher PBI soil binds P). Ideal levels of P for this PBI classification are 20 - 24mg/kg.

Total P indicates some P is available via microbial activity to plant also.

Potassium is low. Magnesium is at good levels.

Calcium is very low. The Ca:Mg ratio is out of balance with a dominating effect of Magnesium.

Ca:K ratio shows in balance, but both are parameters are too low.

Sodium also very high as expected.

Soil tests which show a soil Exchangeable Sodium Percentage (ESP) value of 15% or more require a gypsum treatment program. ESP here is > 43 %. If exchangeable calcium was also very high > 85% then this may be a situation where Elemental Sulphur can be used to improve soil balance and counteract Sodium issues.

Gypsum is Calcium Sulphate. It is essentially a neutral salt and does not reduce soil pH. The proper use of Gypsum is to correct a sodic (high sodium soil) over time. The Calcium in the Gypsum replaces the sodium from the "soil arm", and the sodium combines with the sulphate (sodium-sulphate) which then must be washed (leached) away.

Trace elements (Copper, Zinc, Iron and Manganese) are all low.

Boron is low at 0.17 mg/kg.

Nitrate Nitrogen is low. A low C:N ratio indicates sufficient N in the system if high organic matter is existing. The balance of Nitrate to Ammonium Nitrogen is out of balance at 2.9:3.1 (should be 2:1) indicating low mineralisation rates (less microbial activity then is ideal) Total Nitrogen levels are ok (0.077 x 10 000 = 770) which shows there is N available for microbial activity and transfer to plants.

The low C:N ratio (under 12) at 9.6 can also indicate a soil structure problem, or poor aerobic/aeration considerations. Cultivation may improve aeration and improve N mineralization in this situation.

Paddock 2!

42 sub samples were taken to a depth of 30 cm again mixed for a good paddock average to be sent to the lab for testing. The paddock is used for pasture/grazing.

Figure 2 Paddock 2

The pH level is fine at 6.01. CEC at 1.78 is very low consistent with light sand.

P levels are very very low at 6 mg/kg. PBI is extremely low indicating only small amounts of applied fertiliser will be locked up. There is a high chance of P leaching here if excessive amount were to be applied. Total P indicates some P is available via microbial activity to plant also.

Figure 3 P2 Soil Data Graph

Potassium is also low. Low magnesium also.

Calcium is also low. The Ca:Mg ratio is out of balance at 10.3 with more calcium then required (even though both are low).

Sodium is at adequate levels.

Trace elements (Copper, Zinc, Iron and Manganese) are low.

Boron is also low.

Nitrate Nitrogen is low with C:N ratio indicating if organic matter was high there could be some N in the system for use. The balance of Nitrate to Ammonium Nitrogen is out of balance at 2.4:3 rather than ideal balance of 2:1 indicating little mineralisation is occurring.

The low C:N ratio can also indicate a soil structure problem.

Sulphur is also low.

Paddock 1!

The third paddock tested on this property was quite rocky especially in the region of the gravel hill which was impacting sampling so a section on the flatter region was tested. The paddock area was also 4000 ha so due to timing a smaller comparison area was established.

Figure 4 Paddock 1

The pH levels are fine at 6.3.

CEC is 3.53 consistent with sand.

P levels are low.

PBI is on the very low end of the scale indicating potential for plant available P (higher PBI soil binds P). Total P indicates some P is available via microbial activity to plant also.

Figure 5 Paddock 1 Soil Data Graph

Potassium is sufficient. Magnesium (Mg) is low.

Calcium is sufficient. The Ca:Mg ratio is out of balance with more calcium due to the low Mg.

Sodium is low and not an issue in this paddock.

Trace elements (Copper, Iron and Manganese) are low with Zinc being at sufficient levels.

Boron and Sulphur are also low.

Nitrate Nitrogen is low with a low C:N ratio indicates sufficient N in the system if high organic matter is existing (over 4%). OM here is approx.2. All soils in the wheatbelt have a typically low OM content so keep an eye on N levels. The balance of Nitrate to Ammonium Nitrogen is ok at 5.7: 1.7 which indicates some mineralisation is occurring. Total Nitrogen levels are also looking quite ok with Total N available. The lower C:N ratio (under 12) can also indicate a soil structure problem, with field work also indicating very hard (and rocky) soil, potentially being an issue but not necessarily due to induced compaction. I would suggest using CAN rather SOA when adding nitrogen in future. Cultivation may improve aeration but would be difficult in this paddock due to the rocks.

Comparison/variables between paddocks 3, 2 and 1!

Figure 6 P1, 2 and 3 sampling areas

Further assessment of the data required the generation of comparison graphs for easy viewing, along with data review, refer to the graph below noting it is not 3 samples from 3 depths but 0 - 30 cm samples from 3 paddocks.

The pH levels are fine in all 3 paddocks at 5.91, 6,01 and 6.3 respectively.

The CEC of all paddocks is between 3.33, 1.78 and 3.53 being the highest in the P1 section all representative of sand.

Figure 7 P1 Vs P2 Vs P3 Data Comparison Graph

P levels are all low with the P3 paddock having incrementally more compared to others.

PBI is really low across all sites indicating soil will not bind P, what is applied will be available to the plant however leaching can occur.

Total P indicates P is available via microbial activity to plant also however at low levels across all areas.

Potassium is sufficient in P1 but low across the other paddocks.

Sufficient Mg is apparent in P3 and Calcium low in P3 and P2 but higher/sufficient in the P1 section. The high Mg, low Ca, and high Sodium (Na) in P3 stand out as an issue to balance. Again suggested Gypsum treatment is more important in P3 paddock as the exchangeable sodium percentage (ESP) is much higher than 15% at 43%.

The Ca:Mg ratio across the paddocks again illustrate the dominating balance of Mg in P3 paddock versus Ca in the other two.

Trace elements (Copper, Zinc, Iron and Manganese) are all low except for higher zinc levels in the P1/gravel hills region.

Boron is low across all.

Nitrate Nitrogen is low across all and a low C:N ratio indicates sufficient N in the system if high organic matter is existing. All soils in the wheatbelt have a typically low OM content so keep an eye on N levels. Organic matter is quite low across all between 1.2 – 2.

The balance of Nitrate to Ammonium Nitrogen is out of whack in P3 and P2 having more Ammonium N then Nitrate N however the biological mineralisation process is more effective in the P1 hills region.

Total Nitrogen levels across all paddocks are indicating there is N available for increased biological activity (720 – 970). The P1 gravel hills section has the highest level of activity.

P3 seems to have the biggest issue with soil structure, and this is likely due to the higher Mg along with excessive Sodium.

With this investigation for the Evolving Soils Project a substantial amount of information was made available for better understanding of overall soil health and limiting factors, improving management practises, and ensuring environmental sustainability continues to be at the forefront of considerations!

Raw Lab Data:

SampleName		P3-SA-0-30-12	P2-SA-0-30-13	P1-SA-0-30-14
pH 1:5 water	pH units	5.91	6.01	6.3
pH CaCl2 (following 4A1)	pH units	5.25	5.08	5.59
Organic Carbon (W&B)	% (40°C)	0.74	0.84	1.15
MIR - Aus Soil Texture		Sand	Sand	Sand
Nitrate - N (2M KCl)	mg/kg	2.9	2.4	5.7
Ammonium - N (2M KCl)	mg/kg	3.1	3	1.7
Colwell Phosphorus	mg/kg	13	6	7
PBI + Col P		5	<2	8
Total Phosphorus	mg/kg	62	52	67
Colwell Potassium	mg/kg	34	42	64
KCl Sulfur (S)	mg/kg	17	2.9	4.6
Calcium (Ca) - NH4Cl/BaCl2	mg/kg	243	272	577
Magnesium (Mg) - NH4Cl/BaCl2	mg/kg	70	26	48
Potassium (K) - NH4Cl/BaCl2	mg/kg	31	40	67
Sodium (NH4Cl/BaCl2)	mg/kg	329	23.2	21
Calcium (Ca) - NH4Cl/BaCl2	cmol/kg	1.21	1.36	2.88
Magnesium (Mg) - NH4Cl/BaCl2	cmol/kg	0.578	0.216	0.392
Potassium (K) - NH4Cl/BaCl2	cmol/kg	0.08	0.102	0.172
Sodium (NH4Cl/BaCl2)	cmol/kg	1.43	0.101	0.091
Ca:Mg ratio		2.1	6.3	7.4
K:Mg ratio		0.14	0.47	0.44
GTRI		0.04	0.06	0.05
ECR	%	46	11	7.5
Exchangeable acidity	cmol/kg	0.03	<0.02	<0.02
Exchangeable aluminium	cmol/kg	<0.02	<0.02	<0.02
Exchangeable hydrogen	cmol/kg	0.02	<0.02	<0.02
ECEC	cmol/kg	3.33	1.78	3.53
Calcium	%	36.4	76.4	81.5
Magnesium	%	17.4	12.1	11.1
Potassium	%	2.4	5.7	4.9
Sodium	%	43	5.7	2.6
Aluminium	%	0.1	0	0
Hydrogen	%	0.7	0	0
Salinity EC 1:5	dS/m	0.46	0.063	0.077
Ece	dS/m	11	1.5	1.8
Boron	mg/kg	0.17	0.12	0.18
Iron (Fe)	mg/kg	25	16	9.2
Manganese (Mn)	mg/kg	1.2	2.2	2.3
Copper (Cu)	mg/kg	0.23	0.2	0.21
Zinc (Zn)	mg/kg	0.64	0.55	0.88
Dumas Total Nitrogen	% dry wt	0.077	0.072	0.097
TDS	mg/L	290	41	49
MIR CaCO3 equiv	%	<1	<1	<1
MIR Tot IC	%	<0.12	<0.12	<0.12
Total Carbon	% dry wt	0.66	0.79	1.13