Department of
Primary Industries and
Regional Development

GOVERNMENT OF
WESTERN AUSTRALIA

DEFINING GYPSUM RESPONSIVE SOILS

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Variable gypsum responses on the south coast of Western Australia

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KEY MESSAGES

Gypsum can increase water use efficiency (yields) on dispersive subsoils as well as topsoils.
Gypsum moves rapidly into the soil profile and benefits can remain for many years.
Not all high EM and dispersive sites are gypsum responsive, careful sampling and analysis is required to diagnose likely responsiveness.

KEY QUESTIONS

What is the extent and impact of sodicity on crop yields ?

Which soil properties affect dispersion ?

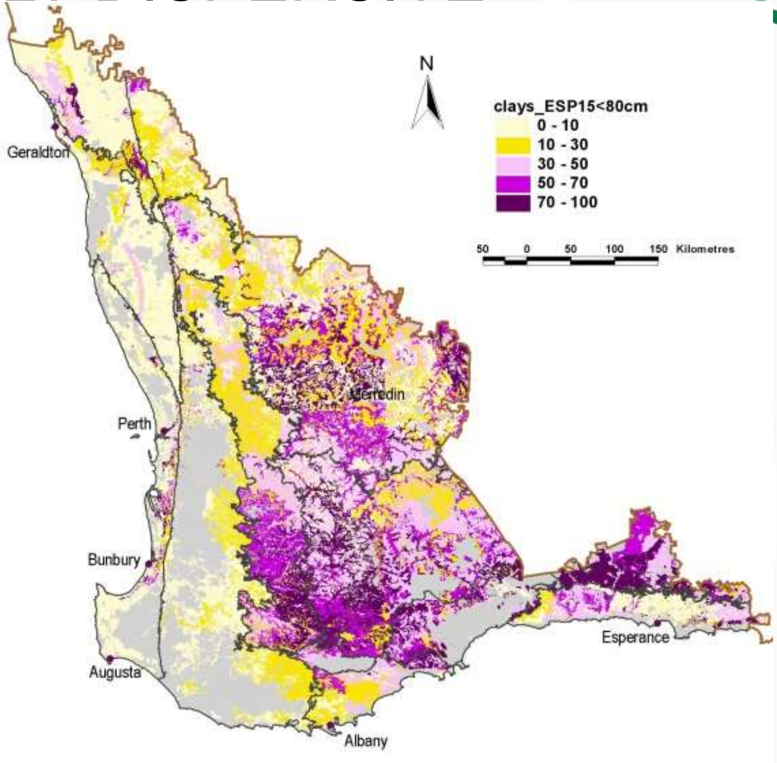
Which soils properties distinguish gypsum responsive from unresponsive soils ?

SODIC AND POTENTIALLY DISPERSIVE SOILS IN WA

30% of the WA wheatbelt soils are strongly sodic.

Poor aggregate stability when wet leading to dispersion.

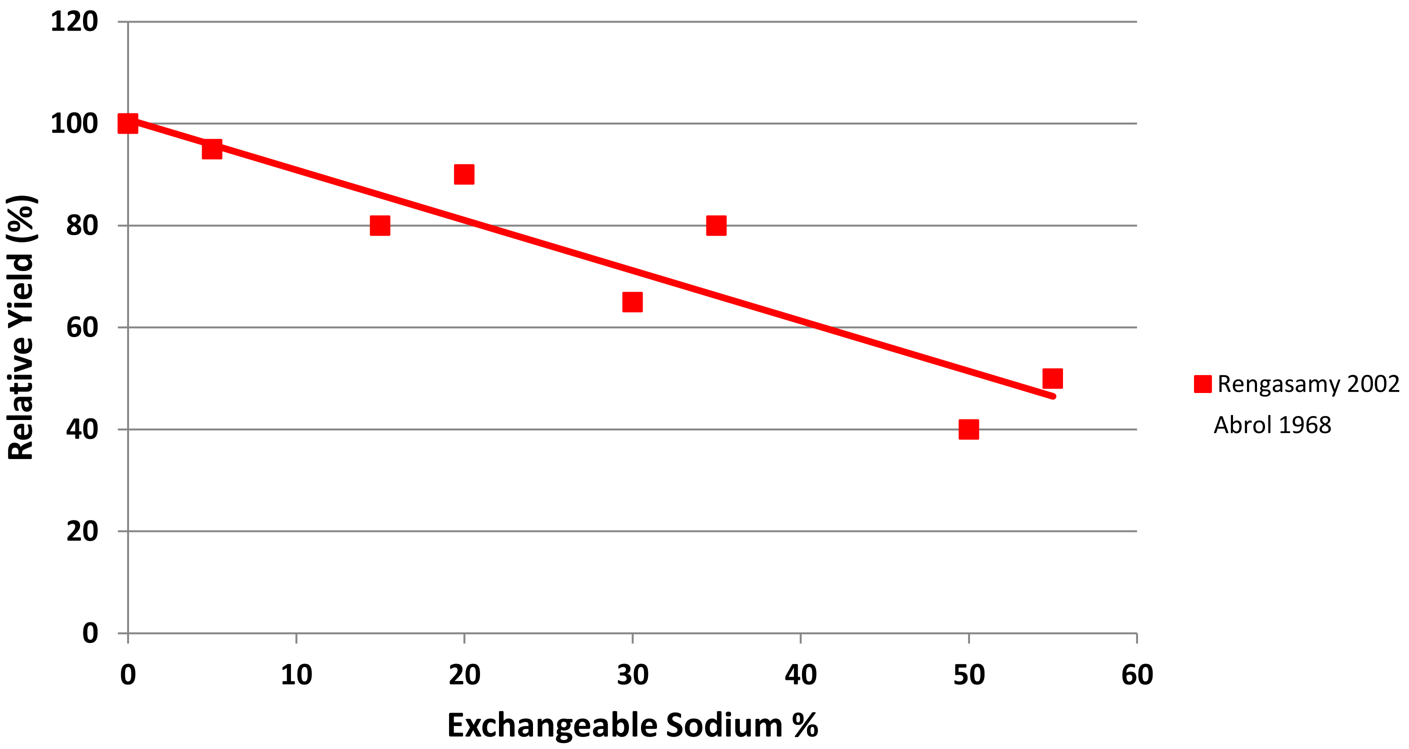
Dispersion is the separation of particles into their sand , silt and clay fractions when saturated.



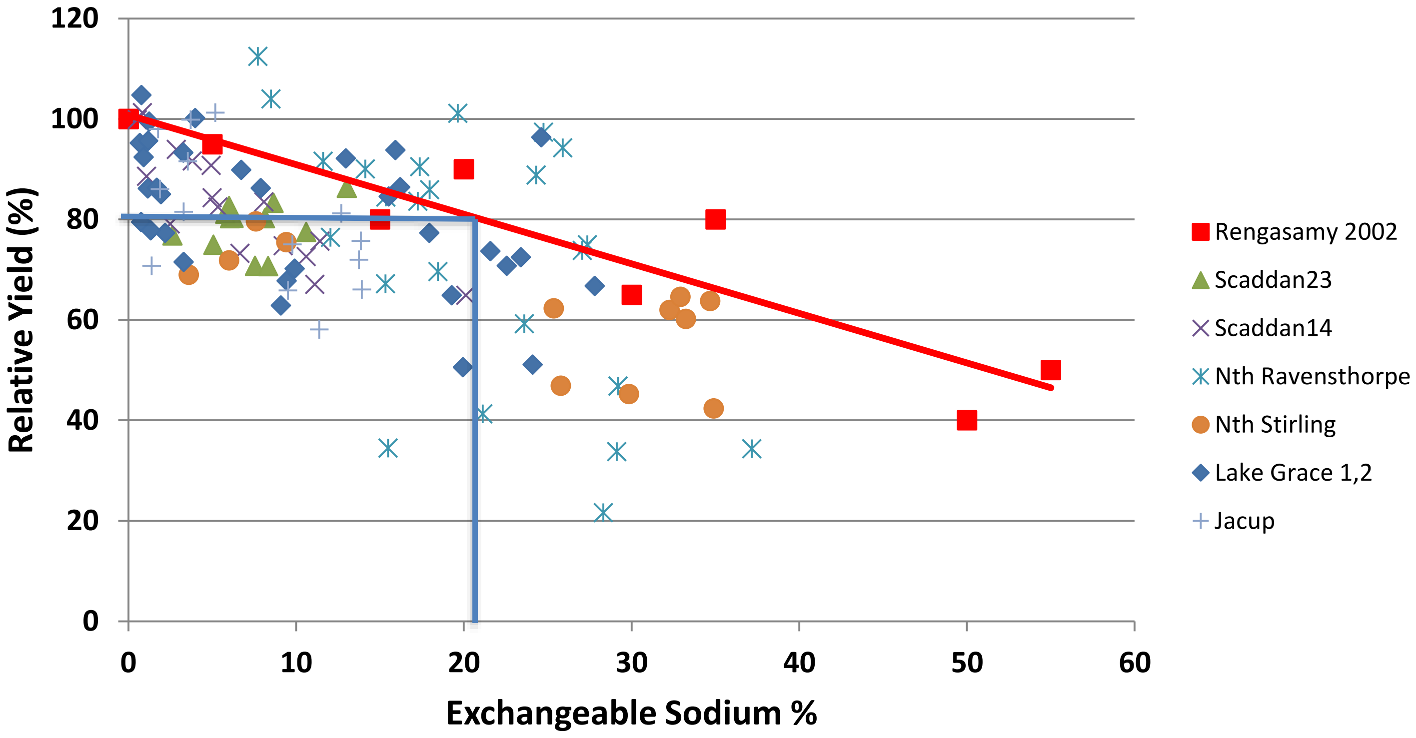
Source: van Gool 2016

Impacts of dispersion on soil structure

Effect of sodicity on crop yield



Effect of sodicity on crop yield : Southern Wheatbelt



KEY QUESTIONS

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Which soil chemical properties control dispersion ?

METHODS: SITES

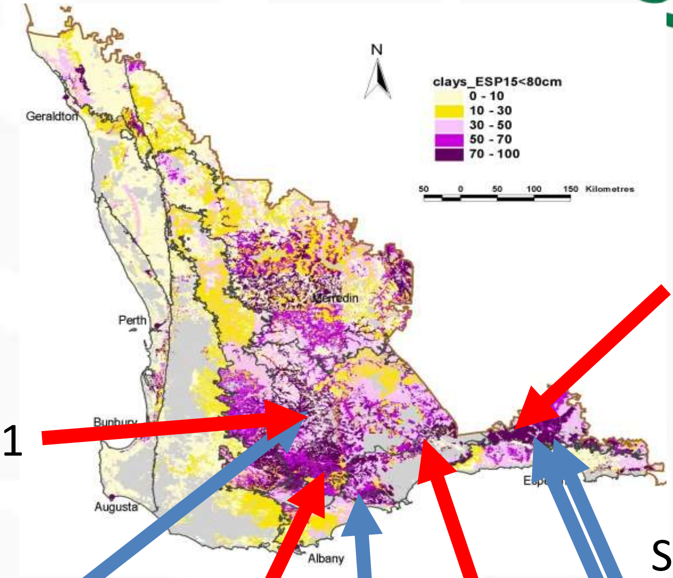
Eight trial sites in southern wheatbelt

Gypsum rate (0 – 10 t/ha) trial sites with replicated Controls.

Soil and plant measurements In five locations in each strip.

Four of the sites were gypsum responsive

Four sites unresponsive to gypsum



Crop un responsive to gypsum

Crop responsive to gypsum

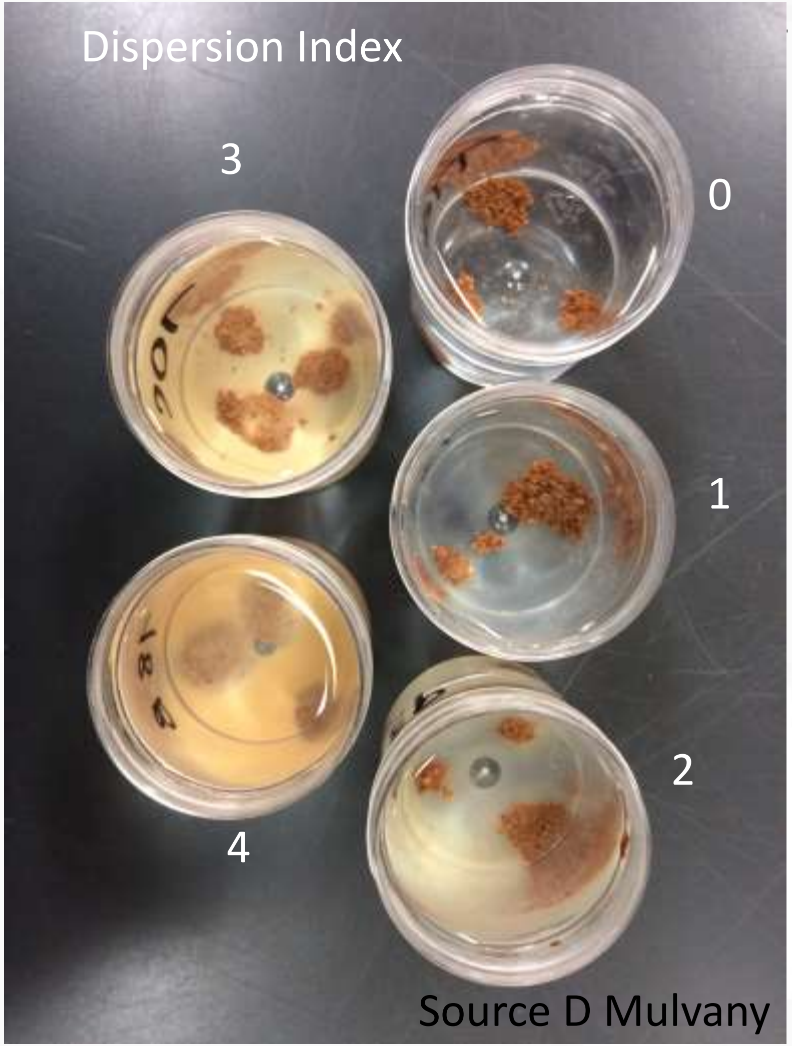
METHODS: MEASUREMENTS

At each site soil samples collected at (10, 20, 30 cm)

- Dispersion Index
- pH, Electrical conductivity (EC)
- Organic Carbon %
- Pre washed exchangeable cations (Ca, Mg, Na, K)
- EM and Gamma at Lake Grace only

Calculated soil stability indices (Av 0 – 30 cm)

- Exchangeable sodium % = Na/(Ca+Mg+Na+K) x 100
- EC/ESP
- Ca:Mg ratio
- Organic Carbon %
- Stability index = f(ESP, EC, OC%, Ca:Mg)



Ranking of soil properties that influence dispersion

$$\text{Dispersion Index (DI)} = a+b(c)^{x}$$

Soil Properties (x) (Av 0-30cm)	Adj r^2	Prob	Critical Level DI > 2	Literature
ESP	67	***	>5	> 6
EC/ESP	43	***	<0.13	<0.2
Stability Index (SI)#	40	***	<0.8	< 0
Organic carbon %	37	***	<0.8	
Ca:Mg	35	***	<2.3	< 2

*** (P<0.001)

Stability Index = f (ESP, OC, EC, Ca:Mg)

KEY QUESTIONS

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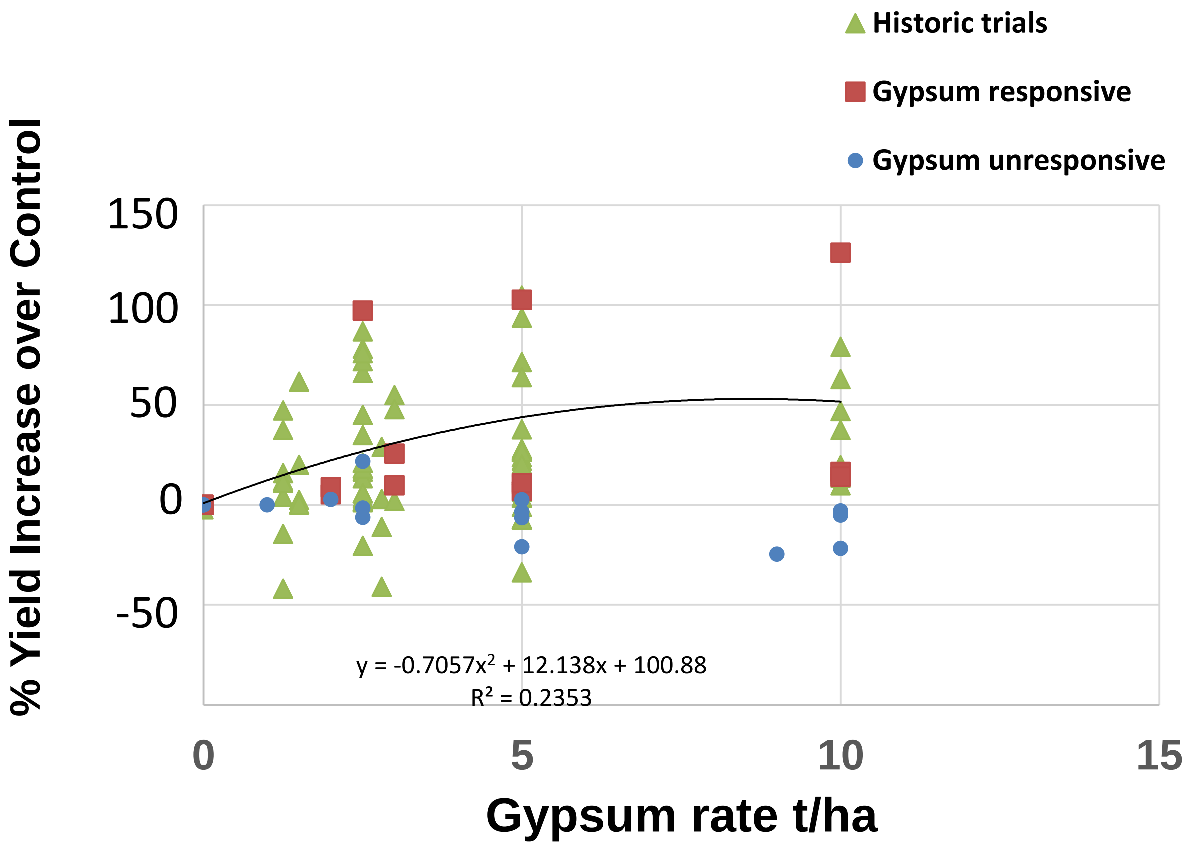
Which properties distinguish gypsum responsive from unresponsive soils ?

Effect of gypsum on crop yields



Identifying gypsum responsive and unresponsive soils

Soil property (Av 0-30cm)	t Statistic	Gypsum Responsive Mean	Gypsum Unresponsive Mean
ESP	10***	15.1	4.1
Stability Index (SI)#	-9.12***	-1.3	0.8
Ca:Mg	-5.63***	1.6	2.9
Dispersion Index (DI)	5.2***	3.4	1.7
EC/ESP	-4.8***	0.07	0.24
Organic Carbon %	-4.8***	0.6	0.83

*** ($P<0.001$)

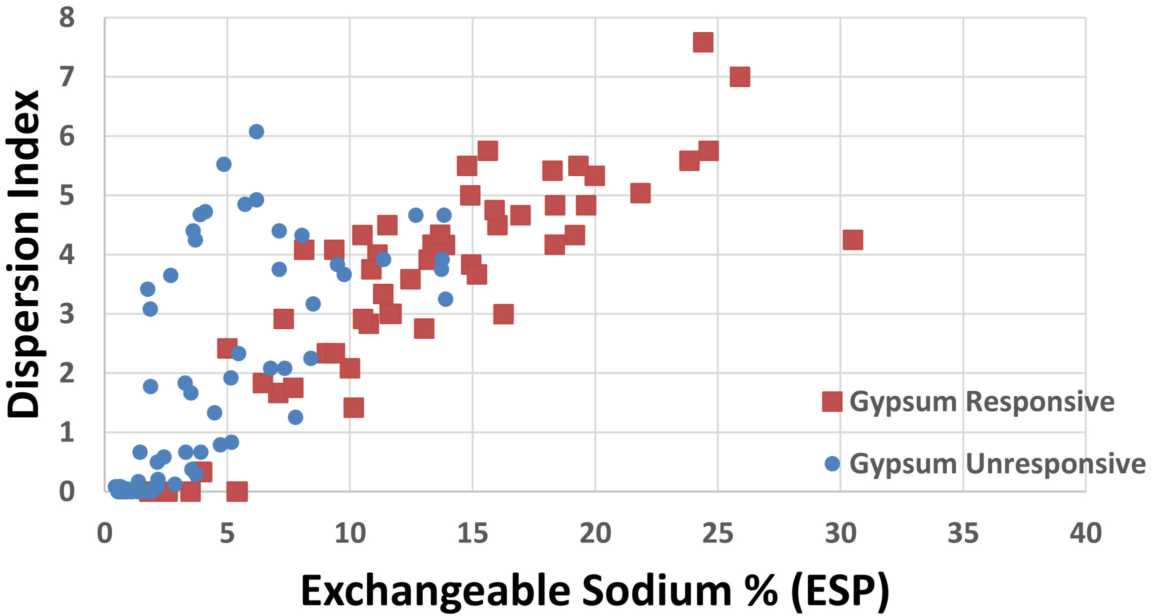
Stability Index = f (ESP, OC, EC, Ca:Mg)

Identifying gypsum responsive and unresponsive soils

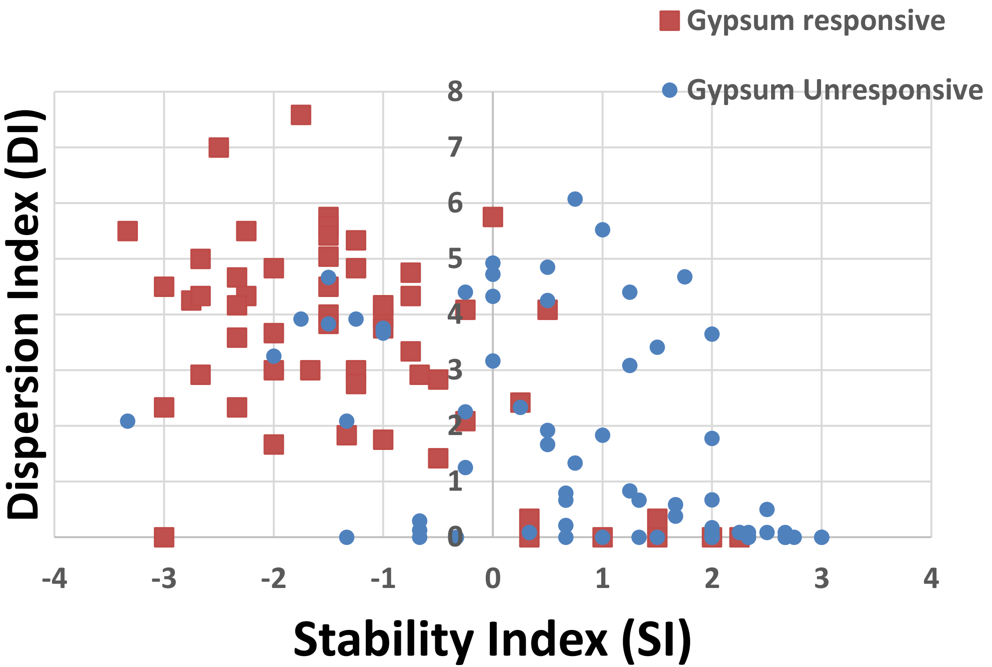
Soil property (Av 0-30cm)	t Statistic	Gypsum Responsive Mean (range)	Gypsum Unresponsive Mean (range)
ESP	10***	15.1 (2 - 33)	4.1 (0.4 - 14)
Stability Index (SI)	-9.12***	-1.3 (-3 – 2)	0.8 (-3 – 3)
Ca:Mg	-5.63***	1.6 (0.2 – 5.8)	2.9 (0.4 – 6.5)
Dispersion Index (DI)	5.2***	3.4 (0 – 7.6)	1.7 (0 – 6)
EC/ESP	-4.8***	0.07 (0.01 – 0.61)	0.24 (0.02 1.28)
Organic Carbon %	-4.8***	0.6 (0 – 1.2)	0.83 (0.4 – 1.6)

*** ($P<0.001$)

Effect of ESP on Dispersion and gypsum response



Effect of Stability Index on Dispersion soil and gypsum response



KEY QUESTIONS

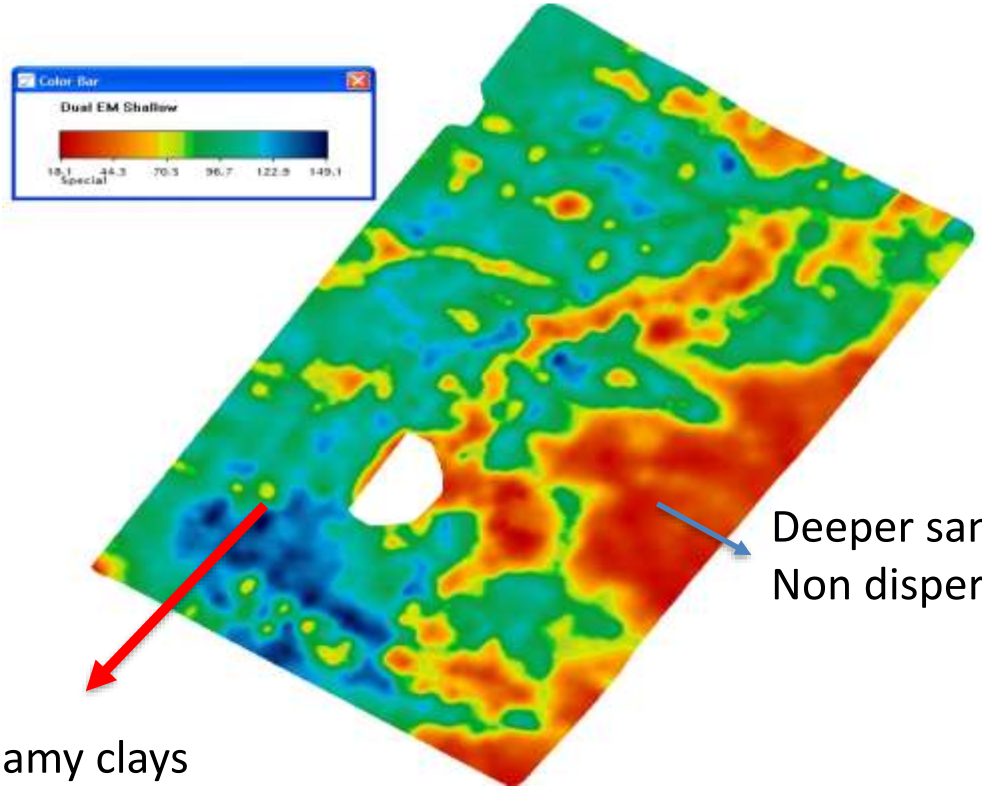
Can we use electro magnetic (EM) induction and gamma radiometrics (U,Th, K) surveys to define gypsum response ?

Geophysics (EM, gamma) ground survey

Using EM to define gypsum response : Mt Madden

EM distinguishes between soils with differing textures, soil water and salinity levels.

EM is useful where there are large textural differences within a paddock ie sands versus clays to locate potential sites.

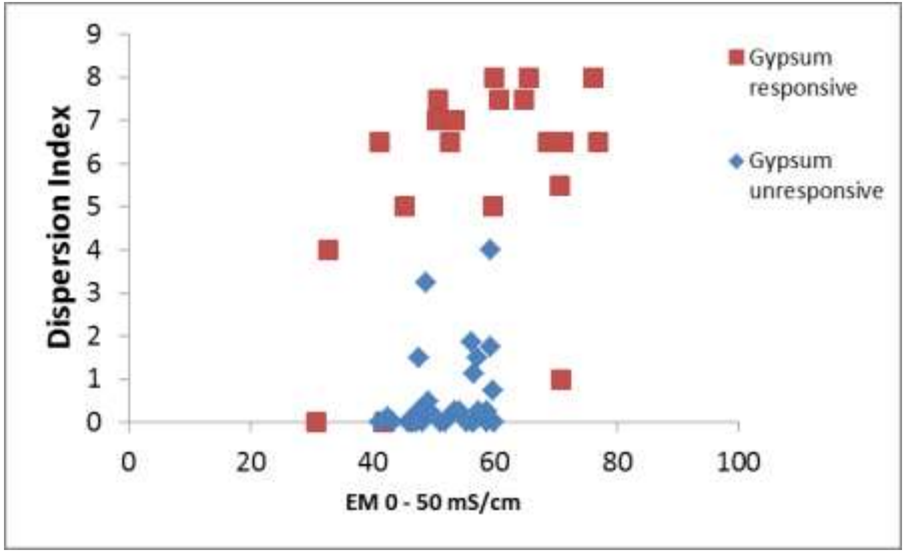


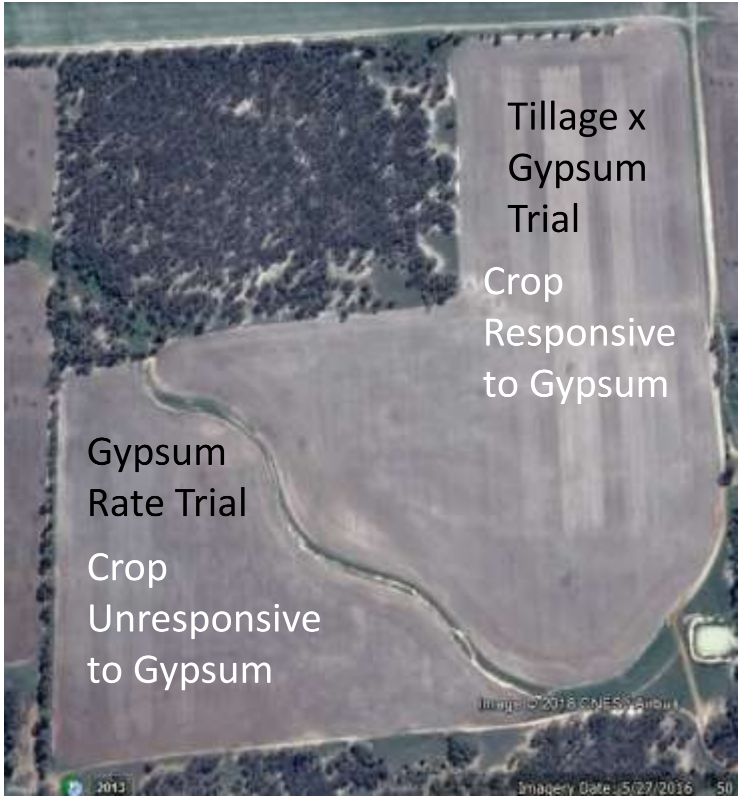
Deeper sands:
Non dispersive

Loamy clays
Gypsum responsive

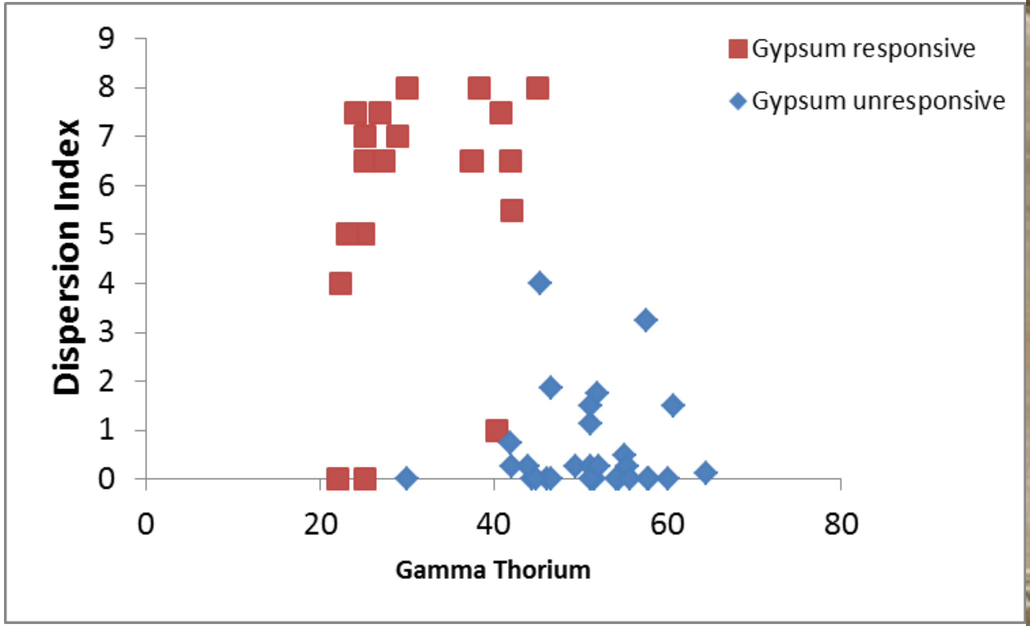
Source PAA, D’Emden

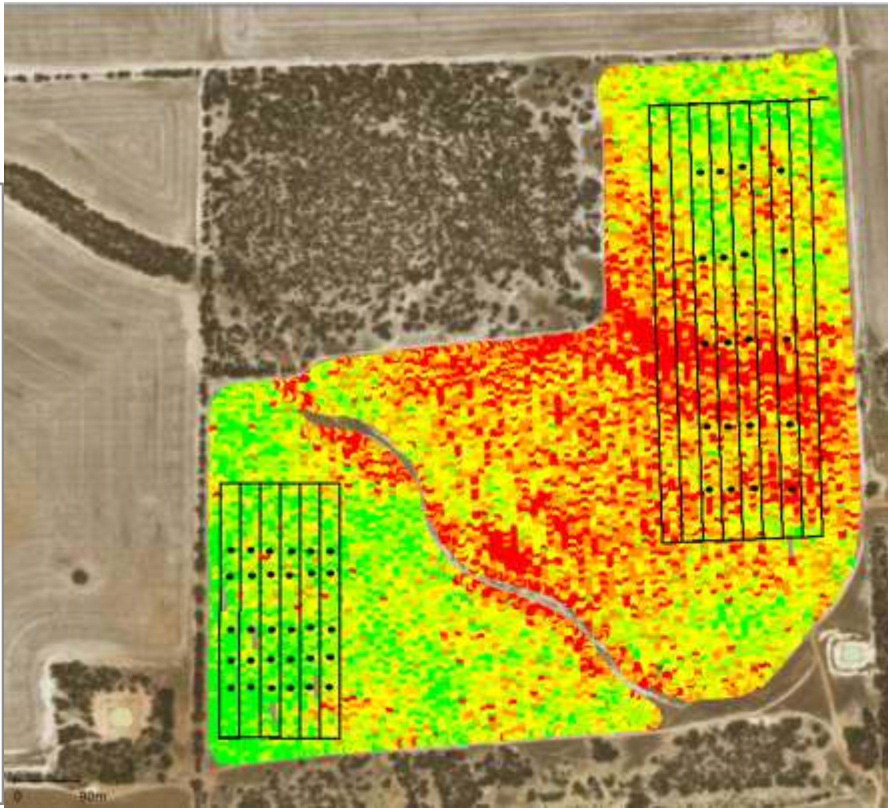
Where soils are of the same texture EM may not be useful in differentiating gypsum responsive from non responsive soils.





Gamma Thorium was able to distinguish between gypsum responsive and unresponsive soils more so than any other soil property at Lake Grace





KEY ANSWERS / CONCLUSIONS

What is the extent and impact of sodicity on crop yields ?

10 – 20 % yield reduction with every 10 % increase in ESP

Which soil$_{(av\ 0\text{-}30cm)}$ properties affect dispersion ?

ESP > EC/ESP = Stability Index (SI) = Organic carbon % = Ca:Mg

Which soil$_{(av\ 0\text{-}30cm)}$ chemical properties distinguish gypsum responsive from unresponsive soils ?

ESP > 10 to 15 = responsive

Stability Index (SI) < -1 = responsive

High variability and overlapping ranges between gypsum responsive and unresponsive sites. Test strips still recommended.

EM and Gamma useful but need to be validated at each site.

Thank you

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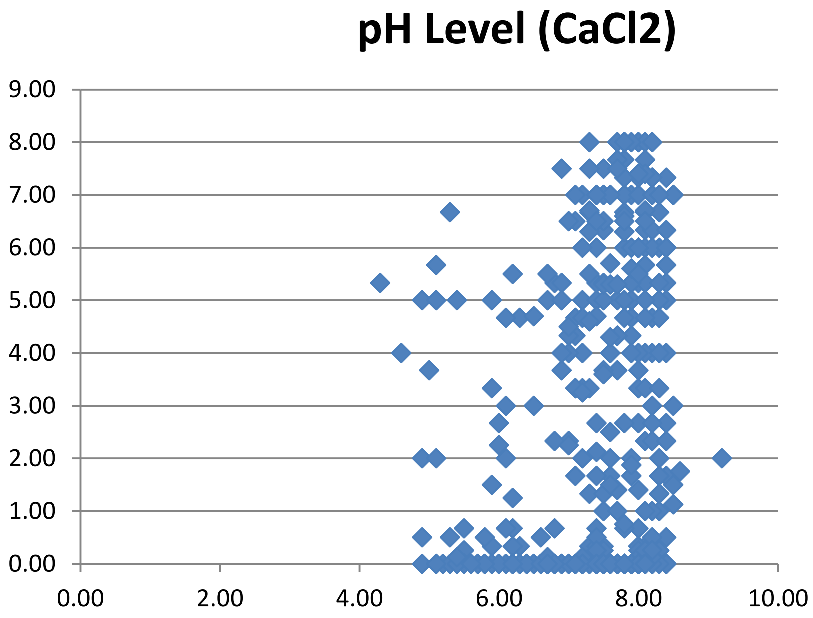
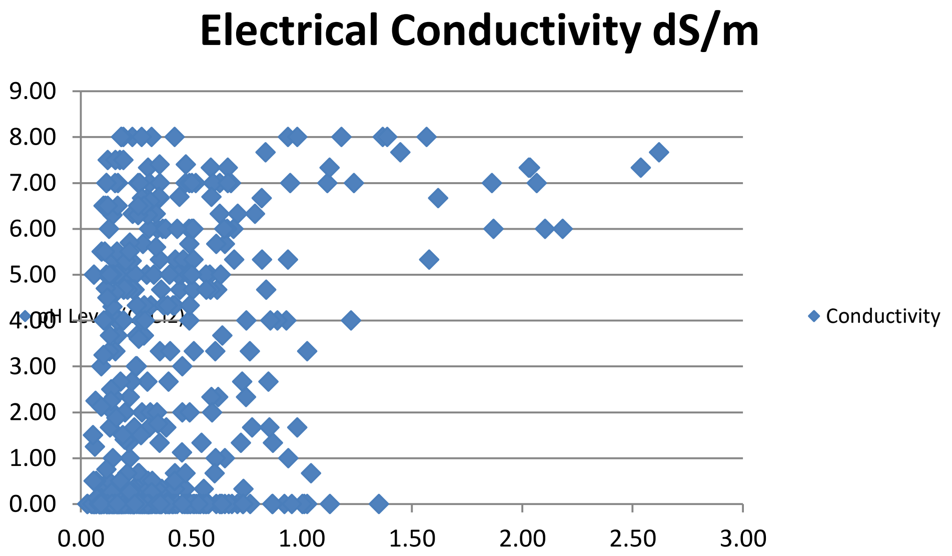
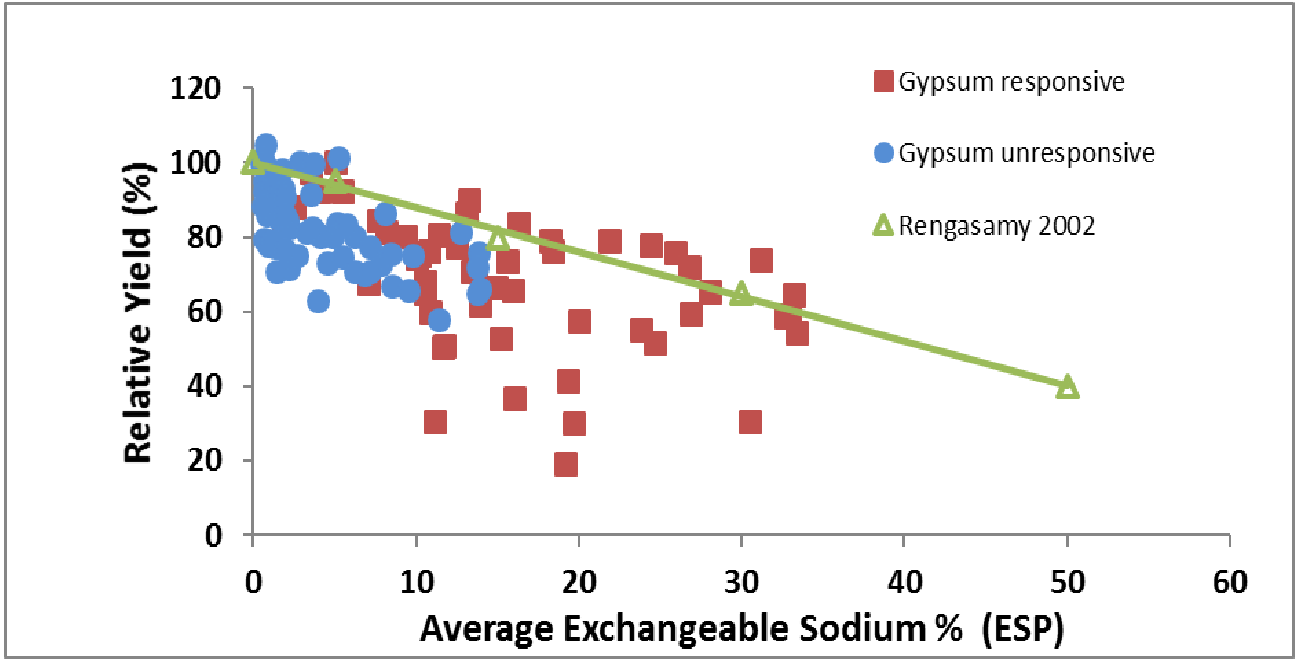


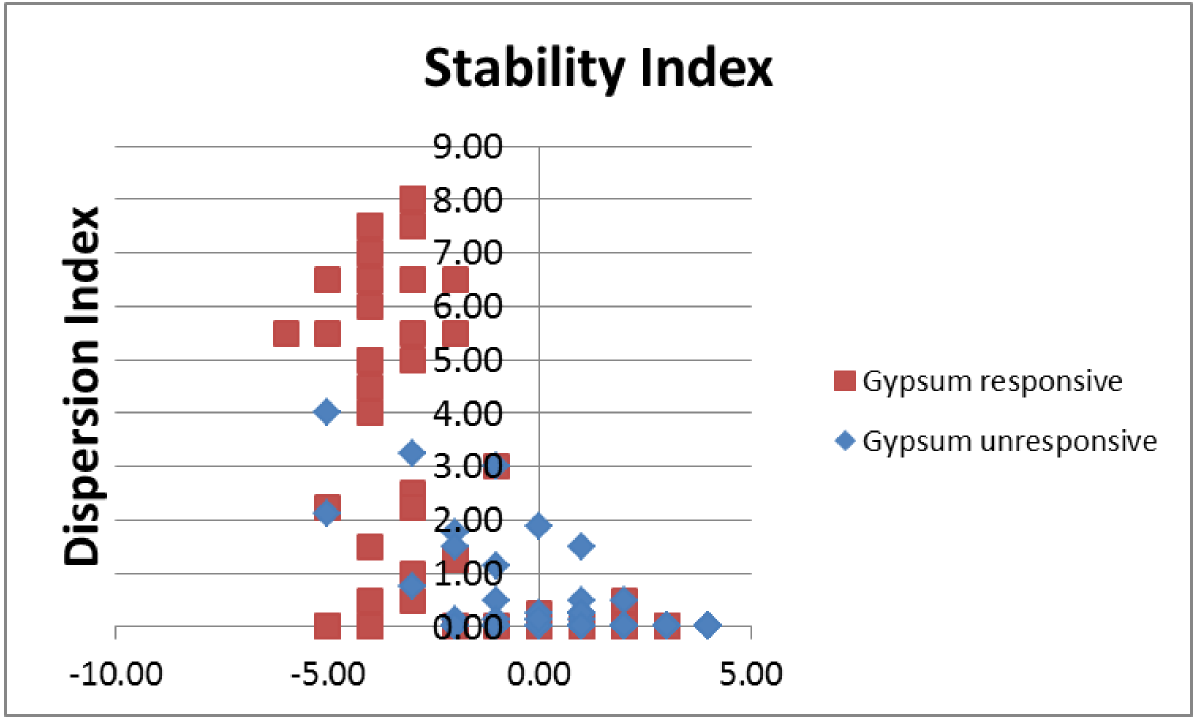


Salts reduce dispersion. Salts are diluted when aggregates are immersed in deionised water. This can artificially accentuate dispersion.

Effect of sodicity on relative yield



Dispersion: Lake Grace



Stab Index = f (ESP, OC, EC, Ca_Mg)   Needham et al. 1992

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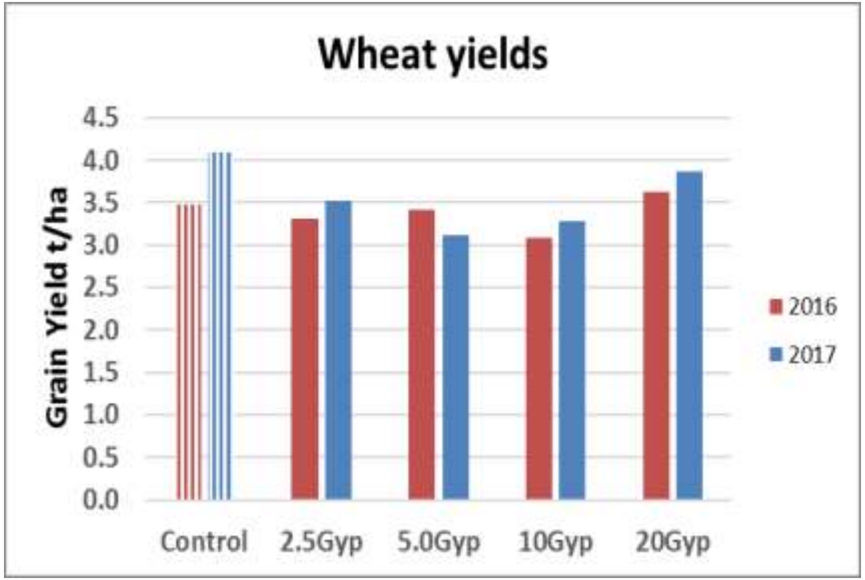
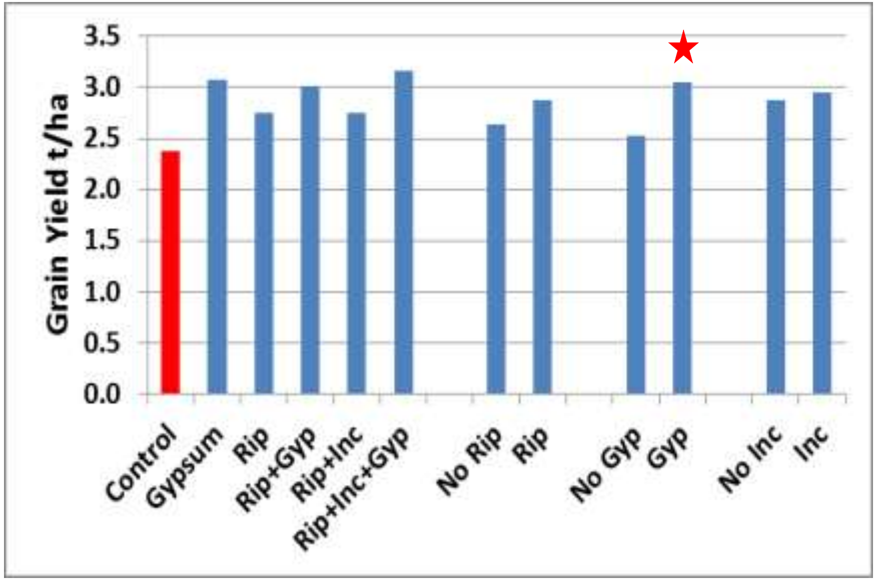
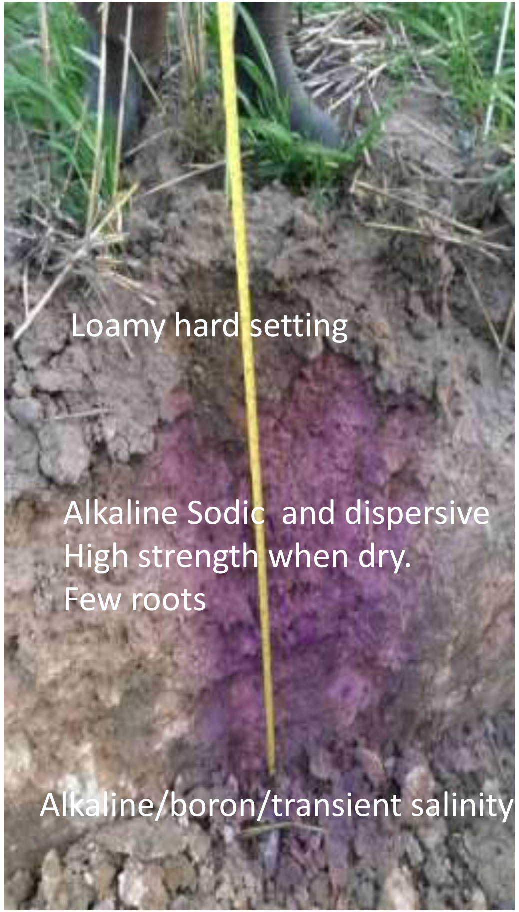
Gypsum unresponsive site



Gypsum Responsive



Lake Grace Gypsum responsive and unresponsive site



Depth	Texture	pHca	OC%	EC dS/m	Exch Ca	Exch K	Exch Mg	Exch Na	ESP%	DI
10	Clay Loam	6.36	1.38	0.24	2.02	0.18	0.75	0.11	3.8	0.00
20	Clay	7.15	0.75	0.17	1.25	0.12	1.50	0.39	10.9	3.65
30	Clay	7.80	0.44	0.20	1.12	0.12	1.95	0.79	20.8	7.00
10	Clay Loam	7.04	1.43	0.12	10.33	0.88	3.21	0.13	1.1	0.00
20	Clay Loam	7.75	0.83	0.14	12.58	0.62	5.68	0.41	2.8	0.50
30	Clay	8.11	0.51	0.17	11.85	0.46	6.99	0.71	3.8	1.00

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