Waterlogging trial

Background

Waterlogging is the biggest issue affecting crops on Kangaroo Island. Previous work has been done looking at drainage solutions such as delving and raised beds. This trial was designed to look at some agronomic solutions to waterlogging.

Yield was measured to enable comparisons between treatments. Other measurements were also taken with the aim of achieving a better understanding of how waterlogging affects plant growth.

The soil redox potential was measured for different treatments. Redox potential is a measurement of the availability of oxygen in the soil and hence its oxidative capacity. The availability of different nutrients and toxic metals in the soil is determined by their oxidation state. Therefore, redox potential determines the toxicity of some nutrients such as iron. It can also affect the availability of some essential nutrients such as nitrogen.

There were two parts to the waterlogging investigation. The first is the soil ameliorant/growth regulant trial which will be the focus. The second was a variety demonstration which looked at some Western Australian varieties best suited to waterlogged acid soils. This will be discussed briefly later.

What was done

Site Selection

The trial was conducted at the Stanton property on Timber Creek road. This soil is a lateritic sandy loam over clay. Soil tests results can be seen in table 1.

TABLE 1
Soil test results

	Result	Comment
Colwell P	73 ppm	High
Colwell K	100 ppm	OK
pH ($CaCl_2$)	5.1	Acidic

The site received 520 mm of rainfall for the 2010 calendar year, which was approximately average. In the previous year the paddock was sown with canola.

The site was selected at the bottom of a long gradual slope. It was chosen as it is an area that is often severely waterlogged.

Trial design

The soil ameliorant/growth regulant trial consisted of five treatments listed and explained in table 2 below. All treatments appeared four times, once in each of the four replicates. The treatments were randomised.

TABLE 2
Treatment explanation

Treatment	Explanation
Control	No treatment
Chicken manure	Chicken manure applied at 2.5 t/ha
Lime	KI lime sand applied at 2.5 t/ ha
Moddus	Moddus growth regulant, 400 ml/ha
Moddus plus cycosel	Modus growth regulant 200 ml/ha and cycosel additive 1200 ml/ha

All treatments including the control were incorporated with a rotary hoe. This was to the detriment of soil structure but necessary to achieve results with lime and manure treatments in the first year.

The trial was otherwise treated in the same way as the rest of the paddock.

Trial agronomy

- 1 June: Knockdown 1.5 l/ha Powermax^{tm}
- 3 June: 500 ml/ha Diuron^{tm} plus 39 g/ha Logran^{tm}
- 15 June: trial was sown with 100 kg/ha Wyalkatchem and 80 kg/ha Granulaock Supreme Z^{tm}
- 10 July: 1 kg/ha Zn+ 1 l/ha Hoegrass^{tm} +2.5 l/ha Boxer Gold^{tm} plus 100 ml/ha Coptrel^{tm}
- 10 September: 30 l/ha easy N, 150 ml/ha Folicur430^{tm}, 100 ml/ha Coptrel^{tm}, 110 ml/ha Zinctrac^{tm} plus 110 ml/ha Mantrac^{tm}
- 30 December: trial harvested.

What was measured

Soil redox potential, soil moisture, soil test, vigour scores, leaf tissue test and grain yield.

Results

Grain yield and quality

Due to the high standard deviations associated with the treatments the stats indicate that there was no significant yield difference (LSD 95 = 0.48 t/ha). The difference of 300 kg/ha between the two controls (the same treatment) alone indicated a lot of variation in the results. The results provide little faith in growth regulants and indicate that poultry manure and lime may be an area for further work. Lime and poultry manure treatments will be monitored in 2011 to determine any possible long term effects. There were no grain quality differences associated with any of the treatments.

Redox potential and soil moisture

FIGURE 1
Soil moisture % from 8 July

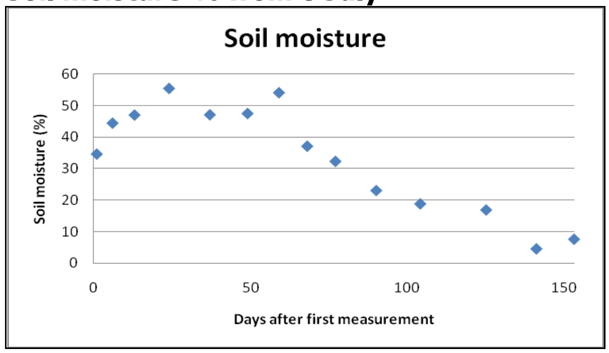
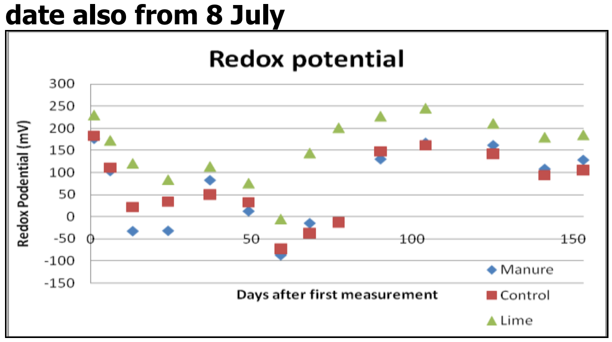


FIGURE 2
Redox potential corrected for pH, start date also from 8 July



Graphs explained

Time is in days from 8 July. Redox and soil moisture measurements were taken on the same days throughout the season. The final measurement was taken on the 28 November.

TABLE 1
Yield and grain quality of treatments

Treatment	Classification	Average yield (t/ha)	Standard deviation
Control	APW1	1.34	0.45
Moddus	APW1	1.39	0.32
Lime	APW1	1.69	0.53
Moddus +Cycosel	APW1	1.59	0.39
Poultry Manure	APW1	1.74	0.46
Control2	APW1	1.59	0.15

Soil Moisture

Soil moisture measurements showed that the site was waterlogged for approximately two months from mid July to mid September. At the trial site this was indicated by a soil moisture percentage of greater than 45%. This means that the yield comparisons in table 1 were under waterlogged conditions.

Redox potential

In figure 2, the redox graph, it can be seen that as soil moisture increased, the redox potential decreased. Low redox potentials result in deficiencies of nutrients such as nitrogen and toxicities of metals such as iron. For example in similar WA soils redox potential less than 250 mV results in reduction in nitrate. When redox potential gets below 150 mV, iron increases potentially, resulting in toxicity. It can be seen from the graph that nitrogen deficiency and iron toxicity could have been a problem for a large portion of the year.

In the redox graph there was no obvious difference between poultry manure and control treatments. This indicates that in the short term at least there was little impact of poultry manure on redox potential and hence nutrient deficiencies and toxicities under waterlogged conditions. There was however, a difference between the lime treatment and the control for all readings.

Redox potential related to yield

The higher redox potential for the lime treatment would suggest better conditions for plant growth: potentially more N available and less severe iron toxicity. This is not seen in the yield results in table 1 as lime did not yield significantly greater than the control. This may change over time and it would be well worth while continuing to monitor the lime treatment.

Variety Demonstration

The variety demo was designed to see if there was any difference in commercial varieties tolerance to waterlogging. Varieties were replicated 3 times in 3 blocks and sown in 8.5 x 1.1 m plots. The trial agronomy was the same as the waterlogging trial. The trial was waterlogged but not as much as the waterlogging trial as it was on slightly higher ground. Commercial varieties listed in the table below were compared to the district standard of Wyalkatchem.

TABLE 3
Yield of different varieties under waterlogged conditions

Variety	Average yield t/ha	Standard deviation
Tammarin Rock	3.13	0.51
Eagle Rock	3.28	0.38
Magenta	3.24	0.72
Wyalkatchem	3.09	0.58

From table 3 it can be seen that there was little variation in the tolerance of the varieties to the waterlogging that occurred at the site. More information on the performance of the varieties under non-waterlogged conditions is available in the variety trial write-up.

Future work

It may be possible to do a similar trial in 2011 using more diverse breeders' lines of wheat. If for example a line is used that is tolerant to iron and performs well it could provide valuable information about the impact of waterlogging.

For further information contact

- Keith Bolto and Erica Marshall on 8553 0349 or 0427311754
- Lyn Dohle, Rural Solutions SA, Kingscote on 8553 4999 or email lyn.dohle@sa.gov.au

Take home messages

- No significant yield difference between treatments in WL trial in first year
- Redox potential affects availability of nutrients and was dependent on soil moisture
- Redox potential higher for the lime treatment which should mean better conditions for plant growth
- Commercial varieties used showed little variation in waterlogging tolerance.

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