Barley Agronomy for the Western Region

Aim: Evaluate the response of eighteen barley lines for grain yield, grain quality and malting quality to changes in soil pH (due to liming).

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Background: Over the last three years (1999 to 2001), the department has tested a number of crossbreds and named lines with reputed tolerance to soil pH and/or Al toxicity at two sites (Kalannie and Carabin) in the eastern wheatbelt. A number of lines from the NSW Department of Agriculture barley breeding program have consistently out yielded Stirling at these low pH sites by between 10% to 30%. One of the lines, Yambla, however has failed to show a yield advantage over Stirling on sites where soil pH is not considered to be limiting yield. The yielding ability of other lines exhibiting tolerance has not been tested outside those two environments.

A biplot comparison of all the cultivars sown in acid soil CVT trials in 2000 and 2001 for grain yield (kg/ha) in relation to an ideal cultivar was conducted. The ideal cultivar is defined as having the highest yield in all acid soil CVT trials (high grain yield and stable yield). The cultivars are ranked based on their distance from this ideal cultivar (concentric circles help ranking). The biplot comparison explains 88% of the variation in grain yield.

(Please note: biplot comparison diagram is documentated under the "Local R&D Results 2002" section of the Liebe website).

The lines sown with reputed tolerance to acid soils included WB223, WB229, WB230, WB240, W92%794, Yambla and Brindabella. WB229 was the highest yielding and most stable cultivar. The next highest yielding variety was WB223. WB240 was lower yielding than WB223 but it was less variable in its grain yield than WB230.

Of the lines with no reputed tolerance to acid soils, the highest yielding was Molloy (with similar but more stable yield than the acid tolerant lines WB230, W92%794 and Yambla). The analysis suggests that Brindabella and Schooner were the worst cultivars on acid soils and Stirling and Hamelin show very little adaptation to acid soils.

These low pH CVT sites used however represent a low proportion of the soil types on which barley is traditionally sown. Barley yields in Western Australia could benefit from a crossing program that incorporates these lines with tolerance to low soil pH and/or Al toxicity if they show a yield benefit on soils which are marginal for their response to lime. These soils would be where soil pH is above 4.5 to 5.0. On these soils, a small yield benefit could have a significant impact on the ability of barley varieties to produce more reliable grain size, as low soil pH and Al toxicity restrict root growth.

The yield advantage of the best performing lines in the low pH CVT trials has not been evaluated on soils with different soil pH. One way of testing the genetic ability of these lines is to sow them on a site that has been previously limed. This removes confounding effects of soil type and climatic conditions.

Trial Details:

Plot size and replication	15m long x 7 rows (22cm spacing) 18 varieties x 3 lime rates x 3 replicates Lime applied in 1996: 0, 1 and 2 t/ha on a long term lime demonstration site.
Soil type	Brown sandy earth
Sowing date	11th June 2002
Conditions at sowing	Dry
Machinery	No till with press wheels
Seeding rate	Target - 150 plants/m^2
Fertiliser	50 kg N/ha, 30 kg P/ha and 40 kg K/ha at seeding
Paddock History	2001 = pasture, 2000 = wheat, 1999 = lupins, 1998 = wheat, 1997 = lupins, 1996 = wheat

Results, Interpretations and Comments:Table 1. Soil pH ($CaCl_2$) and Aluminium levels ($CaCl_2$) at 10cm intervals of the site in 2002 with no lime and either 1 or 2 t/ha lime applied in 1996.

Soil depth (cm)	Lime applied in 1996		
	0 t/ha	1 t/ha	2 t/ha
a) Soil pH ($CaCl_2$)			
0-10	4.2	6.1	6.4
10-20	3.9	4.7	4.6
20-30	4.2	4.8	4.7
30-40	4.8	5.1	5.0
40-50	5.2	5.4	5.3
b) Al ($CaCl_2$) (mg/kg)			
0-10	3	<1	<1
10-20	6	<1	<1
20-30	1	<1	<1
30-40	<1	<1	<1
40-50	<1	<1	<1

The residual value of either 1 or 2 t/ha of lime applied in 1996 was still evident in 2002 with soil pH increased by nearly 2 pH units at the surface (top 10cm) and 0.5 pH units between 20-30cm depth (Table 1). There was no effect of lime application on soil pH at 40-50cm depth. These results indicate that there has been some lime movement and increase in soil pH to 30cm depth since the year 2000. Aluminium levels in the top 20cm of the nil lime treatment are toxic to root growth in barley.

Table 2. Grain yield (t/ha) of 18 cultivars of barley with no lime applied and either 1 or 2 t/ha lime applied in 1996 (REML data from reps 2 and 3).

Variety	Reputed acid soil tolerance	Lime applied in 1996		
		0 t/ha	1 t/ha	2 t/ha
Stirling	No	0.64	0.87	1.11
Gairdner	No	0.63	0.67	1.43
Hamelin	No	0.76	1.19	1.42
WABAR2109	No	0.76	1.27	1.45
Baudin	No	0.65	0.93	1.24
WABAR2147	No	0.56	1.11	0.95
WABAR2175	No	0.67	0.78	1.29
WB223	*Yes*	0.55	0.99	1.50
WB229	*Yes*	0.57	0.81	1.20
WB230	*Yes*	0.53	1.00	1.25
WB240	*Yes*	0.49	0.86	1.04
W92%794	*Yes*	0.87	1.25	1.71
Yambla	*Yes*	0.33	0.82	0.77
Mundah	No	0.63	1.15	1.57
Molloy	No	0.73	1.27	1.41
Skiff	No	0.67	1.20	1.39
Brindabella	**Yes**	0.46	0.75	1.18
Schooner	No	0.73	1.05	1.29
Mean grain yield (t/ha)		**0.62**	**1.00**	**1.29**

The barley crop was sown on 11th June into a dry seedbed with an average of 146 plants/m^2 being established in each plot. Weed control at the site was poor with no effective pre-sowing or post-emergent ryegrass control. There was also significant variability in plant growth between replicates due to a change in soil type over the length of the trial site. The soil type changed from a shallow gravel in rep 1 to deeper sand in rep 3 with little or no surface gravel. Plant height ranged from 27cm in rep 1 to 39cm in rep 3. Data was analysed with spatial analysis to compensate for this variability in the site and data from rep 1 removed from the analysis.

One of the aims was to determine if lines with reputed tolerance to acid soils performed differently once lime was applied. A graphical biplot representation of the grain yields is illustrated on the Liebe website. The analysis of variance suggests that there was no significant interaction between lime application and cultivar performance.

Of the NSW barley lines with reputed tolerance to acid soils only one showed superior grain yield in this trial. The best performing line was W92%794. The previous good performance of WB223, WB229 and WB240 on acid soils was not observed.

W92%794 was the highest yielding and least variable of the cultivars sown. Molloy, WABAR2109, Skiff and Hamelin were as good as W92%794 with nil and 1 t/ha lime and slightly lower yielding than W92%794 with 2 t/ha lime. Brindabella was again one of the worst performing cultivars with Yambla the worst line (primarily due to its very late maturity). The provisional malting lines - Hamelin and Baudin - performed better than Stirling for grain yield regardless of soil pH.

Summary:

- Response of barley lines in this trial was different to what was expected based on past performance in acid soil CVT trials.
- The yield of barley on this site (surface pH of 4.2 and Al levels of 3 mg/kg) was nearly doubled with the addition of lime (from 0.6 t/ha to between 1.0 and 1.2 t/ha with lime). The interaction between lime and variety was not significant suggesting that all barley lines responded similarly to the change in soil pH caused by lime application.
- This research looking at the acid tolerance of barley lines on soils that have been limed will be continuing for another two seasons.
- Crosses have been made to a number of the acid tolerant NSW barley lines with Kaniere or FM37 as parents to improve the acid soil tolerance of malting barley cultivars adapted to the Western Australian environment.
- All the cultivars sown in this trial were sown at four other sites around Western Australia to test their yield performance in different environments (02NO1 AV_1, 02NO2 LG_1, 02WH54 and 02GS80). Unfortunately a similar trial to this one at Holt Rock (02NO2 LG_1) was aborted due to seasonal conditions. The results from this trial will be combined with data from the three remaining sites to provide a more complete analysis.

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