Effect of Lime and Herbicide on the Control of Annual Ryegrass in a Wheat-Wheat-Lupin-Barley Rotation

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Key Messages

- Three years after application of lime, soil pH ($CaCl_2$) increased by 0.68 – 1.45 units at 0 – 10 cm depth, 0.20 - 0.47 units at 10 - 20 cm and 0.08 - 0.18 at 20 - 30 cm depth.
- Lime reduced density of ryegrass by 42% and barley grass density by 67%, improved barley crop vigour by up to 13%, and increased barley grain yield by up to 7% in 2013.
- Boxer Gold® in 2013 season together with Sakura® and simazine in previous seasons reduced annual ryegrass density by 96% and barley grass density by 99%, improved barley crop vigour by up to 15%, and increased barley grain yield by up to 16%.
- Lime effect on efficacy of herbicides in controlling weeds was not evident.

Aim

A four-year study has investigated if lime applied in a low pH soil could enhance the efficacy of herbicides on weeds (ryegrass and barley grass) and improve crop performance in a wheat-wheat-lupin-barley rotation at the Wongan Hills Research Station, Western Australia.

Background

Wheat yield can be reduced by 50% from annual ryegrass competition. Lime application is expected to elevate soil pH resulting in better crop growth, competitive ability and improved weed suppression. Liming applications should have a large impact on the competitive ability of barley crops, as they are highly sensitive to soil acidity. Gazey and Andrew (2010) demonstrated that an application of lime increased the biomass of a barley crop and reduced the biomass of annual ryegrass.

Sakura® (Pyroxasulfone; Group K) and Boxer Gold® (prosulfocarb, Group J + s-metolachlor, Group K) effectively control annual ryegrass in wheat crops when applied and incorporated by sowing. Boxer Gold® is also recommended for weed control in barley crops. The efficacy of these herbicides on annual ryegrass depends on seasonal conditions. The herbicides are less effective if the weeds are stressed. Application of lime may reduce environmental stress experienced by the weeds, and healthy weeds may be easier to kill with herbicides. It is therefore important to examine if there is any interaction between Sakura® or Boxer Gold® rates and lime rates on annual ryegrass control and crop yield.

Trial Details

Property	Wongan Hills Research Station
Plot size & replication	20m x 2m x 4 replications
Soil type	Deep sand
EC (dS/m)	0.028 to 0.108 (lower EC at deeper depth)
Paddock rotation	2009: pasture, 2010: wheat, 2011: wheat, 2012: lupin
Variety	Hindmarsh barley
Seeding date	14/05/13
Seeding rate	90 kg/ha
Fertiliser	14/05/13: 80 kg/ha MacroPro Plus @ 80 kg/ha (N 10%, P 14%, K 8.4%, S 8%, Cu 0.1%, and Zn 0.2%)
Herbicides	Summer weed control: 1.5 L/ha Roundup, 600 mL/ha 2,4-D ester 14/05/13: 2 L/ha SpraySeed, Boxer Gold at different rates (see Treatments).
Growing Season Rainfall	256mm

A four-year study investigated if lime applied in low pH soils could influence the efficacy of herbicides on grass weeds (annual ryegrass and barley grass) at the Wongan Hills Research Station, WA.

Treatments
The trial was laid out in a split plot design, with lime rates in the main plots and herbicide rates in the sub-plots. Lime was applied in 2010 prior to sowing the crop at 0, 1.25, 2.5 and 5 t/ha. Herbicides (Sakura® or Boxer Gold®) were applied in the sub-plots in the relevant seasons.

2010 Wheat: Sakura® was applied at 0, 60, 90, 120 and 150 g/ha in the sub-plots.
2011 Wheat: Sakura® was applied at 0, 60, 90, 120 and 150 g/ha in the sub-plots.
2012 Lupin: Lupin crop was grown with simazine applied at 0 or 2 L/ha and incorporated by seeding (IBS). Brodal® 100 mL/ha + metribuzin 150 g/ha was applied at 4-5-leaf stage of lupins on all the plots except the untreated (no herbicide) control.
2013 Barley: Boxer Gold® was applied at 0, 1, 1.5, 2 and 2.5 L/ha in the sub-plots.

Selective post-emergent herbicides were applied in crops to control broadleaf weeds in cereal crops. No post-emergent grass control herbicide was applied in cereal crop. Soil pH was measured before sowing crops in each season.

Key Results
- Three years after application of lime, soil pH ($CaCl_2$) increased by 0.68–1.45 units at 0-10cm depth, 0.20-0.47 units at 10-20cm and 0.08-0.18 at 20-30cm depth. Soil pH increased with increases in lime rate but decreased with soil depth (Figure 1).
- Increases in lime rate progressively reduced density of ryegrass from 28 to 16 plants/m^2 (42% reduction) and barley grass density from 37 to 12 plants/m^2 (67% reduction) but increased barley crop vigour by up to 13% (Table 1).

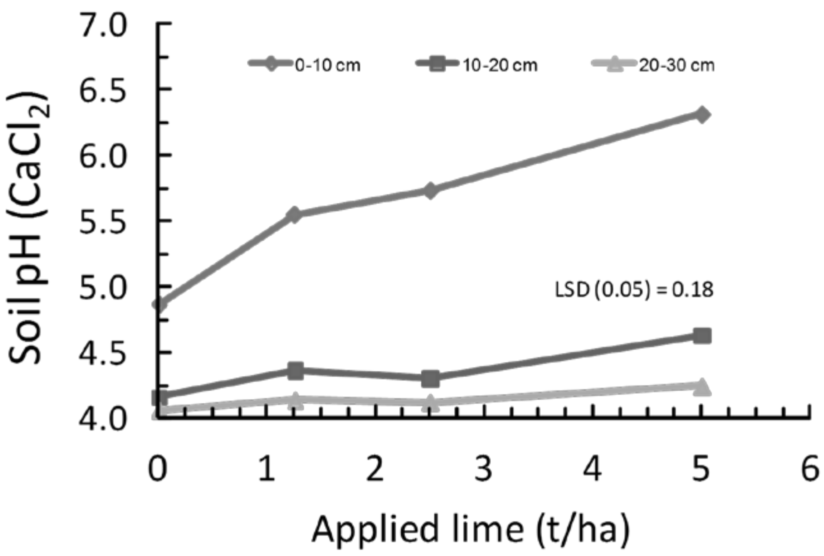

Figure 1: Effect of different rates of lime applied before sowing crop in 2010 season on the soil pH ($CaCl_2$) at different soil depths measured before sowing crop in 2013 season at Wongan Hills.

- Increases in Boxer Gold® rate from 0 to 2500 mL/ha in 2013 season together with Sakura® and simazine in previous seasons reduced annual ryegrass density from 86 to 3 plants/m^2 (96% reduction) and barley grass density from 96 to 1 plant/m^2 (99% reduction) (Table 1). Herbicide also improved barley crop vigour by up to 15% (Table 1).
- Lime increased barley grain yield by up to 7% and Boxer Gold® by up to 16% (Table 1).
- Effect of lime on the efficacy of herbicides in controlling weeds in the current or previous crops was not evident.

Table 1: Effect of lime and Boxer Gold on the initial density of annual ryegrass and barley grass, barley crop vigour, and barley grain yield in 2013 season at Wongan Hills Research Station.

	Rate	Annual ryegrass (plant/m^2)	Barley grass (plants/m^2)	Barley crop vigour (%)	Barley grain yield (t/ha)
Lime (t/ha)	0	28	37	100	3.36
	1.25	26	16	109	3.36
	2.5	19	17	113	3.59
	5	16	12	112	3.56
L.S.D. (0.05)		11.1	14.8	3.65	0.194
Boxer Gold (L/ha)	0	86	96	100	3.13
	1	9	3	112	3.43
	1.5	7	1	112	3.62
	2	5	1	113	3.56
	2.5	3		116	3.60
L.S.D. (0.05)		14.6	32.6	4.08	0.217

Despite significant reduction in the initial density of ryegrass and barley grass by lime and Boxer Gold®, maximum increases in grain yield of barley was rather low (7% due to lime and 16% due to Boxer Gold®). Delayed emergence and growth of barley grass and ryegrass due to continued rainfalls at the later stages of crop development probably diminished the benefit of the initial reduction in weed density in 2013 season. In contrast, there was a severe reduction in barley crop growth at the tillering stages due to the prolonged drought in June and July of 2013 season. This may have reduced the competitive ability of crop plants compared to the grass weeds leading to reduced improvement in grain yield. On the other hand, the density of grass weeds in the no lime or no herbicide treatments was also not high enough to result in a very high reduction in barley grain yield.

It is notable that despite almost no difference in the average initial density of annual ryegrass and barley grass (20.4 and 21.9 plants/m^2 respectively), barley grass had disproportionately greater number of heads (45/m^2) than annual ryegrass (8.3/m^2) recorded at the heading stages of each weed species (data not presented). These results suggest that barley grass plants either survived the drought stress better in June and July in 2013, had greater late emergence, or produced more tillers following rainfalls from late July in 2013 than ryegrass.

An interaction effect of lime and herbicide on barley crop and ryegrass was not evident, and while lime could improve crop growth, it may have no effect on the efficiency of herbicides or it may take a longer period of time to get such an effect.

Gazey and Andrew (2010) demonstrated the benefit of liming about 10 years after lime application. So, it takes time to visualise the total benefit of liming in an acid soil. Since interaction effects of lime and herbicide on barley crop and the weed control was not yet evident, it may be worthwhile to continue monitoring these plots in case an interaction effect of lime and herbicides on crop and weed becomes evident.

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