

Herbicide tolerance of lupin varieties - Eradu

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Key messages

Pre-emergent simazine and propyzamide (IBS) at maximum label rates recorded low crop safety margin.

Higher uptake of simazine following good soil moisture appeared to have made lupins varieties sensitive to damage by normally safe rates of post-emergent broadleaf herbicides.

A new herbicide Ultro[®] 900 WG at 2.3 kg/ha applied before seeding was tolerated by all the lupin varieties.

For blue lupin control/suppression, Garlon[®] 600 (triclopyr) at 30 mL/ha applied at 8-leaf stage and at pod setting on main stem of narrow leafed lupins caused statistically significant yield loss across all the lupin varieties. **Triclopyr use on narrow leafed lupins is not registered.**

Note: Always follow label recommendations. The Department Primary Industries and Regional Development, does not endorse the use of herbicides above the registered rate or off-label use of herbicides or off-label tank mixes. Crop tolerance and yield responses to herbicides are strongly influenced by seasonal conditions.

Aims

To identify herbicide sensitivities of new lupin varieties with the view to reduce their yield losses due to herbicide damage. Mandelup was included as a standard variety for comparison in the trial.

Blue lupins are problematic in narrow leave lupin production, especially in the Northern Agriculture Region of WA Wheatbelt and no herbicide is registered for their control in this crop. There were earlier reports that blue lupins could be controlled/suppressed with triclopyr (e.g. Garlon[®]) safely applied at pod setting on main stem of narrow leave lupins (Quinlan and Fleay, 2016). Two timing of application of Garlon[®] at 30 mL/ha were included in the trial to determine their safety on new narrow leafed lupin varieties.

Method

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|------------------------------------|---|
| Trial Year and Location | 2019 (2019GE41) and Valentine Road, Eradu. |
| Soil Type | Yellow sand plain/Eradu sand plain |
| pH (CaCl ₂) and OC (%) | 0-10 cm: 6.0 and 0.79, and 10-100 cm: 5.2 and 0.39. |
| Paddock history | 2018 - wheat |
| Trial design | Criss-cross with every 5th plot as untreated control plot to check spatial variability. The trial was carried out under weed free conditions. |
| Plot size (net) and replications | 8 m x 1.15 m (5 rows at 23 cm row spacing) and 3 reps. To convert plot yield to kg/ha, 1.8 m plot width was used (plot to plot centre). |

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| Varieties and herbicide treatments | Coyote (tested as WALAN 2546), Mandelup, PBA Jurien and PBA Leeman. See Table 1 for herbicide treatments details. The varieties were completely randomised with in each replication. |
| Seeding date and rate | Sown on 6 June with seeding rate of 84 to104 kg/ha across varieties to achieve 45 plants/m ² . |
| Seed treatment before sowing | Rovral® 100 mL and Thiraflo® 600 170 mL/100 kg seed. |
| Seeding machinery and depth | Coneseeder with knife points and press-wheels and 5 cm deep. The trial was sown at around 3.5 to 4 km/hr speed. |
| Fertilizers and rhizobium Inoculum | Bigphos + Mn 80 kg/ha and Alosca group GS granular 10 kg/ha applied with seed at seeding. |
| Soil moisture at seeding Soil moisture on 11 June 2019 Method used Rainfall one day after seeding Rainfall within a week of seeding | Dry (The trial was sown dry) 0-10 cm: 7.1 % (average of 5 samples) 10-20 cm: 7.4 % (average of 5 samples) Volumetric method 26 mm 93 mm |
| Treatment application date: Incorporated by sowing (IBS) 2 leaf stage 4 leaf stage 8 leaf stage Pod setting on main stem of lupins | Please see Table 1 for treatment details. 5 June 2019 25 June 2019 16 July 2019 26 July 2019 02 September 2019 |
| Herbicide application machinery | Spray rig with shields on boom at a width of 1.5 m. Air induction nozzles (AIXR 11002, TeeJet Yellow) and 80 L/ha water volume used. |
| Visual observations scale: | 0 to 100 %, where 0 = no visible injury & 100 = complete plant death. |
| Visual observation dates: | 20 August and 23 Oct 2019. |
| Lupin plant count | 23 October, two counts per plot using a quadrat size of 100 cm x 46 cm (2 rows at 23 cm row spacing) and presented as plants/m ² . |
| Blanket Sprays | Dominex® 200 mL + Lorsban® 200 mL/ha on 6 June. Select® 500 mL + Hasten™ 1% on 23 July 2019. |
| Harvesting date | 2 November 2019 |
| Data analysis | Seed yield - Reml and plant population - ANOVA using GenStat prog. |
| Rainfall (mm) : | 2019 May June July Aug Sept Oct Total 2 149 60 42 3 8 264 |

Crop safety margins: Higher than label rates of the herbicides were included in the trial to determine the crop safety margin of the herbicides at the maximum label rates. Good crop safety margin means that a herbicide at its maximum label rate and at the higher rate(s) was tolerated well by a crop variety. Whereas, low crop safety margin for a herbicide indicates that the variety tolerated the maximum label rate well, but at higher than the label rate(s) there was significant yield loss. A low crop safety margin implies that when spraying under less than optimal conditions, herbicide damage and yield loss may occur even at the label rate. For example, when overlapping herbicide; spraying under wet conditions (for soil active and residual herbicides) and /or there are stressed plants due to abiotic/biotic factors.

Results

The effect of herbicides during early crop growth stages (Table 1), around flowering time (Table 2), on plant population (Table 3) and seed yield (Table 4) of lupin varieties was as follows:

PBA Jurien was the highest yielding variety with 1.3 t/ha grain yield, followed by Coyote at 1.2 t/ha, PBA Leeman at 1.1 t/ha and Mandelup at 1.05t/ha with a plant population range of 52-55 plants/m² (untreated control plots). Average plant height across varieties in untreated control plots was 45 cm.

Registered herbicides Simazine 600 (1.7 L/ha), Edge[®] 900 (1.1 kg/ha) and Ultra[®] 900 WG (2.3 kg/ha) applied before seeding had no negative effective on plant growth and yielded at par with untreated control across varieties. However, Simazine 600 and Edge[®] 900 at higher than label rates resulted in 10-15% biomass reduction (observed on 20 August, Photo 1) and statistically significant reduction in seed yield across varieties, and thus registered low crop safety margin for top label rates of these herbicides.

Pre-emergent Simazine 600 at 1.7 L/ha followed by Brodal[®] and metribuzin alone, and their mixtures at different rates caused biomass reduction and some treatments had negative effect on plant population also and ultimately resulted in significant yield reduction across all the varieties (Photos 2 and 3).

Pre-emergent Simazine 600 at 1.7 L/ha followed by Brodal[®] 100 mL + Eclipse[®] 70 mL/ha and their higher rate resulted in 10-15% biomass reduction (Table 2) at flowering stage, but the plants recovered by crop maturity. These treatments caused significant yield loss in Mandelup and PBA Leeman.

Pre-emergent Simazine 600 at 1.7 L/ha followed by Garlon[®] 600 at 30 mL/ha at 8-leaf stage of narrow leaved lupins resulted in stunted plants and reduced biomass by 17% across varieties. On 20 August (3 weeks after treatment application), majority of varieties were flowering, but Garlon[®] treated plants were at bud stage or buds were not open and top portion of the plants was yellow (Photos 4 and 5). The plants showed some recovery in terms of pod development by crop maturity, but effect on plant height was still visible. All the lupin varieties recorded significant yield reduction in the range of 15-28%.

Pre-emergent Simazine 600 at 1.7 L/ha followed by Garlon[®] 600 at 30 mL/ha at pod setting on main stem of narrow leaved lupins, killed majority of the plants (79-86%) that were looking black at crop maturity and had only empty pods on them. Some of the plants across lupin varieties were still green at crop maturity, but majority with empty pods (Photos 6 and 7). This treatment resulted in significant seed yield loss of 93-96% across all the lupin varieties.

Discussion/Conclusion

The dry sown trial on 6 June 2019 received 26 mm rainfall the next day and 93 mm rainfall within a week of sowing which could have led to higher uptake of some of the pre-emergent herbicides like simazine.

Pre-emergent simazine and propyzamide (IBS) at maximum label rates had low crop safety margin.

Pre-emergent simazine (at label rate) followed by post-emergent metribuzin alone and in mixture with Brodal® (diflufenican) at label rates caused significant yield loss across all the varieties. The results re-emphasise the earlier findings that higher uptake of simazine following good soil moisture could predispose the crop to damage by normally safe rates of post-emergent broadleaf herbicides.

A new pre-emergent herbicide Ultra® 900 WG (carbetamide) was tolerated well at the maximum label rate by all the lupin varieties. Ultra® 900 WG (Group E) is registered at 1.1 -2.3 kg/ha in lupins for control of ryegrass, brome grass and barley grass.

IBS Simazine 600 at 1.7 L/ha followed by Garlon 600 (triclopyr) at 30 mL/ha applied at 8-leaf stage and pod setting on main stem of lupins for control/suppression of blue lupins, caused statistically significant yield loss across all the lupin varieties. Triclopyr is not registered on lupins.

References

Quinlan R. and Fleay K. (2016) Selective Control of Blue Lupins in Mandelup Crops.
<https://agvivo.com.au/wp-content/uploads/2016/04/Richard-Quinlan.pdf>

Key words

Herbicides, tolerance, lupin varieties, seed yield.

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Plate 1: (L to R) Pre-sowing Simazine 600 at 1.7 L/ha, Simazine 600 at 3.4 L/ha and Untreated control. Coyote in the front followed by PBA Leeman, PBA Jurien and Mandelup. The photo was taken on 20-8-2019.



Plate 2: (L to R) Brodal® at 200 mL/ha, Brodal® at 400 mL/ha, Metribuzin 750 at 150 g/ha, Untreated control and Metribuzin 750 at 300 g/ha These herbicide treatments were applied at 2 leaf stage of lupins and all had Simazine 600 at 1.7 L/ha as a basal pre-sowing treatment. Coyote in the front followed by PBA Leeman, PBA Jurien and Mandelup. The photo was taken on 20-8-2019



Plate 3: (L to R) Brodal® 100 mL + Metribuzin 750 150 g/ha, Brodal® 200 mL + Metribuzin 750 300 g/ha, pre-em Simazine 600 1.2 L followed by Brodal® 200 mL + Simazine 600 415 mL at 4 leaf stage followed by Brodal® 100 mL + Metribuzin 750 75 g/ha at 8 leaf stage and Untreated control. Brodal® + Metribuzin 750 treatments were applied at 4 leaf stage of lupins and all had Simazine 600 at 1.7 L/ha as a basal pre-sowing treatment. Coyote in the front followed by PBA Leeman, PBA Jurien and Mandelup. The photo was taken on 20-8-2019.



Plate 4: (L to R) Garlon® 600 at 30 mL/ha applied at 8 leaf stage , Garlon® 600 at 30 mL/ha nominated to apply at pod setting on main stem of lupins (was not applied yet) and untreated control. Coyote in the front followed by PBA Leeman, PBA Jurien and Mandelup. The photo was taken on 20-8-2019.



Plate 5: Coyote flowering head affected/delayed flowering by application of Garlon® at 30 mL/ha at 8 leaf stage (on left) and normal flower head of untreated plants (on right). The photo was taken 3 weeks after application on 20-8-2019.



Plate 6: (L to R) Garlon® 600 at 30 mL/ha applied at 8 leaf stage , Garlon® 600 at 30 mL/ha applied at pod setting on main stem of lupins and untreated control. Coyote in the front followed by PBA Leeman, PBA Jurien and Mandelup. The photo was taken on 23-10-2019.



Plate 7: Showing effect of Garlon® 600 treatments on seed development and size of Coyote lupins. (L to R) untreated control, Garlon® 600 30 mL/ha applied at 8 leaf stage and Garlon® 600 30 mL/ha applied at pod setting on main stem of lupins. The photo was taken on 23-10-2019

Table 1: Visual biomass reduction (%) averaged over 3 replications across varieties on 20 August 2019 (2019GE41)

| No | Herbicides | Rate/ha | Timing | Coyote | Mandelup | PBA Jurien | PBA Leeman |
|----|--|---|-----------------------------------|-------------------------------|----------|------------|------------|
| 0 | Untreated Control | | | 0 | 0 | 0 | 0 |
| 1 | Simazine 600 (*) X1 | 1.7 L | IBS | 0 | 0 | 0 | 0 |
| 2 | Simazine 600 X2 | 3.4 L | IBS | 10 | 15 | 10 | 15 |
| 3 | Edge® 900 WG X1 | 1.1 kg | IBS | 0 | 0 | 0 | 0 |
| 4 | Edge® 900 WG X2 | 2.2 kg | IBS | 15 | 15 | 20 | 10 |
| 5 | Ultron® 900 WG | 2.3 kg | IBS | 0 | 0 | 0 | 0 |
| 6 | (*)Brodal® X1 | 200 mL | 2 leaves | 0 | 0 | 0 | 0 |
| 7 | (*)Brodal® X2 | 400 mL | 2 leaves | 15 | 15 | 0 | 15 |
| 8 | (*)Metribuzin 750 X1 | 150 mL | 2 leaves | 15 | 18 | 15 | 15 |
| 9 | (*)Metribuzin 750 X2 | 300 mL | 2 leaves | 22 | 22 | 25 | 23 |
| 10 | (*)Brodal® + Metribuzin X1 | 100 ml + 150 g | 4 leaves | 15 | 18 | 15 | 15 |
| 11 | (*)Brodal® + Metribuzin X2 | 200 mL + 300 g | 4 leaves | 25 | 33 | 20 | 25 |
| 12 | Simazine (Pre) fb Brodal® + Simazine fb Brodal® + Metribuzin 750 | 1.2 L fb (200 mL + 415 mL) fb (100 mL + 75g) | IBS fb 4 leaves fb 8 leaves | 10 | 13 | 10 | 10 |
| 13 | (*)Brodal® + Eclipse® X1 | 100 mL + 70 mL | 8 leaves | 10 | 15 | 10 | 15 |
| 14 | (*)Brodal® + Eclipse® X2 | 200 mL + 140 mL | 8 leaves | 10 | 15 | 10 | 15 |
| 15 | (*) Garlon® 600 8 leaf | 30 mL | 8 leaves | 17 | 17 | 17 | 17 |
| 16 | (*) Garlon® 600 Pods | 30 mL | Podding | Treatment was not applied yet | | | |

(*) = Simazine 600 1.7 L/ha, IBS = incorporated by sowing, fb = followed by, Podding = pod setting on main stem

Table 2: Visual biomass or height reduction (%) averaged over 3 replications across varieties on 23 October 2019 (2019GE41)

| No | Herbicides | Rate/ha | Timing | Coyote | Mandelup | PBA Jurien | PBA Leeman |
|----|--|---|-----------------------------------|--------|----------|------------|------------|
| 0 | Untreated Control | | | 0 | 0 | 0 | 0 |
| 1 | Simazine 600 (*) X1 | 1.7 L | IBS | 0 | 0 | 0 | 0 |
| 2 | Simazine 600 X2 | 3.4 L | IBS | 0 | 0 | 0 | 0 |
| 3 | Edge® 900 WG X1 | 1.1 kg | IBS | 0 | 0 | 0 | 0 |
| 4 | Edge® 900 WG X2 | 2.2 kg | IBS | 0 | 0 | 0 | 0 |
| 5 | Ultron® 900 WG | 2.3 kg | IBS | 0 | 0 | 0 | 0 |
| 6 | (*)Brodal® X1 | 200 mL | 2 leaves | 0 | 0 | 0 | 0 |
| 7 | (*)Brodal® X2 | 400 mL | 2 leaves | 0 | 0 | 0 | 0 |
| 8 | (*)Metribuzin 750 X1 | 150 mL | 2 leaves | 0 | 0 | 0 | 0 |
| 9 | (*)Metribuzin 750 X2 | 300 mL | 2 leaves | 15 | 15 | 15 | 15 |
| 10 | (*)Brodal® + Metribuzin X1 | 100 ml + 150 g | 4 leaves | 15 | 15 | 15 | 15 |
| 11 | (*)Brodal® + Metribuzin X2 | 200 mL + 300 g | 4 leaves | 18 | 18 | 18 | 18 |
| 12 | Simazine (Pre) fb Brodal + Simazine fb Brodal + Metribuzin | 1.2 L fb (200 mL + 415 mL) fb (100 mL + 75g) | IBS fb 4 leaves fb 8 leaves | 0 | 0 | 0 | 0 |
| 13 | (*)Brodal® + Eclipse® X1 | 100 mL + 70 mL | 8 leaves | 0 | 0 | 0 | 0 |
| 14 | (*)Brodal® + Eclipse® X2 | 200 mL + 140 mL | 8 leaves | 0 | 0 | 0 | 0 |
| 15 | (*) Garlon® 600 8 leaf | 30 mL | 8 leaves | 18 | 18 | 18 | 18 |
| 16 | (*) Garlon® 600 Pods | 30 mL | Podding | 15 | 15 | 15 | 15 |

(*) = Simazine 600 1.7 L/ha, IBS = incorporated by sowing, fb = followed by, Podding = pod setting on main stem

Table 3: Effect of herbicide treatments on plant population (% of untreated control) of lupin varieties at Eradu (2019GE41).

| No | Herbicides | Rate/ha | Timing | Coyote | Mandelup | PBA Jurien | PBA Leeman |
|--|--|---|--------------------------------------|-----------|-----------|---------------|---------------|
| 0 | Untreated Control | | | 100 | 100 | 100 | 100 |
| | >>>Plant Population/m ² | | | 52 | 52 | 55 | 55 |
| 1 | Simazine 600 (*) X1 | 1.7 L | IBS | 98 | 106 | 108 | 112 |
| 2 | Simazine 600 X2 | 3.4 L | IBS | 97 | 89 | 104 | 74 |
| 3 | Edge® 900 WG X1 | 1.1 kg | IBS | 100 | 108 | 99 | 92 |
| 4 | Edge® 900 WG X2 | 2.2 kg | IBS | 82 | 92 | 76 | 76 |
| 5 | Ultron® 900 WG | 2.3 kg | IBS | 104 | 106 | 83 | 91 |
| 6 | (*)Brodal® X1 | 200 mL | 2 leaves | 102 | 89 | 96 | 101 |
| 7 | (*)Brodal® X2 | 400 mL | 2 leaves | 98 | 101 | 98 | 101 |
| 8 | (*)Metribuzin 750 X1 | 150 mL | 2 leaves | 92 | 104 | 102 | 88 |
| 9 | (*)Metribuzin 750 X2 | 300 mL | 2 leaves | 100 | 92 | 99 | 93 |
| 10 | (*)Brodal® + Metribuzin X1 | 100 ml + 150 g | 4 leaves | 98 | 94 | 105 | 95 |
| 11 | (*)Brodal® + Metribuzin X2 | 200 mL + 300 g | 4 leaves | 85 | 69 | 96 | 79 |
| 12 | Simazine (Pre) fb Brodal® + Simazine fb Brodal® + Metribuzin 750 | 1.2 L fb (200 mL + 415 mL) fb (100 mL + 75g) | IBS fb 4 leaves fb 8 leaves | 100 | 86 | 98 | 98 |
| 13 | (*)Brodal® + Eclipse® X1 | 100 mL + 70 mL | 8 leaves | 100 | 99 | 105 | 81 |
| 14 | (*)Brodal® + Eclipse® X2 | 200 mL + 140 mL | 8 leaves | 102 | 91 | 91 | 94 |
| 15 | (*) Garlon® 600 | 30 mL | 8 leaves | 105 | 81 | 102 | 96 |
| 16 | (*) Garlon® 600 | 30 mL | Podding | 21 | 17 | 14 | 16 |
| Isd (0.05) Control vs Herbicides (1-tail) | | | | 13 | 13 | 12 | 12 |
| Isd (0.05) Herbicides vs Herbicides (1-tail) | | | | 17 | 17 | 16 | 16 |
| CV (%) | | | | 13 | 13 | 12 | 12 |
| (*) = Simazine 600 1.7 L/ha, (*) = Simazine 600 1.7 L/ha, IBS = incorporated by sowing, fb = followed by, Podding = pod setting on main stem, and Figures in Red are significantly lower than untreated Control | | | | | | | |

Table 4: Effect of herbicides on seed yield (% of untreated control) of lupin varieties at Eradu during 2019 (2019GE41).

| No | Herbicides | Rate/ha | Timing | Coyote | Mandelup | PBA Jurien | PBA Leeman |
|--|--|--|--------------------------------------|-------------|-------------|-------------|-------------|
| 0 | Untreated Control | | | 100 | 100 | 100 | 100 |
| | >>>>> Grain yield (kg/ha) | | | 1186 | 1047 | 1285 | 1111 |
| 1 | Simazine 600 (*) X1 | 1.7 L | IBS | 98.0 | 94.5 | 96.6 | 91.8 |
| 2 | Simazine 600 X2 | 3.4 L | IBS | 83.2 | 69.6 | 81.2 | 61.3 |
| 3 | Edge® 900 WG X1 | 1.1 kg | IBS | 102.6 | 100.8 | 96.5 | 96.7 |
| 4 | Edge® 900 WG X2 | 2.2 kg | IBS | 89.5 | 87.3 | 86.0 | 84.6 |
| 5 | Ultron® 900 WG | 2.3 kg | IBS | 106.2 | 111.6 | 102.5 | 98.8 |
| 6 | (*)Brodal® X1 | 200 mL | 2 leaves | 90.4 | 92.5 | 92.9 | 83.1 |
| 7 | (*)Brodal® X2 | 400 mL | 2 leaves | 90.4 | 75.6 | 96.6 | 86.9 |
| 8 | (*)Metribuzin 750 X1 | 150 mL | 2 leaves | 81.3 | 84.2 | 87.5 | 85.7 |
| 9 | (*)Metribuzin 750 X2 | 300 mL | 2 leaves | 70.8 | 73.1 | 74.8 | 73.3 |
| 10 | (*)Brodal® + Metribuzin X1 | 100 ml + 150 g | 4 leaves | 78.5 | 79.9 | 84.3 | 79.8 |
| 11 | (*)Brodal® + Metribuzin X2 | 200 mL + 300 g | 4 leaves | 55.5 | 51.7 | 68.6 | 60.0 |
| 12 | Simazine (Pre) fb Brodal® + Simazine fb Brodal® + Metribuzin 750 | 1.2 L fb (200 mL + 415 mL) fb (100 mL + 75g) | IBS fb 4 leaves fb 8 leaves | 84.7 | 74.7 | 88.4 | 82.4 |
| 13 | (*)Brodal® + Eclipse® X1 | 100 mL + 70 mL | 8 leaves | 94.4 | 87.8 | 94.7 | 87.0 |
| 14 | (*)Brodal® + Eclipse® X2 | 200 mL + 140 mL | 8 leaves | 97.7 | 81.0 | 94.0 | 85.3 |
| 15 | (*) Garlon® 600 | 30 mL | 8 leaves | 85.3 | 72.0 | 81.7 | 78.7 |
| 16 | (*) Garlon® 600 | 30 mL | Podding | 5.0 | 7.2 | 6.0 | 4.0 |
| Isd (0.05) Control vs Herbicides (1-tail) | | | | 7.7 | 8.4 | 7.0 | 7.5 |
| Isd (0.05) Herbicides vs Herbicides (1-tail) | | | | 10.4 | 11.3 | 9.3 | 10.0 |
| CV (%) | | | | 7.7 | 8.4 | 7.0 | 7.5 |
| (*) = Simazine 600 1.7 L/ha, IBS = incorporated by sowing, fb = followed by, Podding = pod setting on main stem, and Figures in Red are significantly lower than untreated Control. | | | | | | | |