

Herbicide tolerance of lentil varieties - Merredin

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Key messages

Lentil varieties PBA Bolt, PBA Hallmark XT and PBA Jumbo2 showed good tolerance to a range of lentil herbicides or herbicide mixtures applied at the label rates and timings with good crop safety margin.

Unregistered use pattern of Brodal[®] (diflufenican) at 200 mL/ha as PSPE and of Metribuzin 750 at 100 g/ha in mixture with Brodal[®] 100 mL/ha as post-emergent application reduced seed yield of PBA Jumbo2 significantly.

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 lentil varieties with the view to reduce their yield losses due to herbicide damage.

Method

Trial Year and Location	2019 (2019ME47) and DPIRD Merredin Research Facility (Paddock 3A)
Soil Type, pH (CaCl ₂) and OC (%)	0-10 cm: Clay, 4.8 and 0.96 10-30 cm: Loam, 4.8 and 0.98
Trial design	Criss-cross with every 5 th 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 1.1 m (5 rows at 22 cm row spacing) and 3 reps. To convert plot yield to kg/ha, 1.35 m plot width was used, even though plot to plot centre was 1.8 m.
Varieties and herbicide treatments	PBA Bolt, PBA Hallmark XT and PBA Jumbo2. See Table 1 for herbicide treatments details.
Seeding date and rate	Sown on 14 June with seeding rate of 53 to 73 kg/ha across varieties to target 110 plants/m ²
Seed treatment before sowing	Gaicho [®] 2.4 mL and P-Pickle T [®] 2 mL per kg seed.
Seeding machinery and depth	Coneseeder with knife points and press-wheels and 4-5 cm deep. The site was not rolled.
Fertilizers and rhizobium Inoculum	K-Start 100 kg/ha and Alosca group EF granular 10 kg/ha applied with seed at seeding.

Soil moisture on 13 June 2019	0-5 cm: 22.7% (average of 5 samples) 5-10 cm: 23.7% (average of 5 samples)
Method used	Volumetric method
Cumulative rainfall:	
1 week before sowing	38 mm
1 week after sowing	1.2 mm
2 weeks after sowing	38 mm
4 weeks after sowing	64 mm
Treatment application date:	Please see Table 1 for treatment details.
Incorporated by sowing (IBS)	12 and 14 June 2019 (Trifluralin treatments were applied on 14 June)
Post-sowing pre-emergent (PSPE)	20 June 2019 (Crop was not emerged yet)
4 node/leaf stage	23 July 2019
Herbicide application machinery	Spray rig with shields on boom at a width of 1.5 m. Air induction nozzles and 100 L/ha water volume used.
Visual observations scale:	0 to 100 %, where 0 = no visible injury & 100 = complete plant death.
Visual observation dates:	15 July, 23 August and 4 November 2019.
Chickpea plant count	4 November, 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	Select [®] 500 mL+ Factor [®] 180 g/ha + Bonza [®] 1% on 18-07-2019.
Harvesting date	12 November 2019
Data analysis	Seed yield – Reml and plant population - ANOVA using GenStat prog.
Rainfall (mm) :	2019
	May June July Aug Sept Oct Total
	6 76 38 51 3 22 196

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.

Table 1: Herbicide treatments

No	Herbicides	Rate/ha	Timing
1	Terbyne® Xt® X1	0.86 kg	IBS
2	Terbyne® Xt® X2	1.72 kg	IBS
3	Edge® 900 WG X1	1.11 kg	IBS
4	Edge® 900 WG X2	2.22 kg	IBS
5	Terbyne® Xt® + Edge 900 X1	0.86 kg + 1.1 kg	IBS
6	Terbyne® Xt® + Edge 900 X2	1.72 kg + 2.2 kg	IBS
7	Terbyne® Xt + Sakura	0.86 kg + 118 g	IBS
8	Terbyne® Xt® + Trifluralin 480 (*)	0.86 kg + 1.25 L	IBS
9	Terbyne® Xt® + Trifluralin 480 + Boxer Gold®	0.86 kg + 1.25 L + 2.5 L	IBS
10	Trifluralin 480 + Diuron 500	1.25 L + 1.8 L	IBS
11	Terbyne® Xt® + Trifluralin 480 fb Spinnaker®	0.86 kg + 1.25 L fb 35 g	IBS fb PSPE
12	Terbyne® Xt® + Trifluralin 480 fb Brodal®	0.86 kg + 1.25 L fb 200 mL	IBS fb PSPE
13	Edge® 900 + Diuron 500 fb Metribuzin 750	1.1 kg + 1.8 L fb 150 g	IBS fb PSPE
14	(*) Brodal® X1	200 mL	4 leaf stage
15	(*) Brodal® X2	400 mL	4 leaf stage
16	(*) Brodal® + Metribuzin 750 X1	100 mL + 100 g	4 leaf stage
17	(*) Brodal® + Metribuzin 750 X2	200 mL + 200 g	4 leaf stage
18	(*) Broadstrike® X1	25 g	4-8 leaves (fully expanded)
19	(*) Broadstrike® X2	50 g	4-8 leaves (fully expanded)
0	Untreated Control		

- IBS = incorporated by sowing, PSPE = post-sowing pre-emergent, fb = followed by,
- Terbyne® Xt® = Terbyne® Xtreme® = terbutylazine 875 g/kg, Boxer Gold® = prosulfocarb 800 g + s-metolachlor 120 g/L, Broadstrike® = flumetsulam 800 g/kg, Brodal® Options = diflufenican 500 g/L, Edge® = propyzamide 900 g/kg, Rustler® = propyzamide 500 g/L, Sakura® = pyroxasulfone 850 g/kg and Spinnaker® = imazethapyr 700 g/kg.
- A minor use permit (PER87042) for use of Spinnaker® or similar products at 70-100 g/ha as IBS or PSPE or post-emergent application (cotyledon to 3-leaf growth stage) on PBA Hallmark XT is valid until 24 February 2024.
- Pre-emergent use pattern of Brodal® (diflufenican) and post-emergent use pattern of metribuzin on lentils is not registered.
- PSPE treatments were aimed to apply on the same day of seeding or within two days of seeding.

Results and discussion

The effect of herbicides during early crop growth stages (Table 2), at flowering stage (Table 3), on plant population (Table 4) and seed yield (Table 5) of lentil varieties was as follows:

Merredin was a low yielding site with average seed yield of 0.87 t/ha (across varieties in untreated control plots) compared to Dongara that had 2.4 t/ha average seed yield. PBA Hallmark XT was the highest yielding variety at 0.95 t/ha seed yield, followed by PBA Bolt at 0.86 t/ha and PBA Jumbo2 at 0.81 t/ha. Average plant height of PBA Hallmark XT, PBA Bolt and PBA Jumbo2 at crop maturity was 24.3, 23.3 and 21.3 cm, respectively (untreated control plots).

Correlation co-efficient between lentil plant population and seed yield was 0.46, 0.32 and 0.28 in PBA Bolt, PBA Hallmark XT and PBA Jumbo2, respectively.

Terbyne® Xtreme® at 0.86 kg/ha and Edge® 900 at 1.11 kg/ha applied alone and in-mixture before seeding did not produce any visual symptoms and were tolerated well by all lentil varieties with good crop safety margin. Higher rate of Terbyne® Xtreme® reduced plant population of PBA Bolt and PBA Jumbo2 and its mixture with higher rate of Edge® reduced biomass and plant population in PBA Bolt and PBA Hallmark, but these negative effects did not result in significant yield loss.

It should be noted that 0.86 kg/ha rate of Terbyne® Xtreme® is the lower end of the label rate for lentils and its highest rate used in the trial (1.72 kg/ha) was only 43% higher than the maximum label rate of 1.2 kg/ha. So use of Terbyne® Xtreme® at top label rate of 1.2 kg/ha (alone and in mixture with herbicides) could have recoded low crop safety margin for lentils at this site.

Application of Terbyne® Xtreme® in mix with trifluralin or diuron before seeding had no negative effect on seed yield of the lentil varieties. Sakura® applied before seeding in mixture with Terbyne® Xtreme® and Boxer Gold® with Terbyne® Xtreme® + trifluralin, reduced plant population of PBA Bolt and PBA Hallmark XT, respectively, but had no significant negative effect on seed yield of these varieties.

Terbyne® Xtreme® 0.85 kg + Trifluralin 480 1.25 L/ha IBS followed by Spinnaker® 35 g/ha PSPE were tolerated by all the varieties well. Imzethapyr or Spinnaker is permitted (permit no 87042) to use only on XT lentil varieties such as PBA Hallmark XT.

Edge® 900 1.11 kg + Diuron 500 1.8 L/ha IBS followed by Metribuzin 750 150 g/ha PSPE caused 20-15% biomass reduction across lentil varieties, reduced plant population of PBA Jumbo2 and PBA Hallmark XT significantly and ultimately resulted in significantly lower yield in PBA Jumbo2. Depending upon soil type, Metribuzin 750 at 180-380 g/ha as PSPE application is registered on lentils.

Terbyne® Xtreme® 0.86 kg + Trifluralin 480 1.25 L/ha IBS followed by Brodal® 200 mL/ha PSPE caused visible bleaching of leaves during early growth stages (Photo 1), reduced biomass by 10-15% around flowering stage (Photo 2), plant population by 11-25% (significant across varieties) and ultimately reduced seed yield of PBA Jumbo2 significantly (31%). The results are in line with Dongara trial site. Pre-emergent use of Brodal® on lentils is not registered.

Registered post-emerged herbicides Brodal® at 200 mL/ha and Broadstrike® at 25 g/ha applied at 4 leaf stage were tolerated well by all the lentil varieties with good crop safety margin. During early growth stages, Brodal application resulted in bleaching/spotting on leaves exposed to spray (Photo 3) and intensity of symptoms increased with increase in its rate. PBA Jumbo2 being bit spreading and more vigorous, exhibited more bleaching symptoms than the other varieties.

Post-emergent application of Brodal® 100 mL + Metribuzin 750 100 g/ha at 4 leaf stage caused bleaching and necrosis on leaves during early crop growth stages, reduced biomass by 10-15% around flowering stage and plant population (at maturity) significantly (12-13%) across varieties. These negative effects did not cause significant reduction in seed yield. At higher rate of this mix, the intensity of these symptoms was higher and seed yield of PBA Jumbo2 was reduced significantly. Post-emergent use of metribuzin on lentils is not registered.

Key words

Herbicides, tolerance, lentil varieties, seed yield.

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Plate 1: Bleaching symptoms caused by PSPE Brodal® on Jumbo 2 lentils. The photo was taken 15-7-19 when plants were at 3-4 node stage.



Plate 2: (L –R) Untreated control, Terbyne® Xt® + Trifluralin (IBS) followed by metribuzin (PSPE)-**Pink Pin Flag**, Brodal® (PSPE) and Spinnaker® (PSPE). PBA Jumbo 2 in the front followed PBA Bolt and PBA Hallmark XT. The photo was taken on 23-8-2019.



Plate 3: Bleaching symptoms caused by post-emergent Brodal® at 200 mL/ha on PBA Jumbo2 lentils. The photo was taken 23-8-19.



Plate 4: (L –R) Untreated control, Brodal 200 mL + Metribuzin 750 200 g/ha (Pink Pin Flag) and Brodal® 100 mL + Metribuzin 750 100 g/ha. Brodal® + metribuzin treatments caused plant population and biomass reduction across all varieties. PBA Jumbo2 is in the front followed PBA Bolt and PBA Hallmark XT. The photo was taken on 23-8-2019.

Table 2: Bleaching/leaf spotting of lentil varieties (%) as observed on 15 July 2019 (average of 3 reps) at Merredin (2019ME47).

No	Herbicides	Rate/ha	Timing	Hallmark XT	Jumbo 2	PBA Bolt
0	Untreated Control			0	0	0
15	Terbyne® Xt® + Trifluralin 480 fb Brodal®	0.86 kg + 1.25 L fb 200 mL	IBS fb PSPE	15	20	15

IBS = incorporated by sowing, PSPE = post-sowing pre-emergent, fb = followed by

Table 3: Biomass reduction (BR), Leaf spotting/bleaching (LS) and Leaf necrosis (LN) of lentil varieties (%) as observed on 23 August 2019 (average of 3 reps) at Merredin (2019ME47).

	Herbicides	Rate/ha	Timing	PBA Bolt	PBA Hallmark XT	PBA Jumbo2
0	Untreated Control			0	0	0
1	Terbyne [®] Xt X1	0.86 kg	IBS	0	0	0
2	Terbyne [®] Xt [®] X2	1.72 kg	IBS	5% BR	0	0
5	Terbyne [®] Xt [®] + Edge [®] 900 X1	0.86 kg + 1.1 kg	IBS	0	0	0
6	Terbyne [®] Xt [®] + Edge [®] 900 X2	1.72 kg + 2.2 kg	IBS	10% BR	5% BR	5% BR
7	Terbyne [®] Xt [®] + Sakura [®]	0.86 kg + 118 g	IBS	5% BR	5% BR	5% BR
11	Terbyne [®] Xt [®] + Trifluralin 480 fb Spinnaker [®]	0.86 kg + 1.25 L fb 35 g	IBS fb PSPE	5% BR	0% BR	10% BR
12	Terbyne [®] Xt [®] + Trifluralin 480 fb Brodal [®]	0.86 kg + 1.25 L fb 200 mL	IBS fb PSPE	15% BR	10% BR	15% BR
13	Edge [®] 900 + Diuron 900 fb Metribuzin 750	1.1 kg + 1 kg fb 150 g	IBS fb PSPE	25% BR	20% BR	25% BR
14	(*) Brodal [®] X1	200 mL	4 leaf stage	15% LS	15% LS	20% LS
15	(*) Brodal [®] X2	400 mL	4 leaf stage	20% LS	20% LS	20% LS
16	(*) Brodal [®] + Metribuzin 750 X1	100 mL + 100 g	4 leaf stage	15% LS, 10% BR	15% LS, 15% BR	15% LS, 10% BR
17	(*) Brodal [®] + Metribuzin 750 X2	200 mL + 200 g	4 leaf stage	20% LS, 5% LN, 20% BR	20% LS, 5% LN, 30% BR	20% LS, 5% LN, 30% BR

IBS = incorporated by sowing, PSPE = post-sowing pre-emergent, fb = followed by. (*) = Terbyne Xtreme 0.86 kg + Trifluralin 480 1.25 L/ha.

Table 4: Effect of herbicide treatments on plant population (% of untreated control) of lentil varieties counted on 4-11-19 (2019ME47).

No	Herbicides	Rate/ha	Timing	PBA Bolt	PBA Hallmark XT	PBA Jumbo2
0	Untreated Control >>>>> Plants/m ²			100 114	100 126	100 115
1	Terbyne [®] Xt [®] X1	0.86 kg	IBS	104	110	108
2	Terbyne [®] Xt [®] X2	1.72 kg	IBS	83	91	83
3	Edge [®] 900 WG X1	1.11 kg	IBS	106	104	92
4	Edge [®] 900 WG X2	2.22 kg	IBS	97	100	94
5	Terbyne [®] Xt [®] + Edge [®] 900 WG X1	0.86 kg + 1.1 kg	IBS	94	100	99
6	Terbyne [®] Xt [®] + Edge [®] 900 WG X2	1.72 kg + 2.2 kg	IBS	82	87	97
7	Terbyne [®] Xt [®] + Sakura [®]	0.86 kg + 118 g	IBS	86	94	91
8	Terbyne [®] Xt [®] + Trifluralin 480 (*)	0.86 kg + 1.25 L	IBS	102	92	91
9	Terbyne [®] Xt [®] + Trifluralin 480 + Boxer Gold [®]	0.86 kg + 1.25 L + 2.5 L	IBS	91	76	92
10	Trifluralin 480 + Diuron 900	1.25 L + 1 kg	IBS	90	96	88
11	Terbyne [®] Xt [®] + Trifluralin 480 fb Spinnaker [®]	0.86 kg + 1.25 L fb 35 g	IBS fb PSPE	91	92	96
12	Terbyne [®] Xt [®] + Trifluralin 480 fb Brodal [®]	0.86 kg + 1.25 L fb 200 mL	IBS fb PSPE	75	85	89
13	Edge [®] 900 + Diuron 900 fb Metribuzin 750	1.1 kg + 1 kg fb 150 g	IBS fb PSPE	100	69	66
14	(*) Brodal [®] X1	200 mL	4 leaf stage	93	93	104
15	(*) Brodal [®] X2	400 mL	4 leaf stage	95	95	91
16	(*) Brodal [®] + Metribuzin 750 X1	100 mL + 100 g	4 leaf stage	87	88	88
17	(*) Brodal [®] + Metribuzin 750 X2	200 mL + 200 g	4 leaf stage	77	74	82
18	(*) Broadstrike [®] X1	25 g	4-8 leaves (fully expanded)	92	95	98
19	(*) Broadstrike [®] X2	50 g	4-8 leaves (fully expanded)	93	87	89
Isd (0.05) Control vs Herbicides (1-tail)				11	10	11
Isd (0.05) Herbicides vs Herbicides (1-tail)				14	13	14
CV (%)				10	9	10

IBS = incorporated by sowing, PSPE = post-sowing pre-emergent, fb = followed by. (*) = Terbyne[®] Xtreme[®] 0.86 kg + Trifluralin 480 1.25 L/ha. Figures in **RED** are significantly lower than untreated control. On 4-1-2019, lentil plants were almost ready for harvesting.

Table 5: Effect of herbicide treatments on seed yield (% of untreated control) of lentil varieties at Merredin during 2019 (2019ME47).

No	Herbicides	Rate/ha	Timing	PBA Bolt	PBA Hallmark XT	PBA Jumbo2
0	Untreated Control >>>>> Seed yield (kg/ha)			100 860	100 951	100 809
1	Terbyne [®] Xt [®] X1	0.86 kg	IBS	112	110	126
2	Terbyne [®] Xt [®] X2	1.72 kg	IBS	107	106	108
3	Edge [®] 900 WG X1	1.11 kg	IBS	105	95	101
4	Edge [®] 900 WG X2	2.22 kg	IBS	117	106	100
5	Terbyne [®] Xt [®] + Edge [®] 900 WG X1	0.86 kg + 1.1 kg	IBS	120	92	93
6	Terbyne [®] Xt [®] + Edge [®] 900 WG X2	1.72 kg + 2.2 kg	IBS	104	90	100
7	Terbyne [®] Xt [®] + Sakura [®]	0.86 kg + 118 g	IBS	112	104	86
8	Terbyne [®] Xt [®] + Trifluralin 480 (*)	0.86 kg + 1.25 L	IBS	113	117	107
9	Terbyne [®] Xt [®] + Trifluralin 480 + Boxer Gold [®]	0.86 kg + 1.25 L + 2.5 L	IBS	112	113	99
10	Trifluralin 480 + Diuron 900	1.25 L + 1 kg	IBS	104	115	107
11	Terbyne [®] Xt [®] + Trifluralin 480 fb Spinnaker [®]	0.86 kg + 1.25 L fb 35 g	IBS fb PSPE	108	108	89
12	Terbyne [®] Xt [®] + Trifluralin 480 fb Brodal [®]	0.86 kg + 1.25 L fb 200 mL	IBS fb PSPE	95	90	69
13	Edge [®] 900 + Diuron 900 fb Metribuzin 750	1.1 kg + 1 kg fb 150 g	IBS fb PSPE	97	85	80
14	(*) Brodal [®] X1	200 mL	4 leaf stage	113	118	109
15	(*) Brodal [®] X2	400 mL	4 leaf stage	98	90	88
16	(*) Brodal [®] + Metribuzin 750 X1	100 mL + 100 g	4 leaf stage	118	86	88
17	(*) Brodal [®] + Metribuzin 750 X2	200 mL + 200 g	4 leaf stage	85	89	54
18	(*) Broadstrike [®] X1	25 g	4-8 leaves (fully expanded)	107	103	99
19	(*) Broadstrike [®] X2	50 g	4-8 leaves (fully expanded)	92	97	86
Isd (0.05) Control vs Herbicides (1-tail)				21	16	20
Isd (0.05) Herbicides vs Herbicides (1-tail)				28	22	27
CV (%)				20	16	20

IBS = incorporated by sowing, PSPE = post-sowing pre-emergent, fb = followed by. (*) = Terbyne[®] Xtreme[®] 0.86 kg + Trifluralin 480 1.25 L/ha. Figures in **RED** are significantly lower than untreated control. To compare yield of different varieties, Isd (0.05) is 165.5 kg/ha.