INVITED ARTICLE

LENTILS IN THE SOUTHERN MALLEE: VARIETIES, SOWING DATES AND HERBICIDE TOLERANCE

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TAKE HOME MESSAGES

- Newly released varieties, PBA Ace and PBA Bolt, had the highest grain yields at Curyo (southern Mallee, Vic.) in 2012. Yields exceeded 2.5t/ha for both varieties when sown early, despite the very dry season.
- All varieties had higher grain yields when sown early (May 4) compared with later dates (June 5 and June 22). Varietal differences were evident in the relative decline in grain yield as sowing dates were delayed.
- Differences in tolerance to a range of group B herbicides were observed in several breeding lines. Pulse Breeding Australia will use this information to define future breeding directions for herbicide tolerant varieties, following PBA Herald XT.

BACKGROUND

The Southern Pulse Agronomy program undertakes a range of agronomic trials that ensures the benefits of new pulse varieties are maximised and delivered to growers. The research outlined below focuses on the impacts of sowing dates and improved herbicide tolerance.

In the southern Mallee, it is generally best practice to sow lentils earlier (late April-early May), to ensure maximum growth and yields. However, varieties often respond differently to delayed sowing, which may be used as an opportunity to control weeds with 'knockdown' herbicides. This means that the varieties sown early and showing best results are not always the most appropriate varieties for delayed sowing.

To provide additional and improved weed control options in lentils from a varietal perspective, a concerted effort by the Pulse Breeding Australia (PBA) lentil and the Southern Region Agronomy programs has been undertaken. One result of this has been the release of the first 'herbicide tolerant' variety, PBA Herald XT. It possesses improved tolerance to imazethapyr and flumetsulam, as well as reduced sensitivity to some sulfonylurea and imidazolinone herbicide residues from a prior crop. Various levels of tolerance to the four imidazolinone herbicides have been observed and require further investigation to provide guidance for the future of breeding programs.

AIM

In 2012, trials were sown in the southern Mallee, Victoria to:

- investigate the adaptability of a range of new lentil varieties and variety mixes to varying sowing dates
- identify levels of tolerance to a range of group B herbicides in several breeding lines of lentils which have been selected from the PBA breeding program for improvements in tolerance to imidazolinone herbicides.

METHOD

Location: Curyo

TRIAL 1: SOWING DATES

Replicates:	4
Sowing dates:	4 May, 5 June and 22 June
Target plant density:	120 plants/m^2
Varieties:	Boomer, Nipper, Northfield, Nugget, PBA Blitz, PBA Flash, PBA Jumbo, PBA Herald XT, PBA Bolt, PBA Ace, CIPAL0901, CIPAL1101
Variety mixes:	PBA Flash:Nipper, PBA Flash:Nugget, PBA Flash:PBABlitz, PBA Flash:CIPAL0901. All sown with a 50:50 ratio based on targeted plants/m^2
Inputs/fertiliser:	MAP + Zn (60kg/ha). Herbicides applied according to industry practice
Seeding equipment:	Lucerne points, 5 rows, 30cm row spacing, sown inter-row into standing stubble

TRIAL 2: GROUP B HERBICIDE TOLERANCE

Replicates:	3
Sowing date:	8 May
Target plant density:	120 plants/m^2
Varieties:	PBA Herald XT, PBA Flash, New1, New2, New3
Herbicide treatments:	See Table 1 below. All herbicides were applied at the 4-5 node stage of crop growth
Inputs/fertiliser:	MAP + Zn (60kg/ha)
Seeding equipment:	Lucerne points, 5 rows, 30 cm row spacing, sown inter-row into standing stubble

RESULTS AND INTERPRETATION

Climate

Growing season and annual rainfall was about 30 per cent below average at Curyo in 2012 (data not shown). Generally, there were frequent small events, with only three days throughout the growing season recording more than 10mm (two in July and one in October). Temperatures were close to average and no frost or high temperature extremes were recorded throughout the flowering and grain filling stages.

TRIAL 1: SOWING DATES

Emergence for the early sowing date was delayed due to a dry period during May, and growth throughout the season was generally slow for all sowing dates. Despite the relatively low biomass production at all sowing dates, grain yields were excellent, ranging between 1.4 and 2.6t/ha (Figure 1). For all varieties and variety mixes, the May 4 sowing date had the highest yield and the June 22 sowing date the lowest. However, there was a significant interaction between sowing date and variety, meaning that the relative yield of varieties and mixes across sowing dates differed.

In the May 4 sowing date, PBA Ace and PBA Bolt were the highest-yielding varieties, producing 2.6 and 2.5 t/ha, respectively. PBA Blitz was lowest at 1.9t/ha. At the June 5 sowing date, the yield of PBA Ace and PBA Bolt dropped by 20 per cent compared with the May 5 sowing, but varieties such as PBA Flash and

CIPAL0901 (and the mixes containing these varieties) dropped by only five to ten per cent (Figure 1). This meant that, while PBA Ace was significantly higher yielding than PBA Flash and CIPAL0901 at the May 5 sowing date, at the June 6 sowing date, PBA Flash and CIPAL0901 were slightly higher yielding (not statistically different) than PBA Ace.

Similar trends occurred at the June 22 sowing date (Figure 1). PBA Blitz, which is an early flowering, lower biomass variety (released for adaption to shorter seasons and the practise of crop-topping), was generally one of the lower-yielding varieties at all sowing dates.

These results confirm that the two newly-released varieties PBA Ace and PBA Bolt have excellent yield potential in the Mallee. When sown early in 2012, grain yields of PBA Ace were significantly higher than all released varieties apart from Nugget. Despite the season being significantly drier than average, a mild spring was experienced, meaning that higher biomass and mid maturing varieties like PBA Ace were likely to be favoured. This also explains why early maturing varieties like PBA Blitz were lower yielding in this season.

Similarly to the results of previous trials in the southern Mallee, the 2012 trials showed that earlier sowing led to highest or equal highest yields. In most instances, delaying sowing into June will result in yield declines. This trial showed that the earlier maturing varieties like PBA Flash, CIPAL0901 and PBA Blitz generally suffer less yield decline at the later sowing dates – yields were similar to or higher than PBA Ace and PBA Bolt at the later dates.

Where possible, it may be desirable for producers to grow two varieties to further minimise production risks. A mid-maturing type such as PBA Ace, sown early, will maximise grain yield in 'normal' or 'mild' seasons, while a earlier maturing erect variety such as PBA Bolt or PBA Flash will continue to produce excellent yields in 'shorter' seasons with more extreme events through flowering and podding.

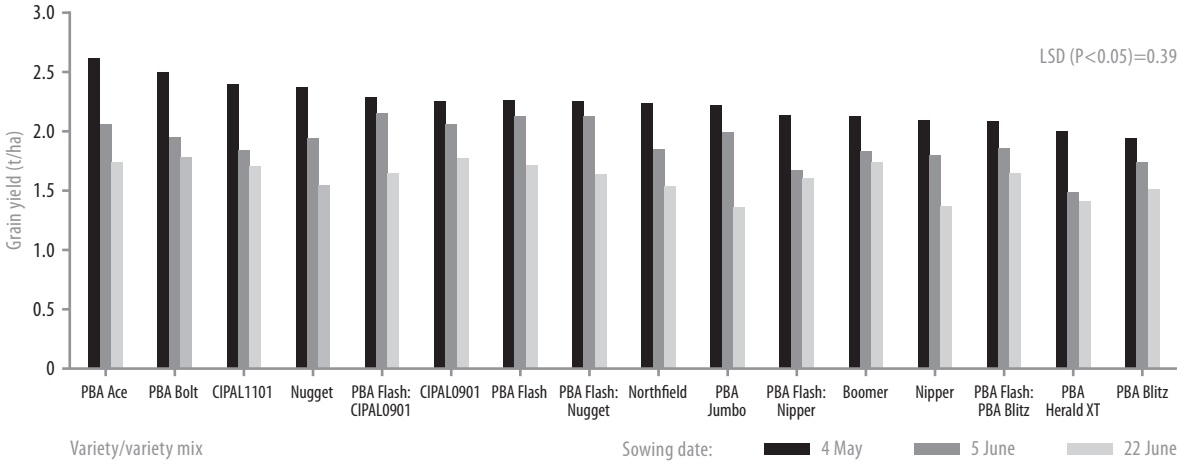

Figure 1. The effect of the interaction between sowing date and lentil variety grain yield (t/ha) at Curyo in 2012.

New lentil varieties

PBA Ace: A vigorous, high yielding, disease resistant, mid maturing red lentil with medium sized grey seed.

PBA Ace has been the highest yielding lentil and is suited to all lentil growing areas, especially longer season areas where Nugget has traditionally been grown. Improved disease resistance makes PBA Ace a better option than the mid-maturing varieties Nugget, PBA Jumbo, PBA Bounty, Aldinga and Northfield in these areas.

PBA Ace has yielded well in drier areas but may be lower yielding than earlier maturing varieties such as PBA Blitz, PBA Bolt and PBA Flash in dry years or when high temperatures cause premature maturity. PBA Ace is higher yielding than Nipper and PBA Herald XT, but these varieties may be better options when small seed size is preferred for marketing or when the better salt tolerance of Nipper, salt and boron tolerance of PBA Bolt or the imazethapyr tolerance of PBA Herald XT are major priorities.

PBA Bolt: An erect, early maturing red lentil with medium sized grey seed.

PBA Bolt is suited to similar areas to those favoured by PBA Flash, in which early maturity, salinity tolerance and erect growth are keys to reliable and profitable production.

PBA Bolt has greater resistance to ascochyta blight and is higher yielding in dry areas or years than PBA Flash. As a result, it is better adapted to the southern Mallee, particularly where ascochyta blight needs to be controlled in PBA Flash.

PBA Bolt is moderately susceptible to botrytis grey mould. The mid maturing varieties PBA Ace, Nipper and PBA Herald XT and the early maturing variety PBA Blitz are more reliable in favourable rainfall areas of the Victorian Wimmera and South Australia's Yorke Peninsula and mid-north.

TRIAL 2: GROUP B HERBICIDE TOLERANCE

Visual herbicide damage symptoms were observed in all treatments applied to the intolerant genotype PBA Flash (Table 1). Varying levels of damage were observed among the four tolerant lines. New1 showed no significant damage symptoms from all imidazolinone herbicide treatments except 'imi-3' applied at the highest rate. It also showed no damage from flumetsulam 800 within the Triazolopyrimidine group and SU-3 within the Sulfonylurea group.

PBA Herald XT, which is a sister line with similar genetic background but less vigour, showed similar trends. However, it also showed slightly increased symptoms for imi-3 applied at the x2 rate and SU-3 (Table 1).

The line New2 appeared to suffer slight damage from imazethapyr and Imi-4 when applied at the highest rates, while the line New3 was damaged by Imi-2 at the highest rates. In addition, New3 showed significant damage from flumetsulam 800 at the highest rate and was completely killed by most Sulfylurea treatments. Both of the lines, New2 and New3, were significantly more damaged by the Sulfonylurea treatments than New1 and PBA Herald XT (Table 1).

Table 1. The effect of various group B herbicide treatments on visual damage score (1=no damage, 9=complete plant death) of the new imidazolinone lentil genotype, PBA Herald XT in comparison with an intolerant genotype, PBA Flash and three new lines differing in tolerance at Curyo, 2012. Significant damage scores have been shaded.

Chemical[1]	Rate	New1	New2	New3	PBA Flash	PBA Herald XT
Nil		1.0	1.0	1.0	1.0	1.0
Imidazolinones						
Imazethapyr 700	100g/ha	1.0	1.0	1.3	7.0	1.0
Imazethapyr 700	200g/ha	1.0	1.0	1.0	7.0	1.3
Imazethapyr 700	400g/ha	1.0	2.0	1.7	8.7	1.0
Imi-2	x1	1.0	1.0	1.0	8.0	1.0
Imi-2	x2	1.0	1.3	1.3	7.3	1.3
Imi-2	x4	1.0	1.7	2.3	8.7	1.3
Imi-3	x1	1.0	1.3	1.0	9.0	1.0
Imi-3	x2	1.0	1.7	1.0	9.0	2.7
Imi-3	x4	4.3	1.3	1.3	9.0	4.0
Imi-4	x1	1.0	1.3	1.3	9.0	1.3
Imi-4	x2	1.0	1.3	1.0	9.0	1.3
Imi-4	x4	1.0	2.3	1.7	9.0	1.7
Triazolopyrimidines						
Flumetsulam 800	25g/ha	1.0	1.7	1.0	2.3	1.0
Flumetsulam 800	50g/ha	1.0	3.0	1.3	4.3	1.0
Tri-1	x1	6.7	9.0	8.0	8.7	6.7
Sulfonylureas						
SU-1	x1	8.0	9.0	9.0	9.0	8.7
SU-2	x1	6.7	9.0	9.0	9.0	7.0
SU-3	x1	1.7	7.3	6.0	8.0	3.3
SU-4	x1	7.3	9.0	9.0	9.0	8.0

1. Herbicide active ingredient or code for unregistered products.

Like the visual damage symptoms observed in this trial, grain yields varied among the genotypes compared (Table 2). For the intolerant genotype PBA Flash, all herbicide treatments, including that which is registered (Flumetsulam 800 applied at 25g/ha), caused significant yield loss, with many treatments resulting in death. Within the tolerant lines, only imi-3 and imi-4 at the highest rates caused significant yield loss in the lines New1 and New2 respectively within the imidazolinone chemical group. New2 showed significant yield loss with the application of Flumetsulam, while no other lines were affected. Within the Sulfoylureas the only unaffected treatment was SU-3, applied to PBA Herald XT and New1.

Table 2. The effect of various Group B herbicide treatments on grain yield (t/ha) of the new imidazolinone lentil genotype, PBA Herald XT in comparison with an intolerant genotype, PBA Flash and three new lines differing in tolerance at Curyo, 2012. Significant damage scores have been shaded.

Chemical[1]	Rate	New1	New2	New3	PBA Flash	PBA Herald XT
Nil		2.40	1.99	2.19	2.52	1.78
Imidazolinones						
Imazethapyr 700	100g/ha	2.07	1.93	2.10	0.80	1.81
Imazethapyr 700	200g/ha	2.31	1.69	2.16	0.00	1.69
Imazethapyr 700	400g/ha	2.10	1.81	2.22	0.00	1.57
Imi-2	x1	2.46	1.81	1.90	0.00	1.84
Imi-2	x2	2.07	1.96	2.13	0.74	1.57
Imi-2	x4	2.19	1.84	2.19	0.00	1.78
Imi-3	x1	2.25	1.90	2.31	0.00	1.69
Imi-3	x2	2.34	1.78	2.04	0.00	1.66
Imi-3	x4	1.48	1.87	2.28	0.00	1.42
Imi-4	x1	2.37	1.87	2.16	0.00	1.51
Imi-4	x2	2.13	1.93	2.28	0.00	1.87
Imi-4	x4	2.25	1.54	2.25	0.00	1.69
Triazolopyrimidines						
Flumetsulam 800	25g/ha	2.40	1.48	2.02	1.33	1.81
Flumetsulam 800	50g/ha	2.34	0.86	1.99	0.89	1.84
Tri-1	x1	1.99	0.42	1.51	0.83	1.69
Sulfonylureas						
SU-1	x1	0.65	0.00	0.00	0.00	0.33
SU-2	x1	1.27	0.00	0.00	0.00	1.24
SU-3	x1	2.04	1.69	1.63	1.07	1.63
SU-4	x1	0.92	0.00	0.00	0.00	0.42

1. Herbicide active ingredient or code for unregistered products.

This data highlights the importance of testing across a range of chemicals within a herbicide group and not assuming that tolerance will be consistent within a herbicide group. This data highlighted that PBA Herald XT has good tolerance to imidazolinone chemicals, but may not be as tolerant to Imi-3 as the lines New2 and New3. Combining lines like New1 and New3 could lead to new genotypes with tolerance to the full range imidazolinone chemicals.

Pulse Breeding Australia will be using this information to define future breeding directions for herbicide tolerant varieties, following PBA Herald XT.

COMMERCIAL PRACTICE

The ongoing introduction and improvement of these herbicide tolerant lentils could result in significant farming systems benefits through improved weed control. This would apply both to increased control options in lentil crops and in the previous rotation phase. Decreased pressure on herbicides currently employed for broadleaf weed control in lentils would also result. However, we need to continuously monitor weed resistance levels and define the optimum methods for maximising the benefits of this herbicide tolerance technology for the whole farming system.

ACKNOWLEDGMENTS

This research was funded by GRDC, DPIVic, SARDI and NSWDPI (DAV00113).