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Project Code	
Project Type	

FINAL REPORT 2018

PROJECT CODE	:	S316

PROJECT TITLE

Improving weed control in new herbicide tolerant lentils

PROJECT DURATION

Project Start date	1 July 2016					
Project End date	30 June 2018					
SAGIT Funding Request	2015/16	$	2016/17		2017/18	

PROJECT SUPERVISOR CONTACT DETAILS

The project supervisor is the person responsible for the overall project

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PROJECT REPORT

Executive Summary

- New lentil germplasm with metribuzin tolerance traits (developed through GRDC project DAS00131) showed a high level of agronomic tolerance to the Group C herbicide metribuzin, with no visible crop damage in any of the treatments applied. This improved level of tolerance presents an opportunity to utilize novel applications of metribuzin in future lentil varieties incorporating these traits, which would significantly improve broadleaf and grass weed control.
- Post-emergent metribuzin treatments significantly improved the control of the difficult to control broadleaf weeds bifora and medic (80-100% reduction in seed-set), however even the highest rate of 750g/ha at the post-emergent timing only provided some suppression of vetch (20-60% reduction in seed-set). Currently, none of the herbicides registered for use in lentil, including metribuzin, provide adequate control of a number of key economic weed species in SA lentil production, including bifora, vetch and medic.
- High rates of 750g/ha and/or post-emergent metribuzin applications were effective in controlling ryegrass, and performed similarly to stand-alone clethodim treatments. Clethodim (Group A) is currently the only registered herbicide for grass weed control in pulse crops, and the availability of a safe and effective herbicide with a different mode of action is imperative to combating group A resistant ryegrass weeds.

Project Objectives

This project aims to improve weed control options in South Australian lentil production, particularly for difficult to control weeds such as bifora, vetch and medic.

This will be done by:

1. Evaluating the control of key difficult to control weed species in South Australian lentil production using novel metribuzin applications, such as higher rates of up to 750 g/ha, alternative timings, and mixtures with other herbicides, to ensure the best strategies can be developed for herbicide tolerant (HT) lentil varieties incorporating high levels of metribuzin tolerance.
2. Assessing potential residual effects of these novel treatments in the following cereal crop.

This work complements GRDC projects DAS00131, DAS00113 and DAV00119 which have worked on developing, validating and incorporating novel lentil germplasm with high levels of metribuzin tolerance into the PBA breeding program.

Overall Performance

The development of new herbicide tolerant (HT) lentil germplasm from GRDC project DAS00131 offers the potential opportunity to register higher rates and/or alternative timings in future varieties incorporating the HT traits (McMurray et al., Development of high levels of metribuzin tolerance in lentil. *Weed Sci* DOI: 10.1017/wsc.2018.57, 2018). Metribuzin is currently only registered at the post-sowing-pre-emergent (PSPE) application timing in lentils for rates of up to 380g/ha depending on soil type. However, its use is mainly based on herbicide avoidance rather than actual tolerance, and under the wrong environmental conditions has been known to cause significant crop damage. Metribuzin is a broad-spectrum Group C herbicide with both soil and foliar activity and alternative timings and/or higher rates could provide control of a number of key weeds where there are currently no safe/suitable herbicide options. This project looked at the efficacy of alternative applications in novel metribuzin tolerant lentil germplasm. A number of key problematic weeds to the major lentil growing regions of SA were targeted over 2 years including ryegrass, bifora, medic and vetch. Bifora was evaluated at 2 sites in the same year (2017) due to lack of adequate germination at the site selected in 2016. Below average June/July rainfall in 2017 reduced the efficacy of PSPE treatments and demonstrated that higher rates and/or alternative timings are required to maintain reliable and consistent weed control regardless of seasonal variability. All sites were assessed the year following the trials, however no residual effects were observed at any sites for any treatments in the following cereal crop.

Results indicated that higher rates and post-emergent treatments of metribuzin provided effective control of bifora and medic, however only some suppression of common vetch was observed. The lack of control of these weeds is a major limitation to lentil production as current registrations do not provide adequate control of these key weed species. Results from this study demonstrated that novel HT lentil germplasm, which could support the application of novel applications (higher rates and/or alternative timings), would significantly improve the control of these weeds. In addition, results indicated that higher rates of 750g/ha and/or post-emergent metribuzin applications could offer an effective alternative to clethodim. Clethodim (Group A) is currently the only registered herbicide for grass weed control in pulse crops, and the availability of a safe and effective herbicide with a different mode of action is imperative to combating group A resistant ryegrass weeds.

Results of this study will be used to support the case for novel metribuzin applications (higher rates and/or alternative timings), and help facilitate effective and appropriate uptake of this new HT technology. Data from this study may also be included in potential registration/label change applications for future lentil varieties which incorporate these HT traits, however this is highly dependent on on-going work to assess the technical, agronomic and commercial potential of this trait.

Outcomes of the project have been shared with industry via field days and industry and farmer meetings.

Personnel:

1. Ms Dili Mao (0.1FTE)
2. Mr Larn McMurray/ Dr Tim Sutton (0.02 FTE)
3. Dr Christopher Preston – Advisor

Key Performance Indicators (KPI)

KPI	***Achieved (Y/N)***	***If not achieved, please state reason.***
First year of Field trials completed	Y	
First year of Glasshouse trials completed	Y	
Results analysed and communicated with industry	Y	
Second year of Field trials completed	Y	
Results analysed, communicated with and made available to support any registration application processes through the APVMA	Y	
Final report completed	Y	

Technical Information

Five field trials were conducted over 2 years to assess the control of key problematic weeds using a range of metribuzin treatments. At all sites, novel HT metribuzin germplasm (developed from DAS00131) was sown in 1.75 x 10 metre plots at 120 plants per square metre using an experimental plot seeder at 0.225m row spacing and at a sowing depth of approximately 5 cm. Trials were arranged in RCBD and blocked in 2 directions. Post-sowing-pre-emergent (PSPE) treatments were applied 2-3 days post sowing, and post emergent treatments were applied at the 5 node growth stage. Treatments are listed in Table 1, and were mostly consistent across all sites except at Turretfield in 2017, which was expanded to include additional treatments of imazethapyr and BS1000 as an adjuvant in an attempt to increase the level of control of vetch compared to 2016 trials. The maximum metribuzin rate of 750 g/ha was chosen as it is the highest registered rate in any crop on any soil type – and it is therefore unlikely that applications would exceed this due to the additional studies (environmental) that would be required.

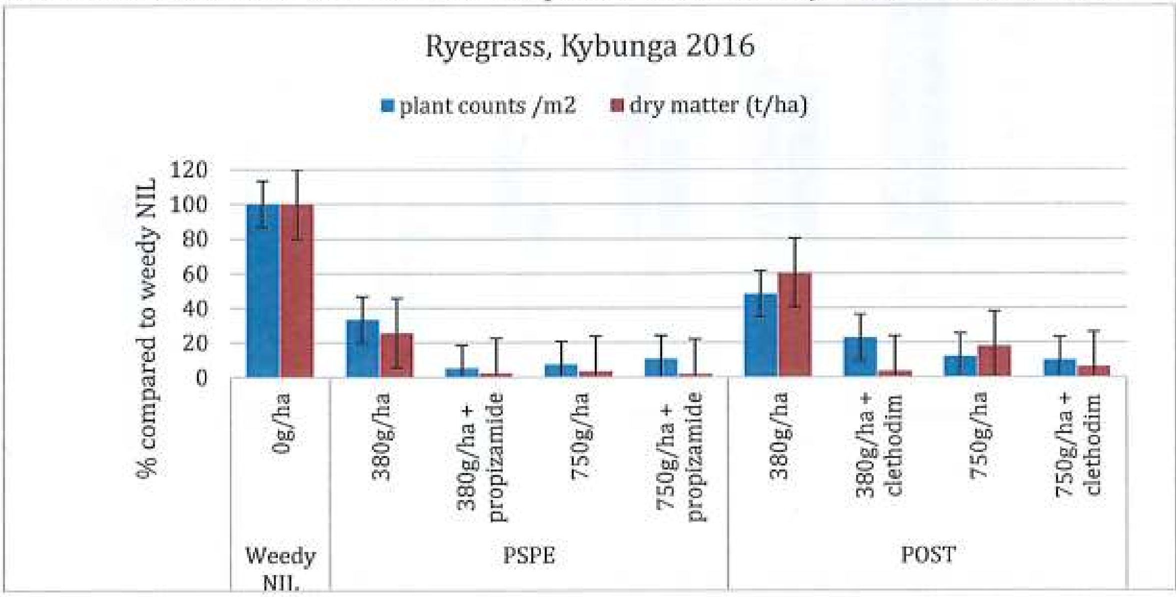
Table 1: Treatment rates and chemistries used in field trials (Site treatment details in Attachment 1).

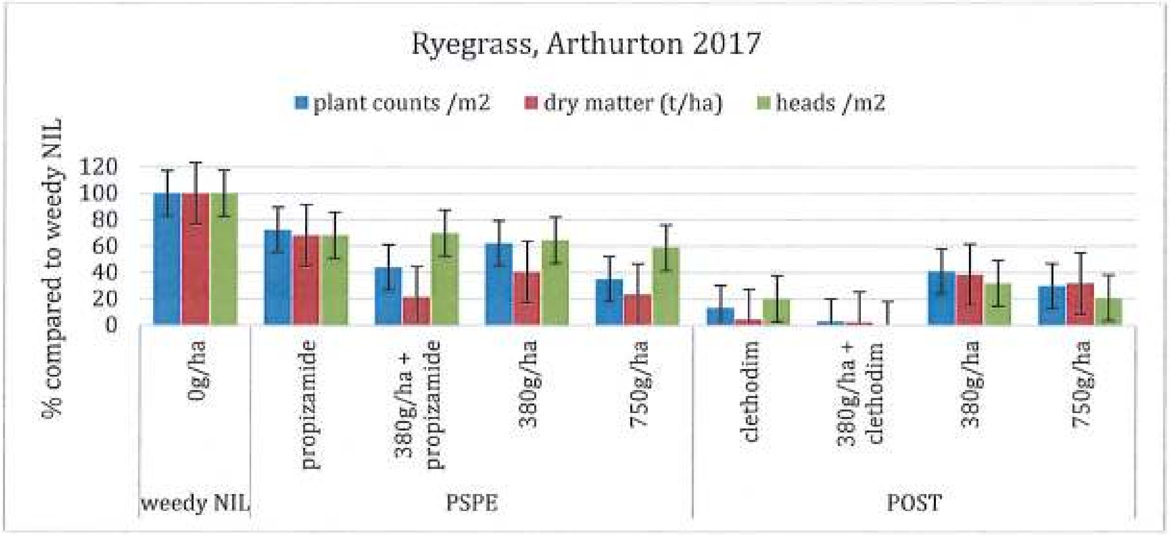
Product Name	Active Ingredient	Treatment Rates (product)	Trial sites
Metribuzin 750 WG	750g/kg metribuzin	380g/ha, 750g/ha	2016 (Turretfield, Kybunga), 2017 (Turretfield, Arthurton, Thomas Plain)
Clethodim 240EC	240g/L clethodim	500g/ha	2016 (Turretfield, Kybunga), 2017 (Arthurton)
Rustler	900g/kg propyzamide	550g/ha	2016 (Turretfield, Kybunga), 2017 (Arthurton)
Spinnaker	700g/kg imazethapyr	100g/ha	2017(Turretfield)

Treatment was applied using a 1.75 m hand-held boom fitted with 4 nozzles (110° flat fan) delivering 107L ha^{-1} at 1m s^{-1} at 220kPa. Crop plant and weed counts were taken at four and six weeks after PSPE treatments and two, four and six weeks after post-emergent treatments, with six week data presented below. Biomass cuts (where possible) were taken at the time of 50% flowering and grain yield and/or head counts were measured at maturity for lentil and the various weed species present. Results were analysed using linear mixed models using the ASReml4 package in R (Gilmour A, Gogel B, Cullis B, Welham S, Thompson R, Butler D, et al. ASReml user guide. Release 4.1 structural specification. VSN International Ltd, Hemel Hempstead, HP1 1ES, UK www vsni co uk. 2014). Additional site specific extraneous fixed and random terms were included as required and residual errors for each site were modelled using spatial methods. The method of residual maximum likelihood (REML) was used for variance parameter estimation and the predicted values for each treatment are presented for each site in Attachment 1.

Ryegrass weed control

Natural populations of ryegrass were opportunistically evaluated using a range of metribuzin treatments at 2 sites. Higher rates of 750g/ha, particularly at the post-emergent timing, were the most effective for the control of ryegrass, and performed similarly to stand-alone clethodim treatments (Figures 1 & 2). In addition, the use of clethodim in conjunction with metribuzin appeared to further improve ryegrass control resulting in greater than 97% reduction in plant counts, dry matter and head counts in 2017 trials, and over 90% reduction in plant counts and dry matter in 2016 trials.

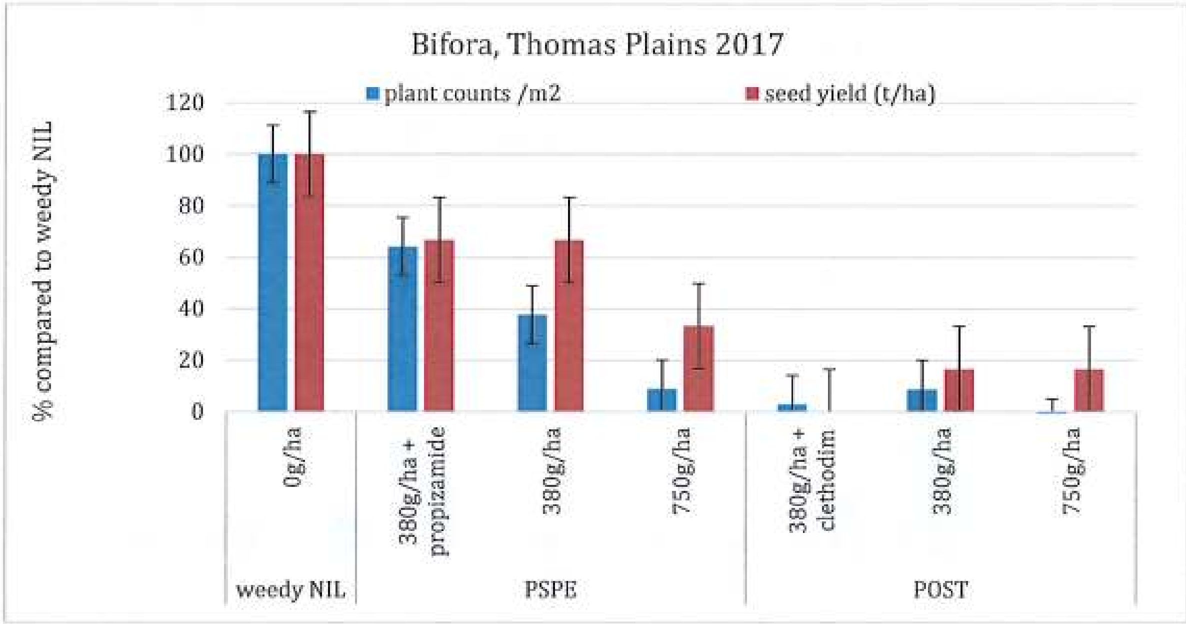


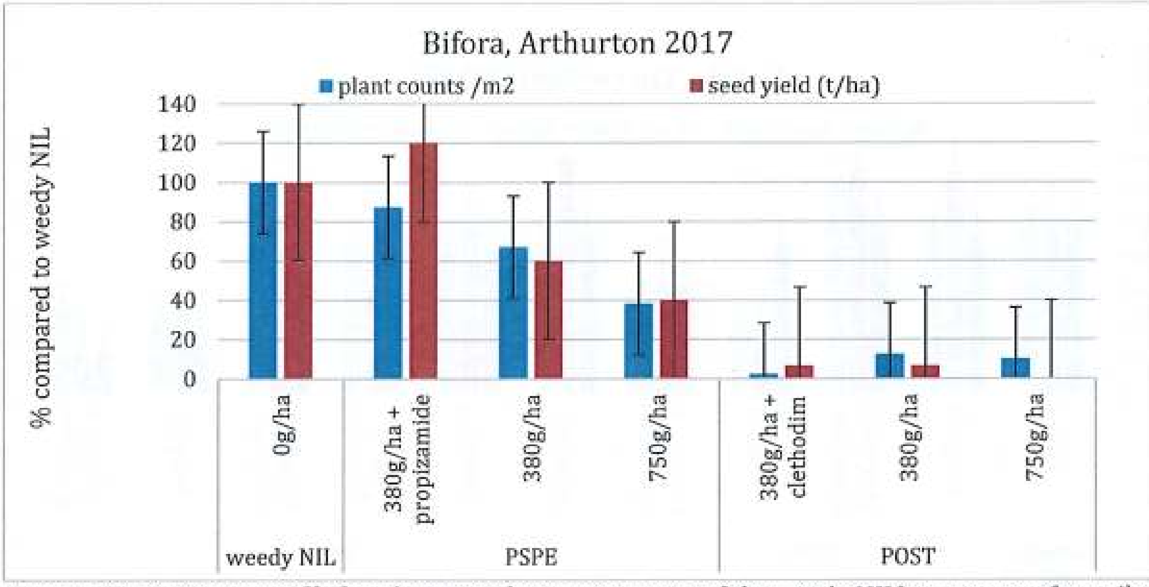


Figures 1 & 2: Response of ryegrass (expressed as a percentage of the weedy NIL) to a range of metribuzin and grass herbicide treatments at Kybunga 2016 and Arthurton 2017, respectively. Error bars represent LSD at p=0.05.

Bifora weed control

Natural populations of bifora were evaluated at two sites during the 2017 season, however at the Thomas Plains site, bifora was also sown to ensure adequate numbers emerged. Bifora seed was obtained from the farmer from the previous season and spread evenly at 40 plants/m^2 over appropriate plots prior to seeding. Post-emergent metribuzin applications were more effective and significantly improved the control of bifora with >90% reduction in plant counts, dry matter and seed production compared to the weedy nil (Figures 3 & 4).





Figures 3 & 4: Response of bifora (expressed as a percentage of the weedy NIL) to a range of metribuzin treatments at Thomas Plains 2017 and Arthurton 2017, respectively. Error bars represent LSD at p=0.05.

Vetch and medic weed control

Two types of vetch and medic with similar properties to the common problematic weed types: haymaker (woolly pod vetch), Morava (common vetch), Paraggio (barrel medic) and Jester (snail medic), were obtained from the SARDI pastures and vetch groups (except for the snail medic, obtained through Chris Butler), tested for germination and sown inter-row to simulate a total weed density of 80 plants/m² at Turretfield site in 2016 and 2017 (only one site is presented below). All treatments were highly effective and significantly improved the control of medic with greater than 90% reduction in plant counts, dry matter and seed production compared to the weedy nil (Figure 5). Higher rates of 750g/ha at the post-emergent timing were somewhat effective for the suppression of common vetch with 50-70% reduction in plant counts and dry matter and 20-60% reduction in seed production compared to the weedy nil (Figure 6), however still led to a significant yield loss in lentil (Attachment 1). Visually, it appeared that metribuzin was more effective in controlling wooly pod vetch compared to common vetch, however this was not able to be accurately quantified.

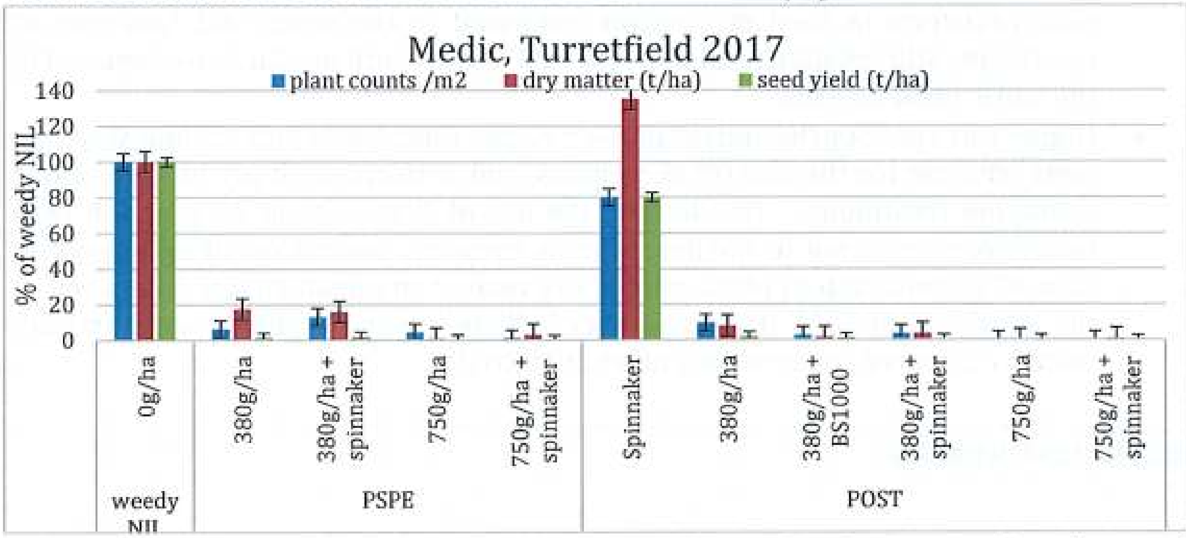


Figure 5: Response of medic (expressed as a percentage of the weedy NIL) to a range of metribuzin and spinnaker treatments at Turretfield 2017. Error bars represent LSD at p=0.05.

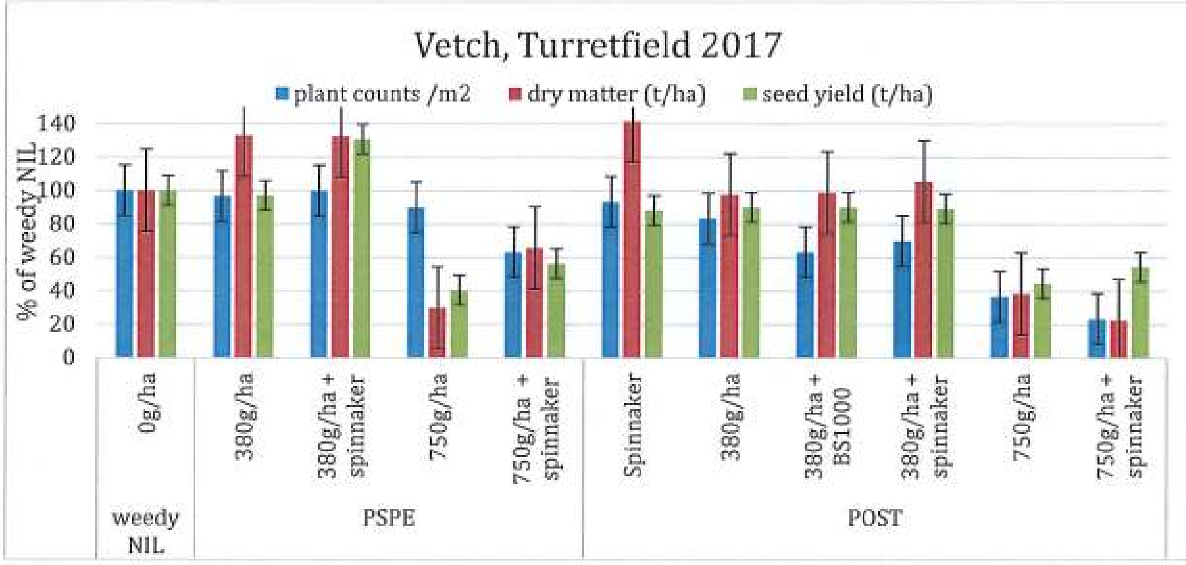


Figure 6: Response of vetch (expressed as a percentage of the weedy NIL) to a range of metribuzin and spinnaker treatments at Turretfield 2017. Error bars represent LSD at p=0.05.

Conclusions Reached &/or Discoveries Made

- New lentil germplasm with metribuzin tolerance traits (developed through DAS00131) showed a high level of agronomic tolerance to the Group C herbicide metribuzin, with no visible crop damage in any of the treatments applied. This improved level of tolerance presents an opportunity to utilize novel applications of metribuzin in future lentil varieties incorporating these traits, which would significantly improve broadleaf and grass weed control.
- Post-emergent metribuzin applications (with no significant differences observed between 380 and 750g/ha rates) were more effective and significantly improved control of bifora and medic, with greater than 90% reduction in plant counts, dry matter and seed production compared to the weedy nil.
- High rates of 750g/ha at the post-emergent timing provided some suppression of common vetch with 50-70% reduction in plant counts and dry matter and 20-60% reduction in seed production compared to the weedy nil, however all treatments still resulted in significant yield loss in lentil production compared to the lentil weed-free nil.
- Higher rates of 750g/ha and/or post-emergent metribuzin applications were the most effective for the control of ryegrass, and performed on par to stand-alone clethodim treatments. In addition, the use of clethodim in conjunction with metribuzin appeared to further improve ryegrass control resulting in greater than 97% reduction in plant counts, dry matter and head counts compared to the weedy nil in 2017 trials, and over 90% reduction in plant counts and dry matter compared to the weedy nil in 2016 trials.

Intellectual Property

n/a

Application / Communication of Results

Main findings

- New lentil germplasm with metribuzin tolerance traits (developed through DAS00131) showed a high level of agronomic tolerance to the Group C herbicide metribuzin, with no visible crop damage in any of the treatments applied.
- Post-emergent metribuzin applications (with no significant differences observed between 380 and 750g/ha rates) were more effective and significantly improved control of bifora and medic, with greater than 90% reduction in plant counts, dry matter and seed production compared to the weedy nil.
- High rates of 750g/ha at the post-emergent timing provided some suppression of common vetch with 50-70% reduction in plant counts and dry matter and between 20-60% reduction in seed production compared to the weedy nil, however all treatments still resulted in significant yield loss in lentil production compared to the lentil weed-free nil.
- Higher rates of 750g/ha and/or post-emergent metribuzin applications were the most effective for the control of ryegrass, and performed on par to stand-alone clethodim treatments. In addition, the use of clethodim in conjunction with metribuzin appeared to further improve ryegrass control resulting in >97% reduction in plant counts, dry matter and head counts compared to the weedy nil in 2017 trials, and over 90% reduction in plant counts and dry matter compared to the weedy nil in 2016 trials.

Potential industry impact

- Currently SA lentil production is limited by the inability to control weeds, particularly late emerging broadleaf weeds, which can contribute to significant costs from production losses, seed cleaning and/or docking grades.
- The recent release and rapid adoption of HT XT lentil varieties across SA demonstrates the high demand for HT traits in lentils, however none of the current registrations provide adequate control of a number of key weed species, and has resulted in some growers using unregistered chemistries, which is a major concern in the lentil industry.
- The development of novel HT lentil germplasm with a different mode of action (Group C) presents an opportunity to register novel applications of metribuzin (higher rates and/or alternative timings) in future varieties incorporating new HT traits. The results of this study have shown that the use of higher rates and/or alternative timings will significantly improve control for a number of problematic broadleaf and grass weeds in SA lentil production, as well as providing an alternative option for the control of Group A resistant ryegrass.
- The availability of a different mode of action for weed control in lentil is imperative for combating herbicide resistance from current usage patterns, and will help to protect the longevity of these technologies.

Extension/Path to market

- Results of this study will be used to support the case for the need of higher rates and/or alternative timings, and help facilitate effective and appropriate uptake of this potential new HT technology.

- Data from this study may also be included in any potential registration/label change applications for future lentil varieties which incorporate these HT traits, however this is highly dependent on on-going work evaluating the technical, agronomic and commercial potential of this trait.
- Outcomes of the project have also been shared with industry via field days, industry and farmer meetings.

POSSIBLE FUTURE WORK

Future work in this space could look at the potential effects of changing herbicide usage patterns in lentil (Group B and C) and effective agronomic practises, as well as the potential impact on weeds in the broader farming system.

Outcomes from this project will provide better understanding of likely herbicide usage patterns and information has been provided to the GRDC-SARDI bilateral weeds program (project DAS00168-BA, started in 2017), which will have the capacity to look into some of these effects in greater depth over the next few years.

Work is on-going with Australian lentil breeding programs to develop agronomically adapted lines incorporating this HT trait. However, this is work is still highly dependent on on-going work which is evaluating the technical, agronomic and commercial potential of this trait.

AUTHORISATION	
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Position:	Acting Research Chief, Sustainable Systems
Signature:	
Date:	22 August 2018

Attachment 1: S316 – Improving weed control in new herbicide tolerant lentils

2016 Field Trials

- Natural populations of bifora and ryegrass weeds were evaluated at the Kybunga site, however bifora populations were low and not significant.
- Two types of vetch and medic with simular properties to the common problematic weed types: haymaker (woolly pod vetch), Morava (common vetch), Paraggio (barrel medic) and Jester (snail medic), were obtained from the SARDI pastures and vetch groups (except for the snail medic, obtained through Chris Butler), tested for germination and sown inter-row to simulate a total weed density of 80 plants/m^2 at the Turretfield site.
- Metribuzin treatments at both sites compared a non-treated nil, two rates (380g/ha and 750g/ha), PSPE and post-emergent timings, and the addition of a grass herbicide (propyzamide at 550ml/ha PSPE and clethodim at 500ml/ha post-emergent).
- Crop establishment and weed counts were taken at six weeks after treatment. Biomass cuts were taken at the time of first flowering and grain yield was measured at maturity for lentil and the various weed species present.

Table 1: Response of ryegrass weeds and metribuzin tolerant lentil germplasm to a range of metribuzin treatments at Kybunga, 2016. Data was analysed using ASReml in R, and LSD's are presented below at p=0.05. [a] shows significance of treatments compared to weedy NIL for each line at P=0.05.

		Ryegrass		Metribuzin Tolerant Lentil		
Timing	Metribuzin Treatments	plant counts /m^2	dry matter (t/ha)	establishment counts /m^2	dry matter (t/ha)	grain yield (t/ha)
NIL	0g/ha	27.75	1.68	109.28	1.67	0.65
PSPE	380g/ha	9.23 [a]	0.43 [a]	100.74	2.07	1.19 [a]
PSPE	380g/ha + propizamide	1.46 [a]	0.04 [a]	116.72	2.07	1.49 [a]
PSPE	750g/ha	2.02 [a]	0.06 [a]	121.93	2.25 [a]	1.45 [a]
PSPE	750g/ha + propizamide	2.95 [a]	0.03 [a]	107.04	2.13	1.67 [a]
PE	380g/ha	13.31 [a]	1.01	107.38	1.58	1.05 [a]
PE	380g/ha + clethodim	6.33 [a]	0.06 [a]	107.53	2.22 [a]	1.42 [a]
PE	750g/ha	3.28 [a]	0.30 [a]	100.00	1.79	1.22 [a]
PE	750g/ha + clethodim	2.74 [a]	0.10 [a]	107.77	2.04	1.43 [a]
	LSD=	7.44	0.68	22.05	0.51	0.32

Table 2: Response of vetch and medic weed, and metribuzin tolerant lentil germplasm, to a range of metribuzin treatments at Turretfield, 2016. Data was analysed using ASReml in R, and LSD's are presented below at p=0.05. ^{a} shows significance of treatments compared to weedy NIL for each line at P=0.05.

		Medic			Vetch			Metribuzin Tolerant Lentil		
Timing	Metribuzin Treatments	plant counts /m^2	dry matter (t/ha)	seed yield (t/ha)	plant counts /m^2	dry matter (t/ha)	seed yield (t/ha)	establishment counts /m^2	dry matter (t/ha)	grain yield (t/ha)
NIL	0g/ha	18.13	1.93	0.23	24.49	2.72	1.69	102.36	1.32	0.27
PSPE	380g/ha	2.11 ^{a}	0.12 ^{a}	0.03 ^{a}	26.21	3.31	2.32	105.47	1.66	0.57
PSPE	380g/ha + propizamide	5.37 ^{a}	-0.01 ^{a}	0.05 ^{a}	19.82	2.46	2.21	119.02	2.13 ^{a}	0.28
PSPE	750g/ha	1.06 ^{a}	0.11 ^{a}	0.00 ^{a}	15.63 ^{a}	1.64 ^{a}	2.15	110.74	2.85 ^{a}	0.87 ^{a}
PSPE	750g/ha + propizamide	-0.93 ^{a}	-0.04 ^{a}	0.00 ^{a}	18.87	1.54 ^{a}	2.26	121.39	2.79 ^{a}	0.86 ^{a}
PE	380g/ha	1.11 ^{a}	0.23 ^{a}	0.02 ^{a}	12.75 ^{a}	1.17 ^{a}	1.90	101.42	2.54 ^{a}	0.48
PE	380g/ha + clethodim	3.83 ^{a}	0.08 ^{a}	0.03 ^{a}	12.89 ^{a}	2.05 ^{a}	2.02	97.92	2.44 ^{a}	0.88 ^{a}
PE	750g/ha	1.26 ^{a}	0.08 ^{a}	0.03 ^{a}	10.90 ^{a}	1.16 ^{a}	1.43	102.86	2.64 ^{a}	0.99 ^{a}
PE	750g/ha + clethodim	1.49 ^{a}	0.14 ^{a}	0.02 ^{a}	9.12 ^{a}	0.68 ^{a}	1.20 ^{a}	96.92	2.73 ^{a}	0.97 ^{a}
	LSD=	3.65	0.26	0.12	7.33	0.43	0.45	21.03	0.37	0.57

2017 Field Trials

- Natural populations of bifora and ryegrass weeds were evaluated at the Arthurton site, while natural and sown bifora populations were evaluated at Thomas Plains in the absence of ryegrass.
- Two types of vetch and medic with simular properties to the common problematic weed types: haymaker (woolly pod vetch), Morava (common vetch), Paraggio (barrel medic) and Jester (snail medic), were obtained from the SARDI pastures and vetch groups (except for the snail medic, obtained through Chris Butler), tested for germination and sown inter-row to simulate a total weed density of ~60 plants/m^2 at the Turretfield site. Data is pooled for vetch and medic due to difficultly, accuracy and time constraints separating the two, however common vetch was the major vetch present at harvest.
- The vetch site included additional treatments of imazapyther and with BS1000 as an adjuvant in an attempt to increase the level of control compared to 2016 trials.
- Crop establishment and weed counts were taken at four and six weeks after PSPE treatments and two, four and six weeks after POST treatments, with 6 weeks after POST treatments data presented below. Biomass cuts were taken at the time of first flowering (at Arthurton and Turretfield sites only) and grain yield and/or head counts were measured at maturity for lentil and the various weed species present.

Table 3: Response of ryegrass and bifora weeds and metribuzin tolerant lentil germplasm to a range of metribuzin treatments at Arthurton, 2017. Data was analysed using ASReml in R, and LSD's are presented below at p=0.05. [a] shows significance of treatments compared to weedy NIL for each line at P=0.05.

		Ryegrass			Bifora			Metribuzin Tolerant Lentil		
Timing	Metribuzin Treatments	plant counts /m²	dry matter (t/ha)	heads /m²	plant counts /m²	dry matter (t/ha)	seed yield (t/ha)	establishment counts /m²	dry matter (t/ha)	grain yield (t/ha)
weedy NIL	0g/ha	60.87	0.47	162.30	18.89	0.06	0.15	71.17	1.28	1.24
PSPE	propizamide	44.00	0.32	110.56	22.94	0.11	0.15	58.43	1.69	1.35
PSPE	380g/ha + propizamide	26.67 [a]	0.10 [a]	113.39	16.50	0.14	0.18	60.71	1.51	1.35
PSPE	380g/ha	37.77 [a]	0.19 [a]	104.86 [a]	12.67	0.09	0.09	63.37	1.43	1.46 [a]
PSPE	750g/ha	21.33 [a]	0.11 [a]	95.31 [a]	7.23 [a]	0.04	0.06	69.91	1.81 [a]	1.58 [a]
POST	clethodim	8.03 [a]	0.02 [a]	32.83 [a]	20.13	0.01	0.27	66.57	1.78 [a]	1.64 [a]
POST	380g/ha + clethodim	1.77 [a]	0.01 [a]	1.05 [a]	0.44 [a]	0.00	0.01 [a]	67.59	1.77 [a]	1.98 [a]
POST	380g/ha	24.87 [a]	0.18 [a]	51.71 [a]	2.37 [a]	0.00	0.01 [a]	60.25	1.63	1.69 [a]
POST	750g/ha	18.20 [a]	0.15 [a]	33.70 [a]	1.94 [a]	0.00	0.00 [a]	65.96	1.78 [a]	1.63 [a]
	LSD=	20.91	0.22	56.94	9.90	0.10	0.12	17.41	0.43	0.17

Treatment timings: PSPE = Post sowing pre-emergent, POST = post-emergent, applied at 5 node growth stage

Table 4: Response of bifora weeds and metribuzin tolerant lentil germplasm to a range of metribuzin treatments at Thomas Plains, 2017. Data was analysed using ASReml in R, and LSD's are presented below at p=0.05. [a] shows significance of treatments compared to weedy NIL for each line at P=0.05.

		Bifora		Metribuzin Tolerant Lentil	
Timing	Metribuzin Treatments	plant counts /m^2	seed yield (t/ha)	establishment counts /m^2	seed yield (t/ha)
weedy NIL	0g/ha	17.53	0.06	59.26	0.68
PSPE	380g/ha + propizamide	11.25 [a]	0.04 [a]	57.04	0.79 [a]
PSPE	380g/ha	6.61 [a]	0.04 [a]	59.26	0.77
PSPE	750g/ha	1.56 [a]	0.02 [a]	66.30	0.85 [a]
POST	380g/ha + clethodim	0.51 [a]	0.00 [a]	65.93	0.87 [a]
POST	380g/ha	1.53 [a]	0.01 [a]	63.54	0.80 [a]
POST	750g/ha	-1.11 [a]	0.01 [a]	58.15	0.81 [a]
	LSD=	3.97	0.02	11.79	0.10

Treatment timings: PSPE = Post sowing pre-emergent, POST = post-emergent, applied at 5 node growth stage

Table 5: Response of vetch and medic weed, and metribuzin tolerant lentil germplasm, to a range of metribuzin treatments at Turretfield, 2017. Data was analysed using ASReml in R, and LSD's are presented below at p=0.05. [a] shows significance of treatments compared to weedy NIL for each line at P=0.05.

		Medic			Vetch			Metribuzin Tolerant Lentil		
Timing	Metribuzin Treatments	plant counts/m²	dry matter (t/ha)	seed yield (g/ha)	plant counts /m²	dry matter (t/ha)	seed yield (t/ha)	establishment counts /m²	dry matter (t/ha)	grain yield (t/ha)
weed-free NIL	0g/ha	0.00	0.00	9.04	0.00	0.00	-0.08	81.15	2.07	1.30
weedy NIL	0g/ha	51.11	1.39	106.93	13.34	1.64	1.01	67.13	0.37	0.04
PSPE	380g/ha	3.11 [a]	0.24 [a]	1.41 [a]	12.89	2.18	0.98	86.31	1.54 [a]	0.65 [a]
PSPE	380g/ha + spinnaker	6.67 [a]	0.22 [a]	2.01 [a]	13.33	2.17	1.32	77.06	1.47 [a]	0.51 [a]
PSPE	750g/ha	2.22 [a]	0.01 [a]	0.20 [a]	12.00	0.49 [a]	0.41 [a]	71.19	2.01 [a]	1.09 [a]
PSPE	750g/ha + spinnaker	0.44 [a]	0.04 [a]	0.00 [a]	8.44 [a]	1.08	0.57 [a]	74.62	1.93 [a]	1.13 [a]
POST	Spinnaker	40.89 [a]	1.88	85.54 [a]	12.44	2.32	0.89	64.95	0.40	0.08 [a]
POST	380g/ha	4.89 [a]	0.11 [a]	2.01 [a]	11.11	1.60	0.91	74.22	1.93 [a]	0.77 [a]
POST	380g/ha + BS1000	1.33 [a]	0.02 [a]	1.20 [a]	8.44 [a]	1.62	0.91	71.43	1.54 [a]	0.75 [a]
POST	380g/ha + spinnaker	1.78 [a]	0.05 [a]	0.40 [a]	9.33	1.73	0.90	71.02	1.03 [a]	0.60 [a]
POST	750g/ha	0.00 [a]	0.00 [a]	0.20 [a]	4.89 [a]	0.63 [a]	0.45 [a]	79.89	1.55 [a]	1.05 [a]
POST	750g/ha + spinnaker	0.00 [a]	0.01 [a]	0.00 [a]	3.11 [a]	0.37 [a]	0.55 [a]	79.28	1.80 [a]	0.85 [a]
	LSD=	4.90	0.17	5.73	4.07	0.61	0.18	13.84	0.43	0.14

Treatment timings: PSPE = Post sowing pre-emergent, POST = post-emergent, applied at 5 node growth stage