Response to metsulfuron-methyl and dicamba in wheat (*Triticum aestivuum* L.) and barley (*Hordeum vulgare* L.) cultivars

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Abstract
Herbicide tolerance research has highlighted the herbicides metsulfuron-methyl (Ally®) and dicamba (Cadence®) as being particularly damaging to wheat and barley cultivars in South Australia. Response of wheat and barley cultivars to these herbicides has shown consistent yield reductions when applied at the recommended rates. Field experiment data collected from 2008, 2009 and 2010 was analysed to investigate the reoccurrence of damage by these herbicides. Grain yield results from herbicide treated plots, expressed as a % of the untreated plots, were used to determine grain yield reductions. Grain yield losses of between 3-15% were recorded in the tested wheat and barley cultivars towards metsulfuron-methyl and dicamba at the recommended rate. Cultivar sensitivity to metsulfuron-methyl and dicamba places considerable importance on ensuring testing occurs on all new breeder and current commercial cultivars to ensure growers are able to make safe application choices.

Key words
Metsulfuron-methyl, dicamba, wheat, barley, cultivar response

Introduction
In-crop herbicides have long shown a varying severity of damage across cultivars of common crop species causing problems with herbicide and cultivar selection in farming systems (Gunsolus and Curran 1991; Wicks *et al*. 1987). To evaluate the extent of this issue in South Australian (SA) crop production systems, a series of experiments were initiated in the mid 90's funded by the Grains Research and Development Corporation and the South Australian Research and Development Institute. The experiments were set up at a number of different locations around South Australia and aimed to characterise cultivar sensitivity within wheat and barley cultivars grown in the Mid North of SA over three seasons. Grain yield and normalized difference vegetation index (NDVI), as compared to the untreated control, is widely utilised as the indicator of herbicide tolerance and has shown high variation between seasons (Harrigan *et al*. 2010) suggesting that herbicide tolerance trials should be repeated across at least 2-3 seasons. It is important for these trials to take place under weed free conditions and on soils with adequate nutrition applied to remove the confounding effects of weed competition and nutrient deficiency. Seasonal variation in damage was observed in both wheat and barley to the commonly used herbicides dicamba and metsulfuron-methyl over 2-3 seasons and clearly illustrated the significant variation that both the environment and individual cultivar tolerance contributes to the outcome.

Method
Every year since the early 2000's, field experiments located near Kybunga in the Mid North of SA were conducted to assess the tolerance of a select number of breeder and commercially released wheat and barley cultivars to a range of commonly used herbicides. Cultivar selection was aimed at attaining between 2-3 seasons of data prior to wide-scale commercial use, and included 5-7 barley and 8-12 wheat cultivars. To eliminate any potential weed competition, experiments were sown relatively late in the season to allow weed germination and control prior to sowing. Commercially acceptable seeding protocols, including the use of diammonium phosphate fertilizer (DAP) with 2% zinc, knife points and press wheels resulted in a minimum till practice being achieved. Each experiment consisted of a wide range of individual herbicide treatments, in this instance dicamba and metsulfuron-methyl being sprayed at label-recommended rates to give information on varietal tolerances and safety margins, achieved through comparing grain yields. The trials were arranged as a split plot design with three replicates.

Results

Yield data obtained from 2008 to 2010 highlighted variability between dicamba (140 g ai/ha) (Cadence®) and metsulfuron-methyl (4.2 g ai/ha) (Ally®) with damage observed in different wheat cultivars. The application of each herbicide produced significantly different grain yield responses between cultivars (Table 1). Wheat cultivars Axe, Catalina, Correll and Frame were found to display tolerance to dicamba with no grain yield losses in 2008. In 2009 all cultivars displayed sensitivity to dicamba resulting in yield reductions of 3-9%. Axe and Catalina displayed repeated sensitivity in 2010 with yield reductions of 9 and 11% respectively. Axe, Catalina and Frame displayed sensitivity in 2008 trials when metsulfuron-methyl was applied, recording a 13%, 13% and 9% grain yield reduction. In 2009 Axe and Catalina displayed increased tolerance to metsulfuron-methyl while Frame recorded a 7% grain yield reduction. Axe displayed sensitivity to metsulfuron-methyl and a subsequent 15% yield reduction in 2010 while Catalina, Correll and Frame displayed no grain yield losses significantly different to the untreated control.

Table 1. The response of wheat cultivars to dicamba and metsulfuron-methyl on cultivar grain yield (t/ha as a % of the untreated control) between 2008 to 2010 at Kybunga, South Australia.

	Untreated control			Dicamba 140 g ai/ha (Z15)			Metsulfuron-methyl 4.2 g ai/ha (Z13)		
				Year					
Variety	2008	2009	2010	2008	2009	2010	2008	2009	2010
	yield t/ha			as % untreated control					
Axe	0.62	2.54	3.82	106	**91***	**91***	**87***	100	**85***
Catalina	0.72	2.58	3.94	103	**96***	**89***	**87***	101	97
Correll	0.61	2.69	4.11	105	**97***	104	96	99	98
Frame	0.65	2.29	3.69	105	**93***	99	**91***	**93***	101
Mean	0.65	2.52	3.89	105	94	96	90	98	95

* Denotes mean yields that were significantly less than the untreated control at the P<0.05 level.

Table 2. The response of barley cultivars to dicamba and metsulfuron-methyl on grain yield (t/ha as a % of the untreated control) between 2008 to 2010 at Kybunga, South Australia.

	Untreated control			Dicamba 140 g ai/ha (Z15)			Metsulfuron-methyl 4.2 g ai/ha (Z13)		
				Year					
Variety	2008	2009	2010	2008	2009	2010	2008	2009	2010
	yield t/ha			as % untreated control					
Buloke	1.71	3.38	3.95	**84***	106	102	96	**94***	103
Flagship	1.93	3.01	3.76	98	**83***	99	95	**96***	97
Hindmarsh	2.41	3.39	3.84	101	100	**90***	**91***	**96***	101
Finiss	1.73	3.08	3.56	**76***	**95***	98	97	98	98
Mean	1.95	3.21	3.78	89	96	97	95	96	99

* Denotes mean yields that were significantly less than the untreated control at the P<0.05 level.

Similarly to wheat, barley yield data highlighted the variability between cultivar sensitivity towards dicamba (140 g ai/ha) and metsulfuron-methyl (4.2 g ai/ha) (Table 2). The tested varieties Buloke, Flagship, Hindmarsh and Finiss all displayed levels of tolerance and sensitivity with seasonal variability. Buloke and Finiss displaying sensitivity to dicamba in 2008 recording 16% and 24% grain yield reductions respectively. Flagship and Finiss displayed sensitivity to dicamba in 2009 with 17% and 5% grain yield reductions. In 2010 Buloke, Flagship and Finiss displayed good levels of tolerance to dicamba while Hindmarsh displayed sensitivity respectively and incurred a 10% yield reduction. Yield reductions were observed in 2009 towards metsulfuron-methyl with Buloke, Flagship and Hindmarsh all recording 4-6% yield losses significantly different to the untreated control.

Discussion

Varietal screening of wheat and barley to metsulfuron-methyl and dicamba has previously shown varieties to suffer significant grain yield reductions when applied at label recommended rates (Ramsey *et al*. 2010). Metsulfuron-methyl and dicamba in a stand-alone application have also been observed to impact severely upon multiple wheat and barley cultivars in experiments run prior to 2012 (Ramsey *et al*. 2010). The levels of sensitivity observed to these herbicides suggested that there was a requirement for the addition of a second herbicide in a tank mix. It was observed that this was becoming a more commercially adopted practice by many growers in South Australia. Over the past 3 years there has been a change to the commonly practiced standalone application of dicamba and metsulfuron-methyl. The addition of a secondary product has suggested that this could act as a "softening" agent and in many instances help reduce the severity and frequency of the damage observed prior to 2010. The addition of the chemical MCPA (Agritone®) to tank mixes has shown to significantly reduced the incidence and severity of damage and grain yield losses, witnessed initially in the preliminary screening trials. Sensitivity within wheat and barley cultivars to metsulfuron-methyl and dicamba may suggest and be supported by long term yield data that wheat displays significantly less tolerance to both metsulfuron-methyl and dicamba than barley.

Conclusion

High degrees of variability within responses in wheat and barley cultivars to dicamba and metsulfuron-methyl during these experiments highlight the need for a holistic approach when selecting crop cultivars and herbicides to ensure financial losses do not result. Cultivar and herbicide combinations should be planned in conjunction with weed-control strategies to reduce herbicide-related yield penalties resulting from generic label recommendations for crop species. Seasonally dependent results emphasise the importance and vigilance growers need to take, depicted in historic long-term yield data. This will help growers make more informed decisions about cultivar and herbicide selection in order to minimise herbicide-related yield losses. Continued testing of newer varieties will ensure growers can confidently make management decisions to maximize profitability. This information could also be utilised by breeding programs to improve herbicide tolerance in these crops.

References

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