Does herbicide-induced phytotoxicity occur in South African wheat cultivars?

The ARC-Small Grain aims to determine the phytotoxicity of herbicides to several Western Cape wheat cultivars. No herbicide tolerance studies have been performed on local dryland wheat cultivars, leaving producers uninformed about the herbicide tolerance status of these cultivars. Some of the products that caused yield reductions in Australia are also registered for use in South Africa.

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According to results from an Australian study, some of their wheat varieties were more prone to damage from certain herbicides than others. They tested nineteen wheat varieties in their study. Fourteen herbicide treatments were applied before seedling/ incorporated by seedling. One was applied immediately after planting and the rest of the treatments were all applied at different post emergence wheat growth stages (Zadoks et al., 1974).

Yield reductions as high as 41% were recorded in some varieties with certain treatments. Variation in tolerance can be due to differences in morphological characteristics or physiological processes and/or the tempo of internal ear development among varieties. Moreover, the applied herbicide rate, environmental conditions during herbicide application and the growth stage of the crop may also impact the levels of tolerance among varieties.

In a study by Protic et al. (2006), a high correlation was noted between the time of application and herbicide dosage on damage in winter wheat. In their study, the largest reduction in grain yield was caused by primisulfuron-methyl applied before emergence at 30.0 g/ha. Orr et al. (1996) found that two of the most critical factors in reducing plant injury are choice of post- (crop) emergence herbicide and the growth stage at which the herbicide is applied.

To minimise risk of wheat injury and to maximise yields, they found that the optimal time to apply post-crop emergence herbicides is at the tillering growth stage. The two-leaf stage was found to be the most sensitive to 2,4-D. Moderate or severe injury caused by 2,4-D and dicamba + MCPA on one-third to one-half of the spikes can cause yield losses of up to 27%. Conversely, Marczewska (2006) found that an application of 67.5 g/ha of chlorosulfuron (Glean 75 WG) was not harmful to the growth or yield of winter wheat. Kieloch & Rols (2010) also found no reduction in grain yield of five winter wheat cultivars screened with different herbicide treatments in normal seasons.

In South Africa, there are currently 15 different dryland wheat cultivars (for planting in the Western Cape) in the ARC-Small Grain National Cultivar Evaluation trials. To date, no herbicide tolerance studies have been performed on these cultivars, leaving producers uninformed about the herbicide tolerance status of these cultivars.

It is alarming that some of the products that caused yield reductions in Australia are also registered for use in South Africa. Although tradenames may differ, the active ingredient(s) stay the same. Some of these active ingredients include chlorosulfuron, dicyfop-methyl, tralkoxydim, bromoxynil, metosulfuron, MCPA and iodosulfuron. Using some of these herbicides unknowingly on herbicide intolerant cultivars, can lead to very high levels of yield reduction. Due to environmental variability, it becomes essential to test herbicide and cultivar interactions over several seasons and at more than one location.

Research
The research project, conducted by ARC-Small Grain, aims to determine the phytotoxicity of herbicides to several Western Cape cultivars. This project includes six cultivars (SST 015, SST 056, SST 027, SST 087, PAN 3408 and Ratell) planted in two regions, i.e., Ruëns (Tygerhoek (2015 and 2016)) and Swartland (Moorreesburg (2015) and Wellington (2016)). Six different herbicide treatments (including the control) are included in the trials. Only the highest recommended rates are tested for all herbicides.

In 2015, a section of the Tygerhoek trial was flooded and had to be excluded from the trial. For this reason, only 2016 data for SST 087 were recorded. It would be unfair to compare the differences between the cultivars, as some cultivars are naturally better yielders than others. If a cultivar is a low yielder under normal circumstances, it would be unfair to both the cultivar and the chemical(s) to state that the cultivar underperformed due to the herbicide(s). Results of the experiments are summarised in Figures 1 to 6.

The active ingredients of the herbicides are as follows:
- Pyroxasulam
- Iodosulfuron-methyl-sodium + mesosulfuron-methyl + safener
- Chlorosulfuron & metsulfuron-methyl
- MCPA (potassium salt, phenoxy compound) & bromoxynil (nitrile)
- Pyrasulfotole (pyrazole) & bromoxynil (nitrile) & mepenpyr-diethyl

PAN 3408
In 2015 in the Swartland, only one herbicide treatment showed antagonism in comparison to the control. This treatment was MCPA & bromoxynil. All other herbicide treatments recorded higher yields than the control. In 2016, only two treatments recorded higher yields than the control. These treatments were iodosulfuron-methyl-sodium & mesosulfuron-methyl & safener and MCPA & bromoxynil. According to the results (Figure 1), Pan 3408 was more sensitive to pyroxasulam than other herbicides in the Swartland.

In 2015 in the Ruëns, only one herbicide treatment resulted in lower yields
in comparison with the control. This herbicide treatment was pyroxsulam. In 2016, two treatments recorded lower yields than the control. These treatments were pyroxsulam and pyrasulfotole & bromoxynil & mfenpy-diethyl. Higher yields were recorded with the chlorosulfuron & metsulfuron-methyl, lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener and MCPA & bromoxynil treatments. According to Figure 1, it is evident that PAN 3408 was most sensitive to pyrazulfotole & bromoxynil & mfenpy-diethyl in 2016.

**SST 056**

In 2015 in the Swartland, all herbicide treatments showed lower yields than the control, thus indicating different levels of antagonism. In 2016, three treatments showed lower yields than the control. These three treatments were lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener, pyroxsulam and pyzasulfotole & bromoxynil & mfenpy-diethyl. The best performing treatment in 2016 was the MCPA & bromoxynil treatment, although it was the second poorest performing treatment in 2015.

During the 2015 season in the Rieuses, the lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener treatment had a lower yield than all other herbicide treatments. During the 2016 season, all herbicide treatments resulted in higher yields. The highest yielding treatment (Figure 2) was the chlorosulfuron & metsulfuron-methyl treatment, which was the second highest yielding treatment in the 2015 season.

**SST 0127**

In 2015 in the Swartland, only two treatments showed an increase in yield when compared to the control. These two treatments were chlorosulfuron & metsulfuron-methyl and pyrazulfotole & bromoxynil & mfenpy-diethyl. The rest of the herbicide treatments all recorded lower yields than the control.

In 2016, all herbicide treatments showed an increase in yield above that of the control. The best performing herbicide treatment was pyroxsulam. As in 2015, the results indicate (Figure 3) that SST 0127 was more sensitive to lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener than any other herbicides.

In 2015 in the Rieuses, the MCPA & bromoxynil treatment had a lower yield than other treatments. The highest yielding treatments were the control and lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener treatments. In 2016, the chlorosulfuron & metsulfuron-methyl treatment recorded a notably higher yield than the control. According to Figure 3, it is clear that during 2016, SST 0127 in the Southern Cape was more sensitive to the pyrazulfotole & bromoxynil & mfenpy-diethyl treatment than any other herbicide treatments.

**SST 015**

In 2015 in the Swartland, only two treatments showed lower yields than the control. These treatments were lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener and MCPA & bromoxynil. The highest yielding treatments were pyroxsulam and chlorosulfuron & metsulfuron-methyl.

In 2016, three treatments recorded lower yields than the control, thus indicating various degrees of antagonism. These three treatments were lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener, MCPA & bromoxynil and pyroxsulam. The best yielding treatment was...
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Pyraflurine & bromoxynil & mefenpyr-diethyl. According to the results in Figure 4, SST 015 was more sensitive to pyroxasulam than any other herbicide. In 2015 in the Rüens, the best-performing treatment was pyroxasulam and the lowest yielding treatment was Iodosulfuron-methyl-sodium & mesosulfuron-methyl & safener. In the 2016 season, the best yielding treatment was chlorosulfuron & metsulfuron-methyl and the lowest yielding treatment was MCPA & bromoxynil. According to Figure 4, it is evident that SST 015 was most sensitive to MCPA & bromoxynil during the 2016 planting season.

**Ratei**

In 2015 in the Swartland, varied yields were recorded over the different herbicide treatments. Only one treatment recorded a lower yield than the control and that was the chlorosulfuron & metsulfuron-methyl treatment. In 2016, only pyroxasulam recorded a lower yield than the control. All other herbicide treatments increased the yield above that of the control. The best herbicide treatment was MCPA & bromoxynil (Figure 5).

In 2015 in the Rüens, all treatments recorded lower yields than the control. In 2016, again most treatments showed lower yields than the control. Only one herbicide treatment recorded a higher yield than the control and that treatment was MCPA & bromoxynil.

**SST 087**

In 2015 in the Swartland, the MCPA & bromoxynil treatment had a lower yield than all other herbicide treatments. The best treatment was pyraflurine & bromoxynil & mefenpyr-diethyl. In 2016, two treatments recorded lower yields than the control. These treatments were Iodosulfuron-methyl-sodium & mesosulfuron-methyl & safener and pyroxasulam. Chlorosulfuron & metsulfuron-methyl, MCPA & bromoxynil and pyraflurine & bromoxynil & mefenpyr-diethyl recorded higher yields than the control (Figure 6).

The highest yielding herbicide treatment in the Rüens in 2016 was the Iodosulfuron-methyl-sodium & mesosulfuron-methyl & safener treatment and the lowest yielding treatment was pyraflurine & bromoxynil & mefenpyr-diethyl. Chlorosulfuron & metsulfuron-methyl and pyroxasulam also showed lower yields than the control.

**Summary**

No herbicide treatment did well in both areas for the same cultivar. Clear differences can be seen between the different cultivars. Overall, the two herbicides that led to the lowest yields were MCPA & bromoxynil and pyroxasulam.
lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener.

It is very interesting to note that lodosulfuron-methyl-sodium & mesosulfuron-methyl & safener also showed the highest yields overall in two cultivars in the Swartland and two in the Rûens. This confirms the suspicion that herbicides act differently in different areas and on different cultivars.

The outcomes of this project will inform wheat producers about the possible phytotoxic effect that some herbicides may have on certain wheat cultivars. Producers must be able to balance the risk of crop damage from a herbicide against the potential yield loss from both the weed competition and the number of weed seeds returning to the soil bank. Any choice of herbicide is, however, dependent on the kind of post-emergence weed(s) to be controlled, since not all herbicides are registered for use on the same weeds.

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References


The project is financially supported by the Winter Cereal Trust and the ARC.