# HERBICIDE RESIDUES – MEASURING HERBICIDE CARRYOVER

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## TAKE HOME MESSAGES

- Carryover of clopyralid at low levels was detected in 2018-2019.
- Measurement of imidazolinone and clopyralid herbicides in soils found faster dissipation of imidazolinone herbicides during 2019.
- Ongoing analysis will determine carryover of imidazolinone and clopyralid herbicides in multiple soil types and seasons and develop crop damage thresholds to inform soil tests.

## BACKGROUND

Herbicides are a valuable tool for controlling weeds and reaching crop yield potential, but herbicide residues in soils can limit crop performance if not managed correctly. The recently concluded Grains Research and Development Corporation (GRDC) project DAN00180 (Rose *et al.* 2019) found 5-15 per cent of surveyed paddocks (n=40) contained residues of sulfonylureas or trifluralin that could reduce seedling vigour of some crops. Damage was avoided in most cases by growing tolerant crops (eg. cereals or tolerant legumes) in paddocks with SU residues. Growers also identified imidazolinone (Group B) and clopyralid (Group I) residues as potentially damaging to crops or limiting rotation options. The exact loss of productivity due to herbicide residues as a soil constraint has not been accurately determined because of a lack of tools for measuring herbicide residues and quantifying herbicide damage. It is difficult for growers and advisors to know whether herbicide residues will cause issues beyond the 'label' plant-back period because the persistence and behaviour of these residues depends on numerous site-specific factors, including soil chemistry, organic matter, microbial activity and climatic conditions.

There are currently very few tools to help growers determine the level of herbicide residues present and if they negatively affect soil and crop performance. This project will develop knowledge and tools to better understand the factors regulating herbicide persistence and bioavailability. This will give farmers greater confidence in crop choice, timing of sowing and herbicide management to ensure soil and crop performance are not limited by herbicide residues.

## AIM

To determine the persistence of imidazolinone and clopyralid herbicides over multiple seasons in different soil types and whether soilborne residues will damage subsequent crops.

## PADDOCK DETAILS

| | |
|---|---|
| Location: | Curyo |
| Crop year rainfall (Nov-Oct): | 368mm |
| GSR (Apr-Oct): | 149mm |
| Soil type: | Sandy loam |
| Paddock history: | 2018 – Scepter wheat, 2017 – PBA Bolt lentil |
| Crop type: | Spartacus CL barley |
| Seeding equipment: | Knife points, press wheels, 37.5cm row spacing |
| Sowing date: | 27 April 2019 |

## PADDOCK HERBICIDE INPUTS

**Table 1. Paddock herbicide inputs during 2018-2019.**

| Date | Product (Active concentration in g/L or g/kg) | Rate (mL or g/ha) |
|---|---|---|
| 5 February 2018 | Glyphosate 450 | 1800 |
| 1 May 2018 | Triallate 500<br>Trifluralin 480<br>Diuron 900 | 1500<br>1500<br>250 |
| 30 June 2018 | LVE MCPA 570<br>Lontrel® Advanced (Clopyralid 600) | 600<br>30 |
| 4 January 2019 | Glyphosate 450<br>Triclopyr 600 | 1500<br>100 |
| 20 February 2019 | Glyphosate 450 | 1800 |
| 27 April 2019 | Trifluralin 480<br>Metribuzin 750<br>Carfentrazone 240 | 2000<br>120<br>35 |
| 1 June 2019 | Intervix®<br>Lontrel® Advanced (Clopyralid 600) | 750<br>30 |
| 1 August 2019 | 2,4-D Amine 625 | 250 |

## METHOD

Soil samples were taken before application of imazamox/imazapyr (Intervix®) and clopyralid (Lontrel® Advanced) and at 10, 26, 47 and 88 days after application. Soils (0-10cm and 10-30cm depth) were analysed for imazamox, imazapyr and clopyralid concentration using gas/liquid chromatography-mass spectrometry methods.

# RESULTS AND INTERPRETATION

**Clopyralid**

Baseline topsoil samples (0-10cm) taken in early April 2019 before sowing wheat, contained an average of 15nanograms(ng)/g of clopyralid. This is equivalent to approximately 0.04L of Lontrel® Advanced (600g/L). Clopyralid was previously applied on 30 June 2018 (0.03L of Lontrel® Advanced), suggesting minimal breakdown of the product and/or potentially slightly higher than intended rates were used.

After a fresh application of clopyralid (0.03L of Lontrel® Advanced) on 1 June 2019, the concentration of clopyralid was estimated to be approximately 27ng/g. Dissipation of the clopyralid (old residues and new application) from the top 0-10cm occurred during the first roughly 25 days. This appeared to be mainly due to movement into the 10-30cm profile rather than significant breakdown (Figure 1). This is supported by a rise in clopyralid concentration at 10-30cm. By 84 days after application, an estimated 80 per cent of the total load of clopyralid remained in the 0-30 cm profile. This suggests the half-life of aged plus fresh clopyralid in this soil may be more than 168 days. This appears higher than commonly reported clopyralid half-life values of 5-65 days (PPDB 2019; Congreve and Cameron 2018), however other studies have reported half-lives of 57-161 days (Schutz *et al.* 1996). As with many herbicides, this would be influenced by moisture and microbial activity leading to biodegradation of the herbicide. Ongoing analysis until sowing in 2020 will identify the total carryover for the following season.

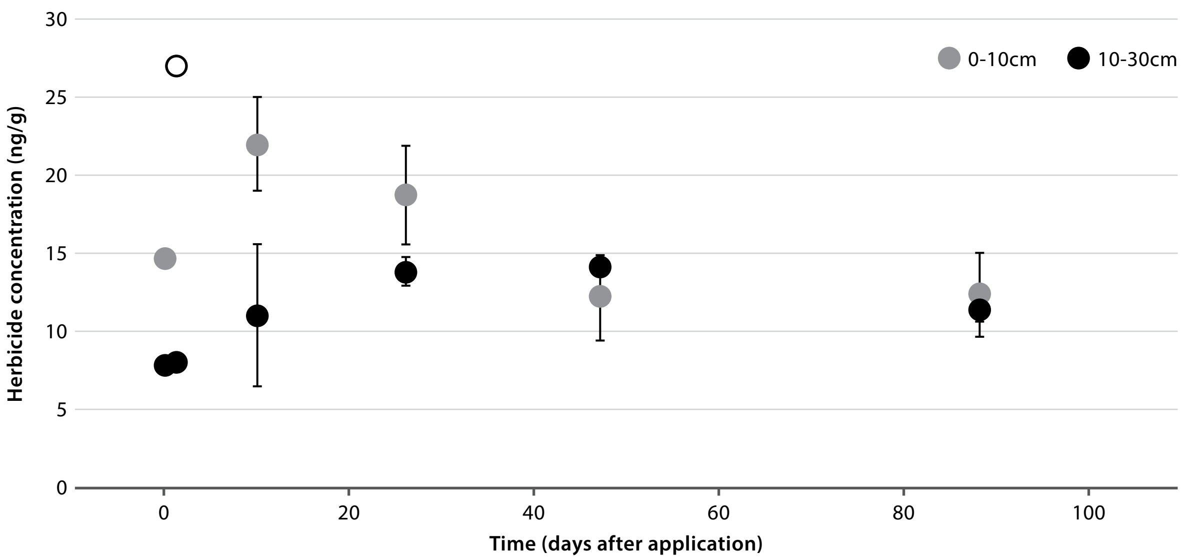


**Figure 1. Concentration of clopyralid in 0-10cm and 10-30cm soil profile before (Time = 0 day) and after (Time = 1-88 days) application of 30mL Lontrel® Advanced on 1 June 2019. The open white circle at Time = 1 d represents an estimated (rather than measured) concentration based on the known application rate and bulk density of the soil.**

**Imazamox and Imazapyr**

No imidazolinone residues were detected in the baseline soil samples (pre-application). This agrees with spray records showing that no imidazolinone herbicides had been applied in the previous two seasons.

A small amount of movement of both imazamox and imazapyr from the 0-10cm to 10-30cm occurred during the first 10 days, but levels subsequently declined in both soil layers (Figure 2). Dissipation of both imidazolinone herbicides as measured using the identified extraction method from the 0-30cm profile was more rapid than clopyralid – less than 20 per cent of imazamox and 40 per cent of imazapyr was estimated to remain 25 days after spraying. The field half-life of imidazolinone herbicides in soil can vary widely from 10 days to more than 300 days, depending on soil and climatic factors, but imazamox is generally considered less persistent than imazapyr (Congreve and Cameron 2018).

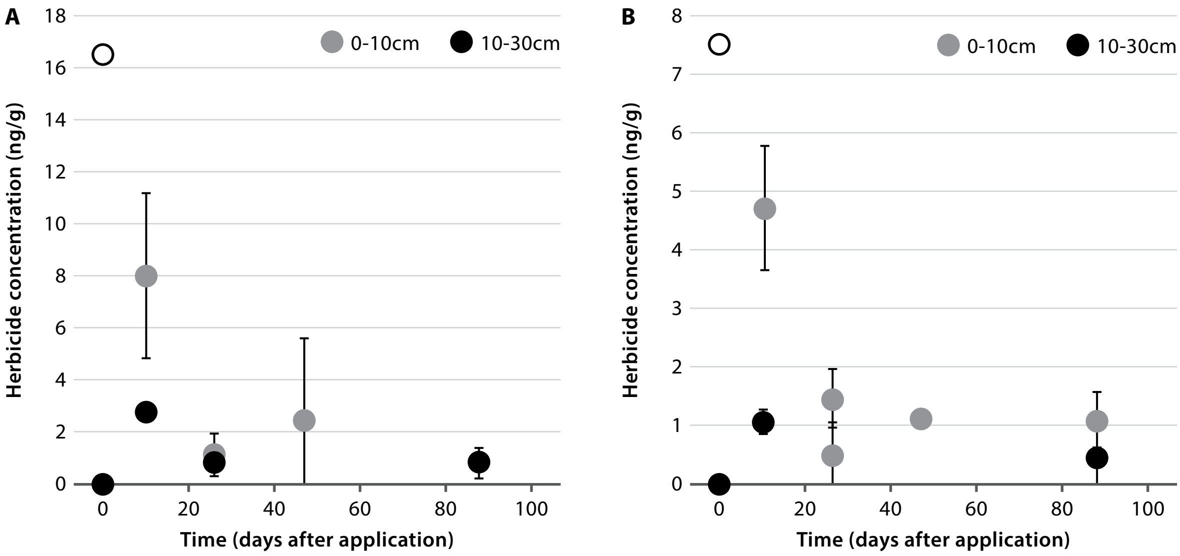


**Figure 2. Concentration of imazamox (A) and imazapyr (B) in 0-10 cm and 10-30cm soil profile prior to (time = 0 days) and after (time = 1-88 days) application of 750mL Intervix® on 1 June 2019. The open white circle at time = 1 day represents an estimated (rather than measured) concentration based on the known application rate and bulk density of the soil.**

# COMMERCIAL PRACTICE

One of the most interesting results to date from this work was the concentration of Group I herbicides – mainly clopyralid (15ng/g) and triclopyr (9ng/g – not discussed in results) in baseline topsoil samples taken before sowing and pre-emergent herbicide application. The load of clopyralid measured in April 2019 was almost equivalent to the amount applied at the end of June 2018, suggesting a substantial amount of carryover or release from stubble, despite significant rainfall over the summer. Bear in mind however, that slight variations in application rate and soil sampling can affect the measured residue load. Without a soil analysis value from directly after application in 2018, the dissipation rate of clopyralid over this period is only an estimate.

To date there are very few threshold values available to indicate the soil concentrations of herbicides at which crop damage can occur. We have previously found a 20 per cent shoot biomass reduction in lupins exposed to 50ng/g of clopyralid in a sandy soil (Rose *et al*. 2019), but the growth of cereals (as occurred this season) would not have been impacted. Other legumes, such as lentil, field pea and faba bean, may be more sensitive than lupins and the presence of an additional herbicide of the same mode of action (triclopyr) may have compounding effects if legumes were sown.

Compared with clopyralid, imazamox/imazapyr appear to be less persistent at this site. Monitoring until sowing in 2020 will determine how much carryover of all herbicides has occurred through the year. Other ongoing work in this project will generate representative damage thresholds for different crops in different soil types, to provide growers with guidance about potential effects of a known residue concentration if a soil herbicide analysis is undertaken. This will help increase confidence in crop selection, timing of sowing and herbicide management to ensure soil and crop performance are not limited by herbicide residues. Importantly, this project aims to prevent major crop damage due to herbicide residues and give farmers greater flexibility in crop rotations to further build soil health.

## REFERENCES

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## ACKNOWLEDGEMENTS

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