Herbicide efficacy in retained stubble systems

Amanda Cook[1], Andy Bates[2], Wade Shepperd[1] and Ian Richter[1]
[1]SARDI, Minnipa Agricultural Centre, [2]Bates Agricultural Consulting

RESEARCH

Farming Systems

Searching for answers

Location:
Minnipa Agricultural Centre
paddock S7
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2015 Total: 333 mm
2015 GSR: 258 mm
Yield
Potential: 3.0 t/ha (W)
Actual: 1.6 t/ha
Paddock History
2015: Mace wheat
2014: Wheat
2013: Wheat
Soil Type
Red loam
Plot Size
20 m x 2 m x 3 reps

Key messages

- **In 2015 the drier start to the season and low soil moisture resulted in lower herbicide efficacy and less chemical damage than expected.**
- **In different stubble management systems the activity and resulting weed control of specific herbicides will be influenced by the solubility index (movement through the soil profile with rainfall events) of that herbicide. Soil texture and soil chemical properties can affect chemical movement and availability in the soil profile.**
- **Herbicide performance will vary seasonally due to soil moisture levels, rainfall pattern post application, timing of weed germination, position and number of weed seeds in the profile, etc. Understanding how the various herbicides work can reduce the likelihood of failures.**
- **Herbicides are only one tool for weed control – always adopt an integrated weed control package that includes non-chemical control, and where possible, consecutive seasons of total weed control.**
- **Consider the whole farming system when making chemical decisions as the impact may last for several seasons (eg. effects on medic germination and medic seed bank).**

Why do the trial?

The GRDC project 'Maintaining profitable farming systems with retained stubble - upper Eyre Peninsula' aims to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula (EP). Weed control in stubble retained systems can be compromised when stubbles and organic residues intercept the herbicide and prevent it from reaching the desired target, or the herbicide is tightly bound to organic matter. Reduced herbicide efficacy in the presence of higher stubble loads is a particular issue for pre-emergence herbicides. Current farming practices have also changed weed behavior with a shift in dormancy in barley grass genotypes now confirmed in many paddocks on Minnipa Agricultural Centre (MAC) (B Fleet, EPFS Summary 2011, p 177). As a part of the stubble project this trial was undertaken to assess herbicide efficacy in different stubble management systems.

Background?

To understand how herbicides preform it is important to know the properties of the herbicide, the soil type and how the herbicide is broken down in the environment. The availability of a herbicide is an interaction between the solubility of a herbicide, how tightly it is bound to soil particles and organic matter, soil structure, cation exchange capacity and pH, herbicide volatility, soil water content and the rate of herbicide applied (Congreve and Cameron, 2014).

Herbicides intercepted by organic material will be subject to a certain level of binding, depending on the herbicide's characteristics. Some will be tightly bound and lost to the system in terms of weed control, others will be loosely bound and relatively soluble and will be returned to the soil by subsequent rainfall events. However, loosely bound herbicides may also be prone to losses by volatilisation and photodegradation (Congreve and Cameron, 2014). The solubility and soil water movement potential of key herbicides is listed in Table 1.

When a herbicide is incorporated into the soil a percentage will bind to soil organic carbon and soil particles. The strength of binding is called the soil/water adsorption coefficient (Kd). The binding is highly influenced by the level of organic matter so is calculated by taking into account the level of organic matter Koc = Kd/soil organic carbon. The higher the Koc value the more tightly the herbicide is bound. A low Koc value means the herbicide is less tightly bound and able to move with the soil water, which happens in sandy soils or soils with low organic matter (Congreve and Cameron, 2014). The Koc values for key herbicides are listed in Table 1.

Table 1 Solubility and soil water movement potential of key herbicides

Chemical	Group	Soil Binding (Koc)	Solubility (mg/L @ 20°C)	Soil water movement
Trifluralin	D	17,500 Tightly bound and non-mobile	0.22 mg/L Low solubility Likely to require moist conditions for incorporation and uptake	Tightly bound and non-mobile so consider stubble load, as well as herbicide and water rate
Lexone (Metribuzin)	C	60 Mobile – likely to move with soil water	Lexone 1165 mg/L High solubility	Quite mobile and highly soluble – moves with soil water down the profile
Logran	B	60 Mobile – likely to move with soil water	815 mg/L High solubility	Quite mobile and highly soluble – moves with soil water down the profile
Diuron	C	813 Slightly mobile	36 mg/kg Low solubility Likely to require moist conditions for incorporation and uptake	Slightly mobile but low solubility therefore tends to stay in topsoil
Avadex (Tri-allate)	J	3030 Slightly mobile	4 mg/L Low solubility Likely to require moist conditions for incorporation and uptake	Slightly mobile but low solubility therefore tends to stay in topsoil
Sakura	K	95 Moderately mobile, will wash off stubble	3.5 mg/L Low solubility Likely to require moist conditions for incorporation and uptake	Moderately mobile but low solubility and limited movement with soil water
Boxer Gold Prosulfocarb and s-metolachlor	K	Prosulfocarb part of Boxer Gold 1500 Slightly mobile s-metolachlor part of Boxer Gold 200 Moderately mobile	Prosulfocarb part of Boxer Gold – 13 mg/L Low solubility Likely to require moist conditions for incorporation and uptake s-metolachlor part of Boxer Gold – 480 mg/L Moderate solubility	Slightly mobile but low solubility therefore tends to stay in topsoil Moderately mobile and moderately soluble – can move with soil water down the profile
Simazine	C	130 Moderately mobile	5 mg/L Low solubility Likely to require moist conditions for incorporation and uptake	Slightly mobile but low solubility therefore tends to stay in topsoil

Data collated from GRDC Pre-emergent herbicide Manual, M Congreve and J Cameron, 2014, and pers comm from A Bates and B Fleet, 2015.

Soil moisture is also critical to the performance of herbicides in soils. If soil water is low, plant uptake will be lower and a greater percentage of the herbicide will be bound onto the soil and become unavailable.

Stubble, existing weed cover and crop cover (for post sowing applications) in a zero or minimal till system will intercept some of the herbicide before it reaches the soil. The amount of herbicide intercepted will be proportionate to the percentage of ground cover. Interception can have two negative effects; herbicide can be tied up on the stubble or in the canopy and will not be available for weed control; and it can lead to uneven coverage on the soil surface lowering herbicide effectiveness and increasing potential weed escapes (Congreve and Cameron, 2014).

How was it done?

The Minnipa Agricultural Centre paddock S7 was sown to Mace wheat on 10 May 2014 and yielded 3.2 t/ha with 9.1% protein. Two different wheat stubble management strategies were implemented at harvest; traditional spread stubble and harvest windrows. The third stubble management strategy was implemented on 15 April 2015 with total stubble removal by burning and the harvest windrows within the trial area were also burnt on the same day.

Table 2 Effect of stubble management on crop establishment, dry matter and yield as well as weed and medic populations in 2015.

	Establishment (plants/m^2)	Early crop dry matter (t/ha)	Early in-crop Barley grass 24 July (plants/m^2)	Medic growth (0-3 rating)*	Late in-crop Barley grass 26 Oct (plants/m^2)	Yield (t/ha)
Burnt stubble	105	0.22	3.1	1.01	6.8	1.63
Spread stubble	93	0.19	1.8	0.78	4.8	1.55
Burnt windrows	97	0.22	6.7	0.94	10.3	1.69
LSD (P=0.05)	*4*	*0.02*	*1.7*	*0.12*	*2.7*	*0.04*

** Visual medic rating system where 0=no medic, 1=small suppressed medic, 2=small and large medic, 3=mostly large medic plants*

The trial was sown with Mace wheat @ 60 kg/ha and DAP @ 60 kg/ha on 11-12 May in dry seeding conditions. The trial area received a knockdown of 1.2 L/ha of Roundup Attack on 11 May. The chemical treatments listed in Table 3 were individually mixed in small pressure containers and applied on the 11 and 12 May using a shrouded boomspray at 100 L/ha of water.

Minnipa received 35 mm rainfall for April and 6 mm in the five days before sowing with 3 mm after sowing. Conditions were drier the week after sowing before another 6 mm fell, with a total of 16 mm for May. The trial was sown at 3-4 cm depth with an Atom-Jet spread row seeding system with press wheels. The trial was also sprayed on 27 July with 5g/ha of Ally and BS1000 at 100ml/100 L for control of soursob (*Oxalis pes-caprae*).

Measurements taken were stubble load pre-seeding, soil moistures, plant emergence counts, early and late grass weed counts, medic growth score, grain yield and grain quality. Data were analysed using Analysis of Variance in GENSTAT version 16. The least significant differences are based on F prob=0.05.

What happened?

Stubble treatments (averaged over all chemical treatments)

Early dry matter and grain yield were lower in the spread stubble system than burnt and windrow and this may have been due to less moisture reaching the seed bed and also tie up of nitrogen resulting in early nitrogen deficiency (Table 2). There may also have been some yellow leaf spot interactions.

Chemical treatments

There were no impacts of stubble management on the performance of individual chemical treatments so results presented in this section are averaged over all three stubble management treatments.

Wheat establishment was not affected by any chemical treatment and varied between 95 and 103 plants/m^2. Grain yield was lowest in the untreated control and most chemical treatments increased yields but only by up to 8% which suggests grassy weed pressure was low. This is consistent with the low populations of barley grass which developed in 2015. As a consequence, few chemical treatments were more profitable than doing nothing for grassy weed control.

On average 45% of the barley grass population emerged later in the season, approximately six weeks after sowing, excluding those treatments with Sakura. Effects of chemical treatments on early barley grass numbers were inconsistent, but by late in the season, any treatments containing Sakura, or Monza alone, had lower barley grass numbers than the untreated control.

Medic germination was affected by some chemicals and the residual effect may impact on future seed bank and germination.

Barley grass numbers at the first sampling were low (less than 10 plants/m^2) across the whole trial, regardless of chemical treatments (Table 3). Sakura and mixes containing Sakura decreased early dry matter of the crop (Table 3).

Trifluralin and Diuron mixes caused some crop damage but the crop recovered better than expected and dry matter production of the crop was as good as in the untreated control by sampling, probably due to less soil water movement of the chemicals. In a dry start Boxer Gold did not appear as effective on barley grass as ryegrass, but post application gave some suppression activity on all grasses.

Medic germination was very low with Monza and Lexone (Metribuzin), so carefully consider the use of these chemicals as some will have more than a one year effect on medic regeneration. Ward's weed (*Carrichtera annua*) was not controlled in this trial by Monza.

Table 3 Effect of chemical treatments on crop establishment, dry matter and yield as well as weed and medic populations in 2015.

Chemical treatment	Group	Dry matter (t/ha)	Establishment (plants/m²)	Early in-crop Barley grass 24 July (plants/m²)	Average Medic growth (0-3 rating) ^	Late Barley grass 26 Oct (plants/m²)	Yield (t/ha)	Chemical cost ($/ha)	Income# less chemical cost ($/ha)
Control Untreated		0.23	102	7.3	1.5	11.1	1.55	-	391
Trifluralin (1.5 L/ha)	D	0.20	98	4.6	1.4	8.8	1.63	9	402
Trifluralin (2 L/ha)	D	0.21	99	2.0	1.1	8.0	1.58	12	386
Trifluralin (1.5 L/ha) + Lexone (Metribuzin) 180 g (post)	D+C	0.20	98	5.3	0.3	11.7	1.64	15	399
Trifluralin (1.5 L/ha) + Diuron 900 (400 g/ha) (pre-emergent)	D+C	0.21	98	3.4	1.0	7.8	1.64	14	399
Trifluralin (1.5 L/ha) + Diuron 900 (high rate) (pre-emergent)	D+C	0.24	102	3.5	1.0	5.7	1.67	19	402
Trifluralin (1.5 L/ha) + Avadex (Tri-allate) (1.6 L/ha) (pre-emergent)	D+J	0.23	95	2.0	1.2	8.3	1.64	25	388
Trifluralin (1.5 L/ha) (pre) + Monza (sulfosulfuron) (25 g/ha) (post)	D+B	0.21	101	3.3	0.2	7.1	1.66	35	384
Monza (sulfosulfuron) 25 g (pre-emergent)	B	0.20	98	5.3	0	2.8	1.65	26	390
Sakura (118 g) (pre-emergent)	K	0.17	96	2.5	0.8	1.8	1.64	40	373
Monza (sulfosulfuron) (25 g) + Sakura (118 g) (pre-emergent)	B+K	0.19	101	2.6	0	1.0	1.61	66	340
Sakura (118 g)+ Avadex (Tri-allate) 3 L (pre-emergent)	K+J	0.22	96	1.0	0.8	0.5	1.64	70	343
Boxer Gold (2.5 L/ha) (pre-emergent)	K+J	0.21	97	4.1	0.9	9.7	1.59	37	364
Boxer Gold (2.5 L/ha) (post)	K+J	0.26	103	5.6	1.3	11.6	1.60	37	366
Sakura (118 g)+ Avadex (Tri-allate) 3 L (pre-emergent) + Boxer Gold 2.5 L (post)	K+J	0.18	97	1.5	0.6	1.0	1.63	107	304
LSD (P=0.05)		*0.04*	*ns*	*ns*	*0.3*	*6.7*	*0.09*		

^ (0-3 rating where 0=no medic, 1=small suppressed medic, 3=larger medic plants)
 # Wheat price of $252/t used for AUH2 on 1 December 2015 at Port Lincoln, less chemical cost.
**some treatments in the trial are for research purposes only.*

What does this mean?

Despite high cereal stubble loads, completely removing stubble by burning did not improve the efficacy of any of the chemical packages tried in this trial. These results suggest that under the production regimes of upper EP, stubble management is unlikely to impact negatively on performance of pre-emergent herbicides targeting grassy weed control, with adequate water rates. However, this trial did not place the chemical packages "under pressure" because grassy weeds populations were low.

As outlined in the background information, the differences in a chemical's ability to bind to organic matter and move through the soil profile with soil water influences will influence the uptake of the chemical by the target weeds, the crop, and the impact on both. Soil texture and soil chemical properties can affect chemical movement and availability in the soil profile. Some chemicals will have greater activity and mobility and "be hotter" in lighter sandier soils than the MAC loam in this trial. The dry seeding conditions and lack of post sowing rainfall at the start of the 2015 season resulted in less damage to the crop than expected with some chemicals (eg. the diuron mixes) due to lower soil mobility.

When choosing the most appropriate pre-emergent herbicide for use in stubble retained systems, it is important to consider;

- the likely rainfall pattern and soil moisture conditions post application,
- the susceptibility of the crop to the herbicide,
- the position of the weed and crop seeds in the soil profile,
- the mobility of the herbicide in soil water,
- and the persistence of the herbicide activity relative to the germination pattern of the target weeds.

References

GRDC Pre-emergent herbicide Manual, M Congreve and J Cameron, 2014.

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Registered products: see chemical trademark list.

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