Maintaining profitability in retained stubble systems on upper Eyre Peninsula

A joint EPARF and GRDC funded project.

Guideline 6: Herbicide efficacy in cereal stubbles

Most growers on upper Eyre Peninsula implement conservation farming systems with stubble retention and reduced tillage. Retaining crop residues reduces the risk of soil erosion due to lower levels of soil disturbance and higher levels of soil surface cover, however there are also some disadvantages.

The effectiveness of weed control from herbicides, or herbicide efficacy, can be impacted by stubble. Stubble (standing or laying) can intercept the spray, and depending on the type of chemical used, may prevent the herbicide from reaching its target. However, this issue can be largely overcome by adopting appropriate spraying techniques and herbicides for the situation.

Herbicide efficacy

To understand how herbicides perform 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 its solubility, how tightly it is bound to soil particles and organic matter, soil structure, soil chemical properties such as cation exchange capacity, water content and pH, its volatility (loss to the atmosphere) and the rate at which it is applied[1].

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 photo degradation[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 (Table 1)[1].

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 soil and become unavailable.

KEY MESSAGES

- Stubble loads on upper EP are generally not high enough to reduce herbicide efficacy, if you use best practice spray application, adequate water rates, best suited nozzles and the right herbicide for the situation.
- Herbicides which may be influenced by high stubble loads include: trifluralin, triallate, pyroxasulfone, prosulfocarb and metolachlor products.
- If high grass weed numbers are an issue in paddocks with high stubble loads (> 50% stubble cover), removal of some stubble may maximize the herbicide activity and grass weed control.
- Later germinating barley grass is limiting early control with pre-emergent herbicides.
- If grass weeds emerge straight after sowing, trifluralin (plus an added herbicide depending on cost and risk factors such as seasonal conditions, soil type, rotation etc.) is the best value for your system.
- If you have a later germinating grass weed population, and aim to reduce the seed bank, investing in some of the more expensive herbicide mixes may be an option even though the cost will be more in the first season.

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 (sulfonylureas)	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 (pyroxasulfone)	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 1500 Slightly mobile s-metolachlor 200 Moderately mobile	Prosulfocarb – 13 mg/L Low solubility Likely to require moist conditions for incorporation and uptake s-metolachlor – 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 (triazines)	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

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

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 proportional 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 secondly it can lead to uneven coverage on the soil surface, lowering herbicide effectiveness and increasing potential weed escapes[1].

The differences in a herbicide's ability to bind to organic matter and move through the soil profile with soil water influences the uptake of the herbicide by the target weeds, the crop, and the impact on both. Soil texture and soil chemical properties can affect herbicide movement and availability in the soil profile, as shown in Table 1.

Management options

Other management options to increase herbicide activity in paddocks with high stubble loads include increasing chemical and water rates, using nozzles to increase spray coverage, and reducing the height of the spray boom or stubble height so herbicides reach the soil surface easier and cover the soil more evenly. Seeding systems and speed at sowing may also influence soil throw and hence herbicide movement in soil water[2].

Stubble management

In 2015-2017 herbicide efficacy trials with different stubble management treatments were undertaken at Minnipa Agricultural Centre. The cereal stubble loads ranged from 1.5 - 5.9 t/ha. The various stubble management treatments included: stubble standing and residue spread out back of header, stubble standing and windrowed, stubble totally removed by burning, stubble slashed with windrows burnt, and stubble chained.

This research showed that stubble loads on upper EP, especially in grazed systems, are not high enough to reduce herbicide efficacy, using best practice spray application; adequate water rates (up to 100L/ha), appropriate nozzles, spray height and speed, and using the right herbicide for the situation.

In paddocks with high grass weed numbers and high stubble loads (greater than 50% stubble cover - see Reducing Stubble Load guideline for method to visually assess stubble load), the removal of some stubble may maximize the herbicide activity and grass weed control. The herbicides which may be influenced by high stubble loads include trifluralin, triallate, pyroxasulfone, prosulfocarb and metolachlor products.

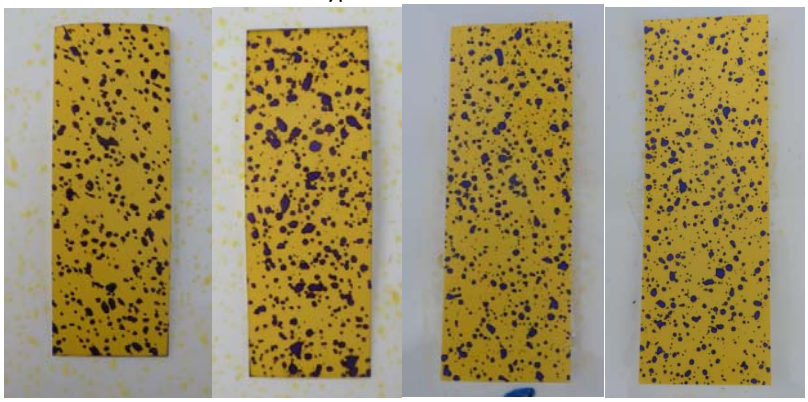
Research on Lower EP in higher stubble loads (>6 t/ha) showed that as stubble height increased from 0 cm to 40 cm, the % coverage of the spray reduced slightly for pre-emergent herbicides. Stubble management at harvest and harvesting height is important to consider if cropping the following season to obtain adequate herbicide coverage[4]. Large droplet sizes are encouraged to maximise ground contact with pre-emergent herbicides in stubble, often compromising number of droplets resulting in an insufficient dispersion of droplets and poor efficacy. Research conducted by LEADA found an increase of water rates from 50 L/ha to 100 L/ha resulted in a significant improvement in ryegrass control[4]. This reflects similar results obtained in Western Australia.

Chained barley stubble at sowing 2017

Standing grazed barley stubble at sowing 2017

Spray coverage

To demonstrate the impact of stubble management treatments (standing or chained barley stubble of 3.5 t/ha) on spray coverage, spray cards were placed within selected treatments (Figure 1). The cards showed no differences in spray coverage between treatments or herbicide types[5].



1 2 3 4

Figure 1 Spray cards and percentage of average spray coverage, calculated using Image J software in 2017[5]
(1) 1.5 L Trifluralin in chained stubble 28% (2) 1.5 L Trifluralin in standing stubble 28% (3) Sakura (118gm) pre-emergent in chained stubble 15%, and (4) Sakura (118gm) pre-emergent in standing stubble 19%.

Barley grass germination patterns

Germination patterns of barley grass from five paddocks on the Minnipa Agricultural Centre showed a later timing of grass weed germination in cropped paddocks compared to an uncropped area (Figure 2). Later in-crop germination patterns are limiting early grass control with pre-emergent herbicides. Growers should check paddocks before crop flowering for late germinating grass numbers. Keep records at harvest of what grass is the biggest issue in paddocks, barley grass, ryegrass or both, and have short and long-term management plans. If most grass weeds are emerging straight after sowing, trifluralin (plus an added herbicide) may be the best option for value. If there is a dormant/later germinating population, to reduce the seed bank, some of the more expensive herbicide mixes with greater longevity may be better to invest in for longer term grass control even though the cost may be more in the first season[3].

Reducing the weed seed bank is pivotal in managing all grass weeds, so effective two year breaks during the pasture/break crop phase may be important in paddocks with high grass weed numbers. If herbicide resistance is an issue, or may potentially be an issue, the first step is to test the population to know exactly what you are dealing with. To ensure resistance is kept in check, make sure any suspected resistant plants are dealt with. If Group A resistance for barley grass is an issue in pasture systems, follow up with a knock down herbicide as early as possible to prevent any seed set. Always have follow up options to control any survivors and to preserve group A herbicides, or maybe use other chemical groups like propyzamide (in moist conditions for best results) to reduce the barley grass population before using a group A herbicide. Using alternative chemical groups by including canola or Clearfield systems as a different rotational break may also be an option. The loss of Group A herbicides within current farming systems will result in high barley grass weed seed bank carry over[5].

This research suggests that under the production regimes of upper EP, stubble management is unlikely to impact negatively on performance of pre-emergent herbicides targeting grass weed control, with adequate water rates.

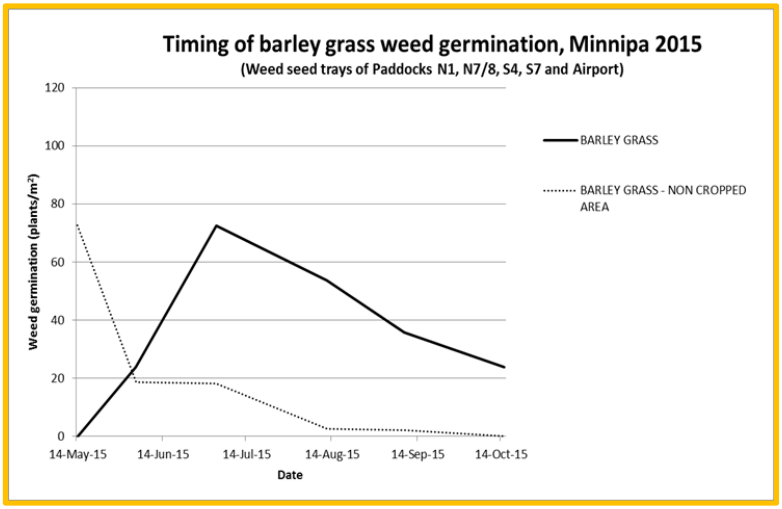


Figure 2 Barley grass germination patterns in 2015 from Minnipa Agricultural Centre[3]

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References

1. GRDC Pre-emergent herbicide Manual, M Congreve and J Cameron, 2014.
2. Herbicide efficacy in retained stubble systems A Cook, Eyre Peninsula Farming Systems Summary 2015.
3. Herbicide efficacy in retained stubble systems A Cook, Eyre Peninsula Farming Systems Summary 2016.
4. Use of herbicides for pre-emergent weeds, Guideline 13 LEADA, 2018.
5. Herbicide efficacy in retained stubble systems A Cook, Minnipa Field Day 2017.

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