Improving pre-emergent herbicide spray coverage in stubble retention systems

How does stubble effect spray coverage?

Stubble interferes with spray coverage as a physical barrier and can tie up some herbicides. This problem has been intensified with advanced cropping systems now retaining more stubble at greater heights due to improved harvesters, seeders and inter-row sowing. In some paddocks we may still be maintaining good spray coverage in the inter stubble rows however, at the base of stubble weed escapes are becoming more frequent. A reduction in herbicide coverage leads to a decrease in the efficacy of the herbicide applied, resulting in poor weed control.

Will the herbicide wash off the stubble?

It depends on the product (a quick recap in Table 1). The behaviour of pre-emergent herbicides in soil is driven by three key factors;

1. **solubility of the herbicide** influences how far the herbicide will move in the soil profile in response to rainfall events.
2. the **rate of breakdown of the herbicide in soil**. That is, how long it takes for herbicide to be degraded chemically or more commonly by soil microbes.
3. how **tightly the herbicide is bound to stubble and soil components** (e.g. soil organic matter, clay).

Recent laboratory research has focused on the amount and frequency of rainfall required to wash common pre-emergent herbicides from cereal stubble (Khalil 2017). The herbicide selected in this study ranged in solubility and binding including, Sakura® (low solubility and medium binding), prosulfocarb (low solubility and high binding) and trifluralin (very low solubility and very high binding). They found a 5 mm rainfall event was sufficient to wash a large percentage of Sakura® (from 4 t/ha stubble load) on to soil, providing good control (>95%) of ryegrass. The authors reported Sakura® was easily washed off stubble, prosulfocarb less so and trifluralin less again. Interestingly, rainfall events above 5 mm (e.g. 10 and 20 mm) was of little additional benefit to herbicide wash off and subsequent ryegrass control.

Another key finding from this work was wet stubble binds herbicides tighter**.** When herbicides were sprayed onto wet stubble, they were bound more tightly than herbicides sprayed onto dry stubble. The exception was Sakura®, which once again was readily washed off wet or dry stubble with rainfall.

Table 1. Water solubility, binding characteristics to soil organic matter and degradation half-life for common pre-emergent herbicides.

Herbicide	Example of product	Water solubility mg/L	Solubility rating	Binding mg/L	Binding rating	Degradation half-life days
Trifluralin	Triflur X®	0.22	Very low	15,800	Very high	181
Pyroxasulfone	Sakura®	3.9	Low	223	Medium	22
Triallate	Avadex® Xtra	4.1	Low	3000	High	82
Prosulfocarb	Boxer Gold®	13	Low	2000	High	12
S-metolachlor		480	High	200	Medium	15
Propyzamide	Edge®, Kerb®, Rustler®	15	Low	840	High	120
Diuron	Diuron	36	Medium	813	High	75.5
Chlorsulfuron	Glean®	12,500	Very high	40	Low	160

Three ways to improve your spray coverage

Number 1 – measure it so you can improve it

An easy way to assess spray coverage in your paddock can be done using water sensitive paper (WSP). This paper can be placed on the soil surface, beneath stubble or attached within standing stubble (Figure 1). In this project the cost of a single packet of WSP (50 cards) ranged from $50-$60 from a local reseller.

Water sensitive paper has a special coating which produces a stain when spray droplet lands on the paper (see below) for a given target. Using the free SnapCard app (Android and IOS), spray coverage as % of the card area stained can be easily measured in the field. In addition to this you can also access droplet size using the examples provided below (Figure 1).

TIPS for placing water sensitive paper in the field:

- Measure coverage in both the inter-stubble row and at the base of the stubble (often where coverage declines and weed escapes occur).
- Place cards on top and below trash.
- Find some different stubble heights within the paddock to compare coverage.
- When using the SnapCard app make sure you are facing direct sunlight (i.e. don't shade the WSP).

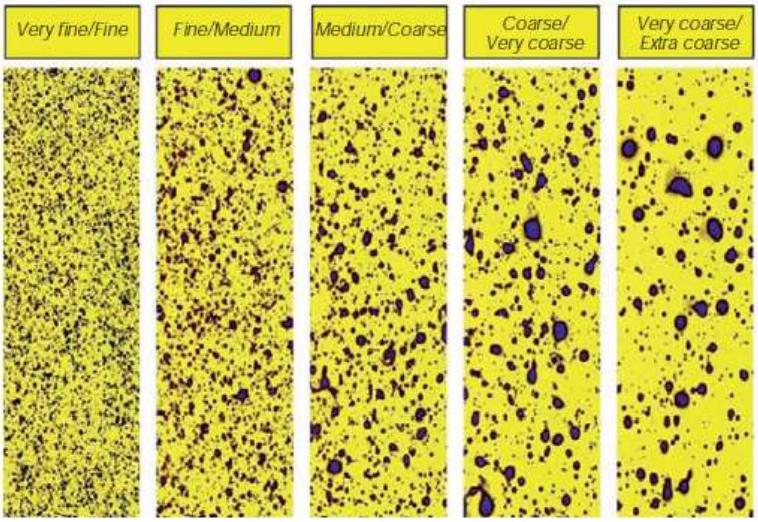


Figure 1.
(above) Water sensitive paper illustrating various spray qualities at the same application volume. Source: Tom Wolf
(left) Water sensitive paper placed within standing stubble. Spray droplets have dyed the card blue.

Rules of thumb for spray coverage using water sensitive paper:

- Fully translocated herbicides >6 - 8%
- Contact herbicides >10 - 12%
- Fungicides >15%
- Pre-emergent herbicides >15-20% (as a guide depends on the product, soil moisture and rainfall)

Source: Bill Gordon

Number 2 - managing your stubble at harvest

As you may expect, the more stubble on the ground, the more likely it is that herbicides will be bound to it. Lower levels of stubble in combination with leaching rain result in the best scenario to achieve herbicide efficacy for all herbicides. Unfortunately, there is no one rule for target stubble height or stubble cover as herbicide efficacy depends on stubble load, summer rainfall to aid decomposition and rainfall following herbicide application.

In case studies completed as part of this project we assisted farmers to assess their paddock/spray coverage. In an example below the farmer had an average wheat stubble load of 6.8 t/ha and of that biomass 40% (2.7 t/ha) was standing stubble and the remaining 60% (4.1 t/ha) was flat on the soil surface (Figure 2). At harvest time the crop had lodged and knowing the stubble load was going to be high, the farmer harvested at 21 cm to make seeding operations easier. However, this resulted in a higher proportion of chaff/trash material returned to soil surface.

Water sensitive paper was strategically placed within the stubble to measure the spray coverage in the inter-row with and without any trash cover and at the base of stubble. The application was made with water only at 80 L/ha to achieve a medium/coarse droplet size. Interestingly there was a 7% reduction in spray coverage in the inter stubble row compared to the stubble base. Furthermore, the amount of stubble hitting the soil surface was <3% where trash was present. In this scenario for a pre-emergent herbicide application the farmer was left with two management options:

1. Selecting a pre-emergent herbicide with high solubility and low stubble binding capacity. In addition to timing the spray application and seeding operations to ensure the herbicide is washed from the stubble onto soil.
2. Burn the stubble prior to seeding to remove some of the physical barrier and potential for herbicide tie up. Removing stubble also gives greater flexibility in pre-emergent herbicide selection.

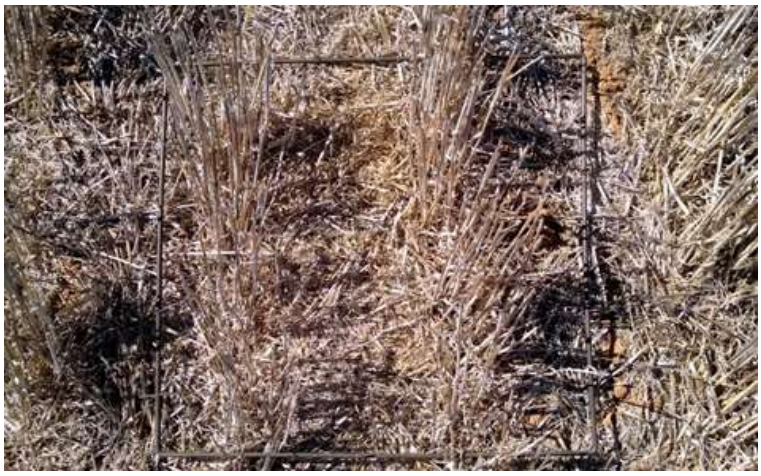
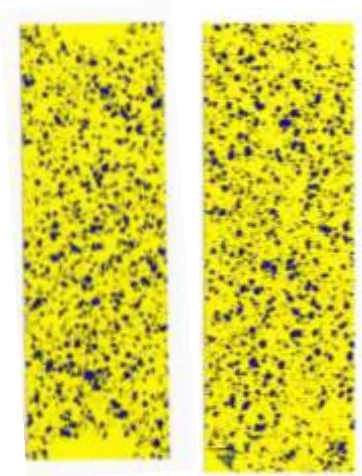
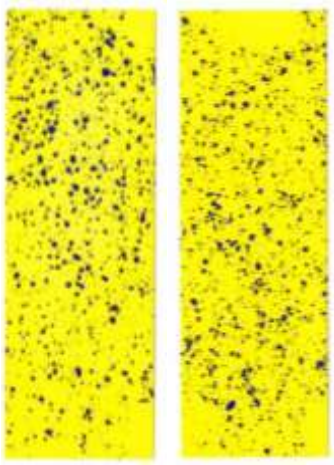


Figure 2. Proportion of 6.8 t/ha stubble load standing versus laying on the soil surface.



Cards placed inter-row NO trash **17.6%**



Cards placed at the stubble base **11.4%**

Cards placed inter-row underneath chaff / trash on soil surface **2.6%**

What about stubble burning and pre-emergent herbicide tie up?

If stubble loads are too high, a last resort of burning windrows or the whole paddock may be an option. Similar to stubble however, ash is a physical barrier between the soil and herbicide. There is limited research in this area to understand if the herbicide also binds to the ash. Despite this, the benefit of burning is less material in the field for herbicides to be intercepted by or possibly bind with. Aiming for warmer burns prior to sowing and if possible waiting for a rain following the burn, before spraying will help minimise the impact of ash on pre-emergent herbicides (Haskins 2012).

Number 3 – adjusting water volume

One of the simplest changes to improve spray coverage in high stubble loads is increasing water rate (Figure 3). Field research conducted in this project showed, on average for stubble heights <30 cm (baled, short and medium) spray coverage was increased from 13%, 20% to 33% for 50 L/ha, 100 L/ha and 150 L/ha, respectively. The second year of results showed a very similar trend with spray coverage increasing from 12%, 20% to 28% for the same three spray volumes. Generally, volumes above 150 L/ha do not provide further improvements in efficacy.

The stripper front harvested stubble was the only treatment to significantly reduce spray coverage. The area covered was reduced by 5 - 16% for the 50 L/ha, 100 L/ha and 150 L/ha treatments. This reduction was not significant in the second season ranging 5 – 9% across the three volumes. This difference in seasons can be attributed to overall stubble load and stubble strength (i.e. how much was knocked over versus upright). Furthermore, in high stubble loads cutting shorter creates a larger volume of chaff returned to the soil surface which will reduce spray coverage on the soil further to that reported below (Figure 4).

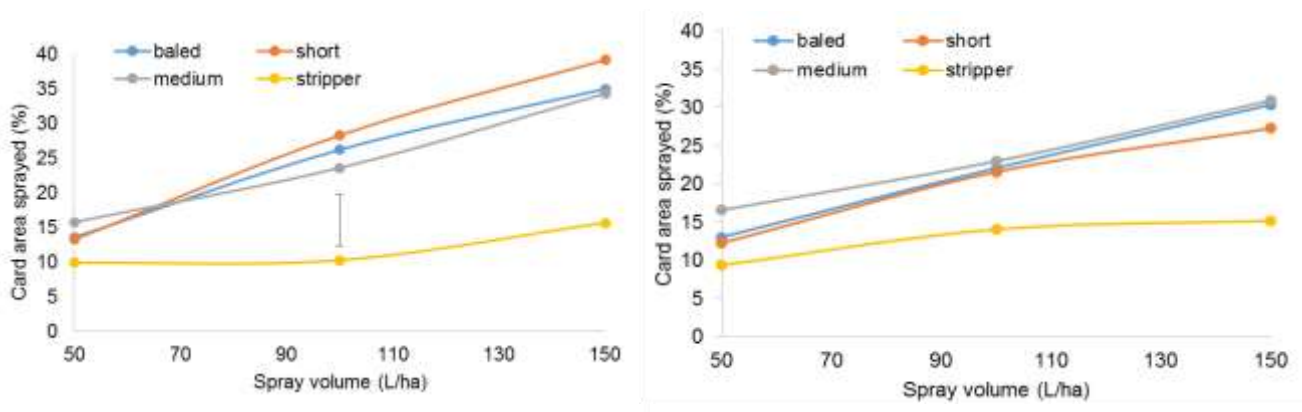


Figure 3. Area (%) of card sprayed in different stubble and spray volume combinations for medium sized droplet in 2015 (left) and 2016 (right). These are the average values for spray cards placed at the stubble base and inter-row. Signification interaction (P≤0.05) for stubble and volume for both droplet sizes is indicated by the error bars.

Figure 4. Baled (left) and stripper front harvested (right) stubble treatments.

An interaction between droplet size and spray volume was not observed (data not shown). The range of droplet sizes tested were not sufficient to see differences. That is, selecting a coarse or medium droplet size did not increase the % area of spray card in any of the stubble treatments or carrier volumes tested. However, other research has shown large droplets in addition to high water rates are required in high stubble loads to ensure the herbicide reaches the soil.

Are there other ways to manipulate my spray setup and improve coverage?

While water volume and droplet size were the focus of this study there are further measures that can be taken by the spray operator to increase herbicide penetration in stubble. In a recent paper by Gordon (2017) some of the strategies highlighted were:

- **Reducing spraying travel speeds** can generally improve the penetration into stubble and improve the evenness of the application.
- **Narrower nozzle spacings** can also be of benefit, provided the spray quality and boom height are suitable.
- Alternately, many operators have plumbed machines with **nozzle spacings to match the crop row width**. Where nozzles are positioned in the centre of the inter-row gap between standing stubble lines, the nozzle height may be lowered to obtain an overlap close to the base of the stubble. This may improve soil contact and reduce interception by the stubble, provided spraying speeds and wind speeds do not excessive.

Other resources:

- Khalil, Y (2017) Effect of crop residue and rainfall on the availability of pre-emergent herbicides in the soil. GRDC Update paper Perth
- AHRI Insight – Herbicide and stubble
- Haskins, B (2012) Using pre-emergent herbicides in conservation farming systems
- GRDC Pre-emergent herbicides manual & GRDC Spray Application Manual
- Gordon, B (2017) Spray Applications tips and tactics GRDC Update Paper

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