Upper North Farming Systems

Stubble Management Guidelines

Weed control at sowing

The amount and condition of stubble residues on the soil surface affects the efficacy of herbicides, particularly pre-emergent herbicides. Photo: Damien Sommerville

The weed spectrum is changing as fewer paddocks are being routinely cultivated — certain species are no longer being controlled by tillage. As a result, growers are increasingly relying on herbicides to control weeds.

Effective weed management in retained-stubble systems is important to take advantage of the many benefits of retained stubble and residue cover, without suffering losses associated with poor weed control.

Emerging weeds develop quickly within the retained-stubble system — keep on top of them before they get out of control. Photo: Matt McCallum

Key facts

- High stubble loads can prevent herbicides from reaching the soil and also tie up some herbicides, making them unavailable for weed control.
- Many pre-emergent herbicides can be used effectively with up to 50 per cent stubble cover.
- At harvest ensure residue is spread evenly across the header width and harvest as high as possible to maximise standing stubble.
- When applying herbicides, use high water rates (80L/ha or more) with larger non-air-inducted droplets.
- Consider using herbicides that will wash off stubbles more easily.

Project information

This *Weed control at sowing* guideline has been developed for the Upper North Farming Systems Group (UNFS) as part of the Maintaining Profitable Farming Systems with Retained Stubble Initiative, funded by the Grains Research and Development Corporation (GRDC UNF00002).

The Stubble Initiative involves farming systems groups in Victoria, South Australia and southern and central New South Wales, collaborating with research organisations and agribusiness, to address challenges associated with stubble retention.

The GRDC, on behalf of growers and the Australian Government, is investing $17.5 million in the initiative that has been instigated by the GRDC Southern Regional Panel and the four Regional Cropping Solutions Networks that support the panel.

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Stubble provides a physical barrier, impeding herbicides from reaching weeds and soil, and it can also bind to and tie up some herbicides. Photo: UNFS

Impact of stubble residues on herbicide efficacy

The amount and condition of stubble residues on the soil surface affects the efficacy of herbicides, particularly pre-emergent herbicides, in two ways. Stubble provides a physical barrier, impeding herbicide from reaching the target weed or soil, and it can also bind to and tie up some herbicides making them unavailable for weed control.

When spraying into stubble it is important to consider:

- herbicide type and mode of action
- timing of application and seasonal conditions
- appropriate water rates
- nozzle type, boom height and spray unit speed.

How pre-emergent herbicides work

Pre-emergent herbicides work in a number of ways. They are generally applied to the soil and taken up by either the emerging root or shoot, or a combination of both. Some (e.g. Logran® and Boxer Gold®) also have some leaf activity, but this activity is not usually as important for efficacy as the root and shoot uptake.

The specific site of 'root' or 'shoot' uptake varies between herbicides and their mode of action, giving each herbicide group its unique weed control attributes. Regardless of the mode of action, for a herbicide to interact with either the root or the shoot, it must first come into contact with the soil.

Stubble can prevent herbicides from reaching the soil, intercepting the droplets on their way to the ground. For some herbicides, such as trifluralin or triallate, this interception can be permanent, as the herbicide binds strongly to the stubble and is unlikely to remain active. Others, such as metolachlor, bind less strongly to stubble and can be washed off stubble and onto the soil surface with adequate rainfall.

When on the soil surface, all pre-emergent herbicides require either physical incorporation or incorporation by rainfall to be effective. Incorporation enables the chemical to access the target part of the weed, by being at the right depth in the soil, as well as protecting it from volatilisation and UV degradation. The amount of rainfall or physical incorporation required varies according to the herbicide chemistry, rate and prevailing conditions.

As well as incorporation, pre-emergent herbicides also need at least some moisture following application to become 'activated' and available to be taken up by germinating weeds.

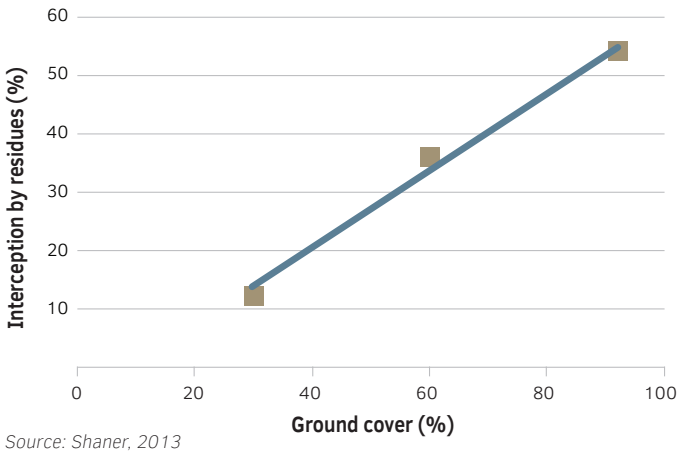
Estimating stubble loads

Up to 50–70 per cent of the stubble from harvest can still be present at sowing and with a high-yielding crop the stubble load could be well above 3t/ha. As the groundcover percentage increases, the amount of herbicide intercepted by the stubble residue also increases (see Figure 1).

Many pre-emergent herbicides can be used effectively with up to 50 per cent stubble cover (1.7–2.5 t/ha stubble, depending on the amount lying on the soil surface) across a paddock. Pre-emergent herbicide efficacy starts to be significantly impacted when stubble exceeds 50 per cent cover.

Estimate the stubble load by looking onto stubble from above and assessing the area of soil/stubble ratio (see the UNFS guideline *Monitoring stubble*).

Figure 1. Relationship between groundcover and herbicide interception by crop residue



Source: Shaner, 2013

Standing stubble offers greater opportunities for herbicides to reach the soil. Photo: Matt McCallum

Thick layers of chaff and straw on the ground are difficult for herbicides to penetrate. Photo: Matt McCallum

Optimising herbicide efficacy in heavy stubble

Although high levels of stubble can compromise the efficacy of pre-emergents, there are ways to improve results.

Herbicides can penetrate standing stubble is more easily than lying stubble, which can form a thatch on the ground.

Managing stubble height at harvest and grazing stubble during summer both influence stubble loads and physical attributes at sowing.

To optimise herbicide penetration in standing stubble, keep water rates up, travel slowly so droplets have a more vertical trajectory, and keep spray quality coarse.

It is important to set up the spray rig correctly. Set the height so the double overlap is occurring at the height of the stubble, rather than the ground. This helps to ensure even application.

Some level of interception can't be avoided, but there are differences in the way various chemicals behave when in contact with stubble. As a general rule the more water-soluble herbicides cope better with crop residues. For example, trifluralin is one of the least water-soluble herbicides, whereas Boxer Gold (containing prosulfocarb and S-metolachlor) is one of the most soluble (see Table 1). As such, Boxer Gold is likely to be more effective than trifluralin in high-stubble situations, where it can wash off. Table 1 highlights some of the properties of common pre-emergent herbicides and their influence on the suitability for use in stubble.

Adjusting herbicide rates in light of different stubble conditions can improve efficiacy. Trifluralin products have label recommendations that allow for higher rates to be used in high-stubble situations to account for the active ingredient that remains tied up on stubble.

Stubble can also affect the evenness of application, particularly when a sowing system struggles to adequately penetrate the stubble. In these situations stubble can bunch up and drag with the sowing equipment, bulldozing soil. This moves previously-applied herbicide with it, and can result in uneven final placement of the herbicide across a paddock.

Planning ahead for optimal efficacy

Some planning is required when using pre-emergents in heavy stubble, starting at harvest, to ensure a trouble-free sowing.

A last resort is always to burn the stubble, which will remove any trash clearance issues at sowing, but if a herbicide has been applied, followed by burning, the herbicide is lost unless it has already been washed into the soil.

In paddocks where burning is the best option, defer herbicide application until you are confident the sowing equipment can handle the stubble load.

Table 2 demonstrates how various stubble management options can influence the performance of pre-emergent herbicides in the paddock.

Burning is a last resort. In paddocks where burning is the best option, defer herbicide application until you are confident the sowing equipment can handle the stubble load. Photo: Hannah Mikajlo (UNFS)

TABLE 1. Key characteristic of common pre-emergent herbicides, which influence their efficacy in high-stubble-load situations

Herbicide group	Herbicide product	Mode of uptake	Water solubility#	Binding to soil organic matter ##	Suitability to be used in high stubble loads (50% cover)
B Sulfonyl ureas	Triasulfuron (Logran)	Roots and leaves — quickly translocated to growing points preventing further growth.	High	Low	Yes
B Sulfonyl ureas	Chlorsulfuron (Glean®)	Roots and leaves — quickly translocated to growing points preventing further growth.	Very high	Low	Yes
C Triazines	Atrazine	Roots and leaves — quickly translocated inhibiting photosynthesis.	Medium	Medium	Yes
	Simazine	Roots and leave — quickly translocated inhibiting photosynthesis.	Low	High	Yes
C Ureas	Diuron	Roots and leaves — quickly translocated inhibiting photosynthesis.	Medium	High	Yes
D Dinitroanilines	Trifluralin (TriflurX®)	Roots — inhibits microtubule assembly.	Very low	Very high	Maybe
	Pendimethalin (Stomp®)		Very low	Very high	Maybe
J Thiocarbamates	Triallate (Avadex® Xtra)	Shoots (predominately) — inhibits fat synthesis.	Low	High	Maybe
	Prosulfocarb (Boxer Gold)	Shoots, roots and leaves — inhibits cell division. Also contains Group K.	Low	High	Yes
K Chloroacetyamides	S-metolachlor (Dual Gold®)	Roots and leaves — inhibits cell division and enlargement.	High	Medium	Yes
K Isoxazolines	Pyroxasulfone (Sakura®)	Roots and shoots — inhibits very long chain fatty acid biosysthesis, causing the growing point and coleoptile to be interrupted.	Low	Medium	Yes

 # At 20°C and neutral pH
In pH neutral soils

Source: Haskins, 2012

TABLE 2. The impact of stubble management and herbicide options on annual ryegrass control at Sandilands, Yorke Peninsula, 2006

Stubble treatment	Trifluralin (% control)	Metolachlor (% control)	Triallate (% control)
Burnt	89.3	66.7	38.3
Slashed	29.3	37.3	16.3
Standing	84.3	78.3	51.7
LSD (5%)	17.3	35.5	20.2

Note: *The trial was sprayed with a hand boom using 02 Flat Fan, 3 bar, 80L/ha and an estimated speed of 8km/hr.*

Benefits of stubble

Stubble also provides some benefits when using pre-emergent herbicides. It can add a margin of crop safety to products prone to leaching into the seed bed, by slowing infiltration rates and pooling of water into furrows. It can also reduce soil throw and provide a buffer from chemical-treated soil being thrown into an adjacent row, acting as a physical fence to reduce soil movement.

Stubble paddocks retain more moisture under marginal conditions than bare paddocks, helping pre-emergents stay active in the soil for longer, thereby improving weed control.

Stubble can aid in summer weed spraying by slowing moisture loss from the soil, and keeping weeds fresher for longer. This can lengthen the window for effective summer weed spraying, when moisture stress often limits the effectiveness of herbicides.

The impact of stubble on knockdown herbicides

The same issues with stubble interception and pre-emergent herbicides apply to knockdown herbicides, both when spraying summer weeds and at sowing.

In the case of knockdowns, shading from stubble and stubble residue can significantly reduce efficacy, particularly when using contact herbicides, such as paraquat. Translocated herbicides, such as glyphosate and 2,4-D can both remain effective when coverage is compromised, and may provide better results when stubble cover is high and weeds are hidden.

To improve coverage when using a double knock before sowing, spraying in alternate directions can be useful, ensuring weeds that may be hidden in one spray direction are covered in the second spray.

Tips for more effective weed management in stubble-retained systems

Although using herbicides in stubble has its challenges, there ways to maximise the success of weed control:

Start managing stubble at harvest — Ensure trash is spread evenly across the header width. Trash concentrations in the header row can bind to herbicides impacting weed control. Remember, the header row is also where many weed seeds concentrate. Consider tools to reduce chaff and control weed seeds at harvest, such as windrow burning or chaff carts.

Leave stubble standing — Straw choppers on headers mulch and pulverize stubble into chaff, which breaks down faster. This is much better than slashing, chaining or harrowing, which leaves stubble in long lengths acting as an impenetrable thatch, limiting herbicide access to the soil surface.

Increase water rates — Use high water rates (>80L/ha) with larger non-air-inducted droplets (coarse at a minimum) to deliver more herbicide to the soil. Even the more water-soluble herbicides (Boxer Gold, Sakura) control annual ryegrass better when applied at higher water rates.

Use the right spray nozzles — Non-air-inducted nozzles produce droplets with more capacity to 'bounce' off stubble, and still reach the ground. Air-inducted droplets do not bounce as readily and are more likely to stay on the stubble they hit.

Match spacings — Matching row spacing and nozzle spacing on real time kinetic (RTK) guidance allows precise positioning of nozzles between stubble rows, minimising stubble shadowing of herbicide.

Choose a suitable product — Select herbicides that are more suited to high-stubble-load situations (see Table 1). Most herbicides are washed off stubble residues with 5mm of rainfall, with more herbicide being washed off with increasing rainfall and following rainfall events.

Understand your product — Some pre-emergent herbicides are sensitive to sunlight and need to be incorporated or covered by soil to minimise losses. Herbicides like trifluralin only need a light cover of soil to reduce photodegradation. Some herbicides are volatile and can be lost to evaporation, especially from wet soil.

Up the rate — Use higher herbicide rates, particularly for products like trifluralin, which has label recommendations that support higher rates of product for use in higher-stubble-load situations.

Manage inter-row soil throw — In most no-till sowing systems the soil from the sowing row is thrown to the inter-row space, reducing the rate of application of soil-applied herbicide near the seed and increasing the effective application rate in the inter-row. Pay attention to detail during sowing and ensure soil throw on the inter-row while maintaining a seed furrow free from herbicide. Concentrated chemical soil in the furrow can damage crops and reduce plant vigour.

Close the furrow — Ensure the seed furrow is closed to prevent herbicide washing onto the seed. Sowing systems vary in their ability to 'close the slot'.

Monitor sowing depth — Ensure even seed depth placement (typically 3–5cm of loose soil on top of the seed in cereals for optimal crop safety). This is a key safety mechanism. Whatever else you do, keep the seed more than 3cm deep if in marginal moisture conditions, or in crops sensitive to particular herbicides. If you can't – wait for better conditions!

Consider spraying conditions — If applying herbicide onto dry sandy soil where there is a risk of significant rainfall (more than 25mm) the chemical can move rapidly through the soil profile and damage the crop. Stubble cover will slow infiltration rates and act as a buffer to improve crop safety.

Consider herbicide timing — Incorporate by sowing (IBS) rather than post sowing pre-emergent (PSPE) to improve crop establishment and early vigour.

Take a toolbox approach — Establish a toolbox approach to weed management in retained-stubble systems. Stubble interferes with herbicide target contact, reducing efficacy. Plan to tackle escape weeds with tools such as crop rotations, windrow burning, chaff carts, seed destructors and targeted in-season and at-harvest spray applications. Emerging weeds develop within the retained-stubble system — keep on top of them before they get out of control.

Start managing stubble at harvest to make weed management easier later on. Photo: UNFS

Incorporation at sowing offers efficacy and flexibility

Brendon Johns, Warnertown

In order to get better soil contact with his pre-emergent herbicides Warnertown farmer Brendon Johns has been using a spray bar mounted on the front of his seeder for the past 15 years. The system works with a Dosatron unit direct injecting the herbicide into the mix as water is pumped through from a 7000 litre liquid tank following the air cart.

Brendon uses a pre-emergent mix of trifluralin and triallate extensively with this system. He finds these two particular chemicals work well, as they are getting incorporated 'within a second' of application. The slow sowing speed (10km/hr) versus a typical spraying speed also means droplets can penetrate through stubble to the soil surface and Brendon estimates he is getting around 70 per cent spray coverage with this method.

The combination of herbicides and the incorporation during the sowing process improves the efficacy of the mix, meaning Brendon achieves effective weed control from relatively moderate application rates.

Another advantage of Brendon's system is the flexibility of the boomspray during sowing. The timing of the knockdown is no longer compromised by the need to have the pre-emergent incorporated, and good spraying conditions for knockdowns can be exploited. There is also less risk of loss with the pre-emergents due to a breakdown — they are only going out when the seeder is actually running, rather than being exposed to a seeder breakdown, which leaves them on the surface and subject to loss.

Brendon uses a spray bar mounted on the front of his seeder to get better soil contact with his pre-emergent herbicides.
Photo: Diesel Performance Solutions

As a further innovation to his system Brendon is now developing some modifications that will enable full 'inter-row spraying' to occur. He is already inter-row sowing, and by positioning a nozzle in front of each sowing tyne, with a drop tube to lower the nozzle height, he expects there to be a further benefit in coverage and efficacy, rather than the current nozzle height, which still provides some interception with stubble. This additional innovation will help concentrate the chemical on the exposed soil rather than interacting with the stubble, further enhancing coverage.

Planning allows for targeted weed control before sowing

Chris Crouch, Wandearah

Wandearah farmer Chris Crouch considers each paddock's stubble loads carefully when applying knockdown herbicides during summer and before sowing.

In paddocks with heavier stubble, Chris uses higher water rates (up to 100L/ha), coarse droplets and sprays in the direction of the stubble row to enhance penetration and get better coverage. To keep droplets angled downwards Chris operates at a maximum travel speed of 15km/hr.

Chris also considers stubble load when choosing his herbicides. He prefers to use a translocated herbicide, such glyphosate, when spraying in heavy stubble, to ensure an effective result even if droplet coverage is not complete. Barer paddocks following a pulse crop open up more options for contact herbicides, as spray coverage is generally better.

Chris also considers stubble levels when determining spraying priorities and urgency. He sprays barer paddocks or pulse stubbles first, as weeds are more visible when they are small. These paddocks also tend to dry out the fastest during summer, meaning a shorter window for herbicide uptake before weeds become stressed. For paddocks with taller cereal stubbles, Chris prefers to wait until weeds are slightly larger before spraying. This gives a better chance of getting effective coverage among the stubble and the delay does not affect efficacy as the cover maintains soil moisture and keeps the weeds fresher for longer than on the bare paddocks.

Chris Crouch carefully considers stubble loads before selecting his herbicide options
Photo: Iris Crouch

By retaining soil moisture, stubble can lengthen the window for effective summer weed spraying. Photo: Damien Sommerville

References and further information

» *Understanding pre-emergent herbicides*, GRDC Updates (GRDC). Click

» *Balancing crop safety and effectiveness when using pre-emergent herbicides*, Grain and Graze 2 (GRDC). Click

» *Using pre-emergent herbicides in conservation farming systems* (NSW DPI). Click

» *Achieving good pre-emergent spray results*, GRDC Fact Sheet (GRDC). Click

Acknowledgements

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