IN-CROP HERBICIDE USE FACT SHEET

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GRAINS RESEARCH & DEVELOPMENT CORPORATION

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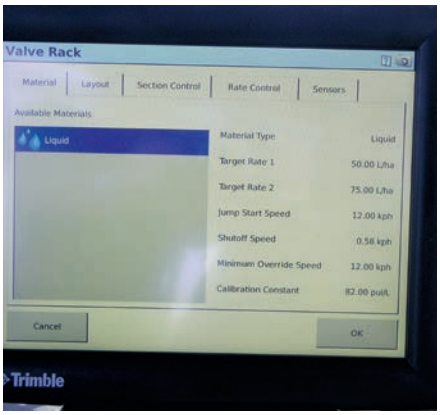
Application considerations for in-crop herbicide use

KEY POINTS

- Knowledge of a product's translocation and formulation type is important when selecting nozzles and application volumes
- Evenness of deposit is important for poorly or slowly translocated products
- Crop growth stage, canopy size and stubble load will influence decisions about nozzle selection, application volume and sprayer operating parameters
- Robust product rates and appropriate water rates are often more important for achieving control than the nozzle type. Correct nozzle type can widen the spray window, improve deposition and reduce drift risk
- Travel speed, boom height and stability can affect coverage, efficacy and drift potential
- Always check the product label for specific application details

PhotoS: Graham betts



Test controller settings and nozzle performance well before cropping starts.

Importance of knowing how a herbicide works

The mode of action (MOA) of the chemical being applied and the crop situation determine the water volume and droplet size and how a sprayer should be set up.

It is also important to know how a product enters the plant and how it is translocated within the plant to determine where the spray coverage is required and what adjuvants may assist with the uptake of the product into the plant.

UPTAKE, TRANSLOCATION AND APPLICATION VOLUME

Products that have a slow uptake or limited translocation (such as Group 1 herbicides) require very good coverage and should be applied at high water rates, typically 70 to 100 litres per hectare (L/ha) in cereals and higher in many pulses.

Products that are phloem and xylem transported (such as herbicide Groups 2, 4 and 9) can often be applied using lower application volumes of 50 to 70L/ha in low stubble situations and in small crop canopies, where a coarse spray quality (or smaller) is permissible.

There is a need to increase application volumes to 70 to 100L/ha or more where high stubble loadings, dense crop canopies or the use of spray qualities larger than coarse (very coarse, extremely coarse or ultra-coarse) result in reduced coverage. Always check product labels and the manufacturer's technical information for specific advice about appropriate application volumes and timing in relation to a crop's growth stage.

WATER VOLUME AND SPRAY QUALITY

Depositing droplets onto foliar targets is a numbers game and comes back to droplets per square centimetre which is driven by water volume. Increasing application volume produces more droplets and better coverage, which usually increases the evenness of the application, provided the droplets reach the foliage where they are required.

More droplets can be produced by decreasing the droplet size or increasing water volume. However, fine spray qualities do not penetrate dense canopies or thick stubbles as well as medium or coarse spray qualities. Finer spray qualities also increase spray drift risk and are likely to be intercepted by stubble when the load is high.

'False targets' that are situated between the nozzle and the desired target weed, such as stubble or a large crop canopy, have the potential to intercept spray droplets. Where crop canopies are large or stubble load is heavy, it is always advisable to use higher water rates. Low boom heights, which result in double overlap of the nozzle patterns occurring below the top of the stubble or crop canopy, can increase interception by false targets, especially with larger droplets at faster spraying speeds.

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Adjuvant choice

The MOA, crop situation and product label will determine the most appropriate adjuvant. Correct adjuvant for the pesticide is commonly built into the formulation. Where this does not occur, the label typically indicates the type and amount of adjuvant to be used. Adding additional adjuvant where not recommended, or switching to a different type of adjuvant may often reduce product performance. Adjuvants have multiple functions including improving efficacy (wetting, spreading and uptake) and improving water quality and compatibility. A few adjuvants have the capacity to reduce the production of fine droplets, but generally this effect is far smaller than a change to a coarser spray quality by changing nozzle type to mitigate the risk of drift.

Non-ionic surfactants may improve efficacy and droplet spread on the leaf surface, especially when using aqueous concentrate formulations that require good coverage. However it is important to read and follow label directions, as adding the wrong surfactant may decrease efficacy in some situations. An example is with glyphosate, where adjuvants that substantially reduce surface tension can reduce product efficacy.

Non-ionic surfactants may also not be an ideal replacement in situations where an oil-based adjuvant is recommended, due to the way oil based or emulsifiable concentrate products (for example, clethodim) are absorbed into the plant. Oil-based adjuvants are usually mixed with oil-based formulations, some emulsifiable concentrates and some low volatile ester-based formulations. The addition of oil-based surfactants to water-soluble products such as glyphosate is not recommended by most manufacturers.

Always check the label recommendations and the manufacturer's recommendations about the most suitable adjuvant for mixing with a particular product.

INTERACTIONS BETWEEN NOZZLE TYPE, FORMULATION AND ADJUVANTS

When choosing a nozzle, select the nozzle type and size to deliver the desired volume (water rate x spraying speed) and the coarsest spray quality appropriate to the product being applied.

More recently, specific spray quality requirements for drift mitigation require the use of a minimum spray quality, for example Very Coarse (VC) or larger spray quality for 2,4-D. These situations may require the use of higher water rates to generate enough droplets to ensure coverage.

When many air-induction nozzles are operated at the lower end of their pressure range the spray quality becomes coarser (towards extra-coarse and ultra-coarse depending on the nozzle make and type). This may result in greatly reduced coverage, particularly on some hard-to-wet weed species.

This may become an issue when speeds are reduced at the ends of paddocks, around trees and over contours, when the automatic rate controller reduces the pressure to maintain the application rate. Using the minimum hold (or lower limit function) in the controller can reduce this, but can also encourage overdosing leading to crop damage.

New spray technologies such as multi-step and pulse width modulation give more flexible working speed ranges with multiple or individual nozzle section control and turn compensation.

DRIFT AND SPECIFIC PRODUCT FORMULATION RISKS

Be aware of the risk of drift as certain formulations have specific 'adjuvant packages' that can increase the percentage of driftable droplets produced through some nozzle types.

'Wetters' (surfactants) reduce surface tension and typically reduce droplet size. They may be included in the formulation, or tank mixed, or both. Adding an 'oil' may slightly increase the solution viscosity, leading to a slight increase in droplet size. However, many of the leading 'spray oil' products used in Australia contain both an oil and a high concentration of surfactant, so often the surfactant load may cancel the benefit of the oil.

As previously stated, the formulation or adjuvant effect is much smaller than that of the nozzle. Generally, the coarser the initial spray quality is, the smaller the impact of the tank mix is on the percentage of driftable droplets.

Travel speed

As spraying speed increases, droplet deposition and retention on target weeds is often reduced. Higher spraying speeds may also result in greater interception of droplets by vertical false targets such as stubble and crop canopies. Generally, speeds above 20 to 25 kilometres an hour (km/h) will result in reduced efficacy unless compensating with higher water volumes.

Windy conditions, and wake effects behind the boom, sprayer and wheels, can also affect efficacy at high spraying speeds.

Nozzle design

Nozzle design can affect coverage and the evenness of application. With standard flat fan nozzle patterns that face straight down, as travel speed increases the net droplet movement is often in a forward direction, especially for larger droplets. This can result in more droplets depositing on the leading face of the weed or increasing retention on stubble. The use of offset (angled) nozzles or twin designs can improve the evenness of deposition, provided the travel speed is not excessive.

Efficacy-based trials in fallow have shown that several angled and twin designs perform well at speeds up to 21km/h. Efficacy-based trials overseas have shown more even deposition from angled or twin nozzles compared with standard patterns that face directly downwards when spraying at low speed. However, be aware that the combination of small droplets, backwards facing release from angled nozzles, high boom height and fast travel speed will greatly increase spray drift.

Photo: Andrew storrie

Ensure the nozzle type and spray quality match the product type and label requirements.

TABLE 1: A summary of herbicide groups and the properties that interact with spray practice.

Group	Examples	Uptake	Translocation	Site of Action	Notes
1 (fops)	clodinafop diclofop haloxyfop	Fast	Fully systemic, but slow/poor translocation	ACCase inhibition -most active at the growing point (crown)	Adjuvants required. Coverage is important. Selects for resistance rapidly
1 (dims)	tralkoxydim sethoxydim clethodim	Moderate to fast			Adjuvants required. Clethodim can degrade in sunlight. Water quality (bicarbonates) important. Selects for resistance rapidly
2 (imidazolinones)	imazamox imazethapyr	Moderate speed of foliar uptake. Soil uptake also important	Fully systemic	ALS inhibition – most active at the growing point	Selects for resistance rapidly. Soil pH important for carryover (increases with low pH)
2 (sulfonamides)	florasulam flumetsulam				Selects for resistance rapidly
2 (sulfonylureas)	chlorsulfuron metsulfuron triasulfuron				Selects for resistance rapidly. Soil pH important for carryover (increases with high pH)
4 (phenoxys)	2,4-D MCPA	Foliar and some soil	Fully systemic	Growth regulator. Affects many plant processes. Most active at growing points.	Reliable in most environments. Ester formulations (where available) enter the plant faster than amine formulations
4 (benzoates)	dicamba	Foliar			
4 (pyridines)	aminopyralid clopyralid fluroxypyr halauxifen picloram	Foliar. Soil uptake varies			
5 (triazines)	atrazine simazine terbuthylazine	Soil and some limited foliar	Upwards / outwards only	Photo-system II	Requires sunshine for good foliar activity. Soil moisture determines soil activity.
5 (triazinones)	metribuzin	Soil and foliar			Small weeds, needs good coverage
6 (nitriles)	bromoxynil	Mainly foliar	Limited / poor		Small weeds. Good coverage and robust rate essential
9	glyphosate	Foliar only	Fully systemic	EPSP synthase inhibitor	Avoid muddy and hard (Ca, Mg & bicarbonate) water. Uptake reduced on dusty leaves.Can only be used in glyphosate tolerant crops, or for defoliation/desiccation in crops where label permits
10	glufosinate	Foliar only	Limited / poor	Glutamine synthetase inhibitor	Excellent coverage required. Best under warm temperatures and high humidity. Poor control of large grasses. Can only be used in glufosinate tolerant crops.
12	diflufenican picolinafen	Foliar/soil	Limited / poor	Carotenoid biosynthesis (PDS) inhibitor	Very small weeds. Good coverage is essential
14	carfentrazone pyraflufen	Foliar	Limited / poor	Chlorophyll – PPO inhibitor	Works faster under warm / high light conditions
22	paraquat	Foliar only	Limited / poor	Photosystem I	Good coverage required. Poor control of large weeds. Only to be used in-crop for crop-topping, as per label.
27	bicyclopyrone pyrasulfotole topramezone	Foliar	Limited – systemic	HPPD inhibitor – leads to bleaching	Good coverage is important. Most active under sunny conditions

Always refer to the specific product label for compatible mixing partners, always follow label directions.

Other important factors

Other factors that are important for application include:

- maintaining boom height to achieve double overlap at the top of the stubble or crop canopy;
- ensuring that water quality is suitable;
- ensuring the correct mixing order for tank mixes;
- spraying under suitable weather conditions away from sensitive areas where daytime wind speeds are above 3km/h and not exceeding the maximum wind speed on the product label; and
- never spray during a hazardous surface temperature inversion. Check weather forecasts and spray advice services for inversion risk.

FREQUENTLY ASKED QUESTIONS

Can I use the same nozzles for all of my in-crop applications?

Often it is difficult to use just one set of nozzles for all spray applications. Some Group 4 applications will require a coarse or very coarse spray quality (2,4-D application must be a minimum of very coarse for all applications), while Group 1 grass sprays, insecticides and fungicides will typically perform best using a medium spray quality (typically at a higher volume). Sometimes one nozzle can achieve this but can limit speed range. Often it is better to have two (or three) sets: one set that holds at least a very coarse spray quality, such as a high-pressure air-induction, and another set that holds a medium spray quality.

Why do I get poorer grass control at the ends of runs?

This can happen with some nozzles, particularly air-induction, where the spray quality becomes too coarse due to the reducing pressure as the sprayer slows down. Using the minimum hold function, higher water rates and bigger headlands can all help to reduce the problem. Newer boom spray technology, such as Pulse Width Modulation (PWM) helps to alleviate these issues by maintaining constant pressure with changes to travel speed.

My in-crop grass control is not as good as it used to be when I used smaller droplets. What can I do?

If you do not increase application volume, moving to bigger droplets can result in poorer grass control due to poor coverage. Unfortunately, it is often difficult to compare the level of control achieved between seasons. Efficacy is not driven by coverage alone; factors such as tank mix partners, water quality, adjuvant choice, mixing order, weed size, resistance levels, the addition of some foliar fertilisers and the weather conditions before and after spraying can all have an impact on the level of control obtained.

USEFUL RESOURCES

How herbicides work: biology to application, by Linda Hall, Hugh Beckie and Thomas M. Wolf, Alberta Agriculture, Food and Rural Development (Canada)

Adjuvants: oils, surfactants and other additives for farm chemicals, grdc.com.au/resources-and-publications/all-publications/publications/2018/adjuvants-booklet

Understanding post-emergent weed control, grdc.com.au/understanding-post-emergent-herbicide-weed-control

Nozzle selection guide, grdc.com.au/resources-and-publications/all-publications/publications/2022/grdc-nozzle-selection-guide

Maintaining efficacy with larger droplets – new 2,4-D application requirements, GRDC Fact Sheet, grdc.com.au/maintaining-efficacy-with-larger-droplets

Hazardous surface temperature inversions, GRDC Fact sheet, grdc.com.au/resources-and-publications/all-publications/factsheets/2022/hazardous-inversion

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Weed control in wheel tracks, GRDC Fact Sheet, grdc.com.au/resources-and-publications/all-publications/factsheets/2014/08/weed-control-in-wheel-tracks

Nozzle selection for boom, band and shielded spraying: The Back Pocket Guide, grdc.com.au/resources-and-publications/all-publications/publications/2017/07/nozzle-selection-for-boom,-band-and-shielded-spraying

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