An update on new pre-emergent herbicide options

By GRDC

WHEN devising a weed control strategy, pre-emergent herbicides can be a valuable additional tactic to help drive weed numbers down. Used alone, they often do not achieve the objective of driving down weed seedbank numbers as small numbers of weed escapes often occur and provide seedbank replenishment. But when used as a component amongst a suite of tactics, they can be particularly effective.

To understand how a pre-emergent herbicide will behave in your farming system, you need to be able to answer the following questions:

- What weeds are in the paddock and where are the seeds? Knowing what is in the weed seedbank and where these seeds are located (i.e. mainly on the surface or distributed in the top 10cm) will be important in selection of the herbicide to be used and will assist in setting realistic expectations for control.
- Is the herbicide subject to volatilisation or photodegradation? Knowing this will determine the incorporation strategy required to minimise loss to the environment.
- How soluble is the herbicide? This will influence: how much rain is required for incorporation and to wash off stubble; how easily it will be taken up by the germinating weed and crop; and susceptibility to moving deeper into the soil profile with soil water (or off-site in run-off), potentially causing crop injury or being lost to leaching.
- What is the soil type and level of organic matter? Sandy or low organic matter soils (low CEC) have fewer binding sites. Other factors being equal, more herbicide will be available for crop and weed uptake in lighter soil types than in a heavier or higher organic matter soil.
- How tightly does the herbicide bind to soil and organic matter? Herbicides that bind tightly generally stay close to where they are applied (unless the soil moves) and will persist for longer. They will also be more difficult to wash off stubble.
- What is the soil pH? The pH affects how long some herbicides persist for and how available they are for plant uptake and soil binding.
- How persistent is the herbicide and how does it break down? This will give an indication of the expected length of residual control and plant-back constraints to sensitive crops.
- Rainfall and temperature: Rainfall after application is important for incorporation and to allow the herbicide to be available for root uptake. Rainfall and temperature also affect degradation.
- What application rate? The choice of application rate will affect the efficacy, length of effective residual and possibly crop selectivity.
- Have I read the product label? Product labels are developed to reflect how herbicides behave in the soil. Always read and follow product label directions.

Having a copy of the recently updated GRDC Reference Manual: *Soil behaviour of pre-emergent herbicides in Australian farming systems* is an excellent place to start in helping to answer these questions. Commonly used pre-emergent herbicides and their chemical properties are discussed in the manual.

This information assists in understanding why they behave as they do and what considerations are important in their performance as a pre-emergent herbicide.

ICAN senior consultant Mark Congreve says the updated manuals aim to simplify the complex interactions of our existing and new pesticide chemistry with environmental conditions.

The updated manual also includes an overview and discussion of new pre-emergent herbicides now available to the grains industry. The following is a summary of those new entrants according to their chemical group.

Group 13

Mode of action: Group 13 herbicides inhibit deoxy-D-xylulose phosphate (DOXP) which is a key enzyme required in the early stage of the methyl-D-erythritol phosphate (MEP) pathway. The MEP pathway is one of two pathways that plants utilise to produce isoprenoid precursors required for the production of geranylgeranyl pyrophosphate (GGPP). GGPP is the key precursor for production of carotenoids, gibberellins, tocopherols and chlorophyl.

Visual herbicide symptoms appear as bleaching in some species, or a bright magenta discolouration in other species (for example, bixlozone on annual ryegrass).

Herbicides with the Group 13 mode of action that are available in Australia include bixlozone (for example, Overwatch) and the rice/horticultural herbicide, clomazone.

To date, no resistance to the Group 13 mode of action has been reported in Australia.

Practical considerations

The current Australian label for bixlozone (for example, Overwatch) supports use in wheat, faba beans, field peas, canola and barley. While it can be used safely in these crops, canola and especially barley have less tolerance, and therefore higher risk of crop effect.

Positional separation of the herbicide from the crop seed is important for crop safety. Ensure a minimum planting depth of 1.5 cm for canola and 3 cm for other crops. IBS adds additional crop safety by removing most of the herbicide-treated soil from the planting furrow. The label specifically recommends against using disc seeding systems when used in canola or barley.

Volatility is low. The Overwatch label recommends a three metre buffer to non-target vegetation.

Bleaching symptoms are extremely visual to certain sensitive species. Where application results in product leaving the treated field (for example, spray drift, movement under hazardous inversion conditions, physical particle drift on dust), visual damage to sensitive species may be observed. This should serve as a warning that any other products also being applied under the same conditions will be moving equally, just that they are often not as 'visual' in expression of their effects.

Persistence is relatively long, increasing under anaerobic conditions. Where planting rotational crops (outside of those where registered for use) ensure that full label plant-back conditions are met, paying especial attention to the need for rainfall over summer months.

Group 23

Mode of action: Despite being in use for several decades, the mode of action of Group 23 is not well understood. It is believed that these herbicides inhibit cell division (mitosis) and microtubule organisation and polymerisation.

Carbetamide is the only current Group 23 herbicide registered for use in Australia.

Predominantly emergence is prevented, however should grass weeds emerge after a pre-emergent application, symptoms appear as severe root pruning and stunting. Plant death may follow.

The 2020 label expansion of carbetamide for use in broadacre pulse crops and winter fallow means that most broadacre paddocks will have had little exposure to this mode of action to date, and hence resistance is not currently expected. However, annual ryegrass with multiple cross-resistance to several modes of action, including carbetamide, was identified in South Australia in 1982.

Practical considerations

- High solubility and low Koc indicates that carbetamide will be mobile in soil water. Plant uptake will be primarily via herbicide dissolved in soil water.
- Photodegradation or volatilisation are not primary dissipation pathways. When used in winter fallow, carbetamide will be stable on the soil surface and relatively easily incorporated with following rainfall.
- The label for use in pulse crops recommends IBS application with a planting depth of 3 to 5 cm. IBS application provides an additional level of crop safety by moving the majority of the herbicide to the inter-row and away from the planting line. However, with subsequent rainfall, it is likely that carbetamide will disperse through the soil water.
- Post-sow pre-emergent application is also supported for use in chickpea only, however only at the low application rate.
- Under conditions favouring microbial activity (warm, moist soils), degradation is expected to be relatively fast. The period of residual control is achieved by selecting higher application rate and application in late autumn/winter where microbial activity is declining due to temperature.
- Accelerated microbial degradation has been demonstrated where multiple applications have been applied to the same field. The label advises a minimum of three years between applications.

Group 30

Mode of action: Cinmethylin is currently the only active ingredient within Group 30.

Cinmethylin was first discovered in the early 1980s. Historically the mode of action of cinmethylin was unclear, with the active ingredient initially being grouped in mode of action 'Z' (unknown) for several years. It was originally proposed that cinmethylin may inhibit tyrosine aminotransferase (TAT).

More recent studies propose that inhibition of fatty acid thioesterases (FAT) is the likely mode of action. FAT is located in the plastid and is required to facilitate fatty acids movement to the endoplasmic reticulum where the plants require fatty acids for further lipid biosynthesis. As a result of this study, cinmethylin has been allocated Group 30 mode of action.

It was not until 2019 that significant use in broadacre wheat production in Australia commenced following the registration of Luximax herbicide. Due to the relatively short period since commercial release, there is not expected to be significant resistance present in Australian weed populations at this point in time.

Practical considerations

- Moderate solubility and moderate binding reduces movement in the soil, however there may be some movement especially on lighter soil types and under high soil moisture.
- For adequate crop safety, it is very important to achieve clear separation of cinmethylin and the wheat seed via the planting process. The label only supports IBS with knife points and press wheels to move treated soil away from the planting furrow, with a minimum of 3 cm planting depth required.
- "Volatilization of cinmethylin from either plant or soil surfaces may be significant with maximum volatilization rates after 24 hours of 73 per cent and 89 per cent of the applied amount from soil and plant surfaces, respectively" (APVMA, 2019). This would suggest that incorporation by sowing should be undertaken promptly after application. The Australian label requires IBS within three days.
- The mode of action of cinmethylin blocks fatty acid transfer to the endoplasmic reticulum (ER). Group 15 herbicides work in the ER by blocking transformation of these fatty acids to very long chain fatty acids. Therefore, it could be expected that the combination of Group 30 and Group 15 mode of action may enhance efficacy on grass species – both weeds and grass crops. The Luximax label recommends not to mix with either Sakura (pyroxasulfone) or Boxer Gold (prosulfocarb + s-metolachlor) "as increased crop damage may occur".
- Average soil persistence is often reported as short to moderate, depending on the soil and environmental conditions. However, in some situations, persistence can be extended (especially under anaerobic conditions or where there is a lack of soil moisture in the top 15 cm over summer months).

Herbicide workshops hosted by ICAN Rural have been designed to complement GRDC's essential herbicide resources for growers. (PHOTO: ICAN Rural)

Group 32

Mode of action: Aclonifen is currently the only active ingredient from Group 32.

Aclonifen was first commercialised in 1983. It has a diphenyl ether chemical structure so initially it was proposed that the mode of action may be similar to other diphenyl ethers which inhibit protoporphyrinogen oxidase (PPO), and therefore Group 14 mode of action. However, others suggested aclonifen symptoms typically appear as 'bleaching' similar to phytoene desaturase inhibitors

(Group 12), as opposed to rapid cell necrosis typical of Group 14 mode of action.

Research published in 2020 proposes that the actual mode of action inhibits solanesyl diphosphate synthase (SDS) and hence aclonifen has been allocated Group 32. SDS is a critical enzyme in plastoquinone synthesis. Inhibition of plastoquinone will disrupt both photosynthesis and carotenoid production.

Due to the relatively short period since commercial release in Australia, coupled with availability only as a three-way formulation, there is not expected to be significant resistance present in Australian weed populations at this point in time.

Practical considerations

- When applied to the soil, the low solubility and very high binding would suggest that soil movement will be very low.
- Incorporation by sowing with knife points and press wheels in a zero-till system should physically position aclonifen in the same location as germinating weed seeds on the soil surface. Significant movement back into the planting furrow is unlikely. Conversely, weed seeds germinating from depth (typical where cultivation has been previously utilised) may have roots, and the coleoptile node for grasses, below the immobile herbicide band and hence uptake may be limited.
- When applied in combination with diflufenican (in Mateno Complete) the modes of action are likely to be complementary on susceptible weeds.
- Persistence is moderate to long. Ensure good summer rainfall for adequate degradation. As aclonifen is only currently available as a three-way formulation with diflufenican and pyroxasulfone, the degradation of all three herbicides needs to be considered.
- Aclonifen also has significant foliar activity on emerged weeds.

Group O

Mode of action: Group O is reserved for herbicides where the mode of action is yet to be confirmed. Herbicides listed within Group O are diverse in their chemical structure and may have no similarities to other herbicides within this group.

Napropamide

While napropamide has been available for use in some horticultural crops in Australia since the late 1990s, use in canola was only added to the label in recent years. Historically napropamide was listed in the previous Australian mode of action classification system as a different subclass within Group K, however it currently has been moved to the 'unknown' mode of action group.

Napropamide reduces root growth in susceptible species, possibly by inhibiting cell division. When applied as a pre-emergent application, target weed species typically do not emerge. However, where individual weeds have emerged, root growth is compromised and roots may become necrotic at the tips. ■

Updated herbicide manuals

THE Grains Research and Development Corporation (GRDC) has released updated editions of two essential herbicide manuals for Australian grain growers:

- *Soil behaviour of pre-emergent herbicide in Australian farming systems;* and,
- *Understanding post-emergent herbicide weed control in Australian farming systems.*

These manuals, first published in 2019 and 2020, have undergone a revision that incorporates the latest in herbicide research and practice, including the transition to an international numbering system for herbicide mode of action.

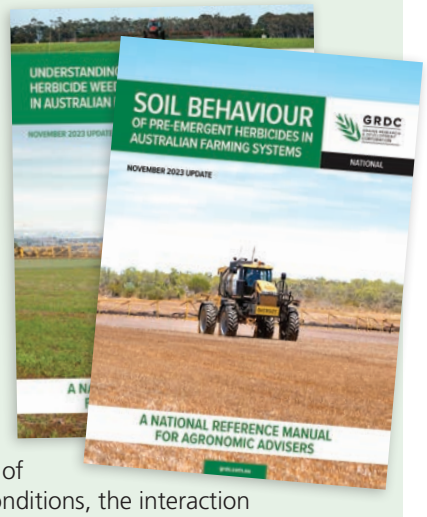
This change aligns Australian agricultural practices with global standards, ensuring that Australian farmers and agronomists have access to the most current and relevant information.

According to GRDC Manager Chemical Regulation Gordon Cumming, key updates include the incorporation of new herbicides and modes of action in the pre-emergent herbicide manual.

"These additions highlight the growing range of pre-emergent herbicide options available to Australian growers in managing weed challenges," Gordon said.

"The post-emergent herbicide manual has seen fewer changes, with minor improvements in understanding certain herbicide modes of action, however, new research improving our understanding of the Group 10 herbicide glufosinate has been included, which is an increasingly important non-selective knockdown herbicide."

According to Mark Congreve, senior consultant with Independent Consultants Australia Network (ICAN), both manuals aim to simplify the complex interactions of pesticide chemistry with environmental conditions.



"They are valuable resources for agronomists, researchers and growers, providing insights into the behaviour of herbicides under various conditions, the interaction of different products, application techniques, crop safety, and environmental dissipation," Mark said.

Complementing these manuals and in collaboration with ICAN, GRDC offers specialised workshops to further assist agronomists in putting this information into context. The 1.5-day workshops focus on the principles of herbicide biochemistry and their practical applications.

Details of the workshops can be found on the ICAN Rural website: *https://icanrural.com.au/herbicideworkshops.html* ■