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Residual herbicides

From the ground up

Solubility, adsorption, mobility and persistency – considering herbicide properties is all part and parcel of informed decision making, but how do current options stack up? *CPM* goes back to basics with residual herbicides.

By Janine Adamson

As growers face increasing pressure from resistant grassweed strains, coupled with a lack of contact herbicide options, ensuring residual chemistry hits the spot is critical in maximising the establishment potential of cereal crops.

But with a raft of properties to consider – from persistency to mobility – plus ever unpredictable weather conditions, is there an easy formula to follow to help growers with product choice depending on the season?

Some might say so, although according to BASF's cereal herbicide & PGR technical lead, Stuart Kevis, it's rarely black and white when it comes to interactions with the environment.

"Residual chemistry interacts with the environment, and the environment plays a considerable part in its performance – both efficacy and selectivity – it becomes much more complex than if you were talking about a contact-acting herbicide or perhaps a fungicide where it's about hitting the leaf of the plant."

Soil coverage

"Whereas for residual chemistry, soil coverage is the target. Equally, no treatment for blackgrass control in winter wheat should be applied as a single active – they're used in combination. So as that mix hits the ground, each active ingredient's individual soil properties all start coming into account," he explains.

"Some have different solubility, mobility, adsorption or persistence, and they all then act independently of each other."

According to Stuart, two properties which are worth paying particular attention to are how persistent a product is (soil degradation) and how well it binds to soil particles, known as adsorption.

Soil degradation is evaluated using a DT50 value – also known as 'half-life' – which is the time required for a chemical to decline to 50% of the amount at application. Critically, because

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environmental conditions have an impact on this number, Stuart says this is why the figure should be presented as a range.

"With persistency or soil degradation, it's not a linear line of decline and depends on the soil conditions and moisture as well as how each active is degraded. Many of the residual herbicide actives are broken down by microbial activity and so in general, provided there's sufficient soil moisture, the warmer it is, the shorter the persistency; the cooler it is, the longer a product lasts.

"This means it depends on when a farmer actually applies a herbicide and what the environmental conditions are at that time, as to how persistent it will be."

Considering current options on the market, prosulfocarb has one of the shortest half-lives with a DT50 value of 6.5-13 days making it non-persistent, whereas at the opposite end of the spectrum are tri-allate (8-205 days) and diflufenican (44.3-248.5 days).

"Two key grassweed actives for soil residual chemistry – Luximo (cinmethylin) and flufenacet – are actually very similar in terms of their moderate persistency," adds Stuart. "But it's important to remember that persistency only really matters if a product is effective at killing the target weed.

With residual chemistry, soil coverage is the target rather than a plant leaf.

"So although some products are persistent, they aren't out and out grassweed killers and should be used alongside other active ingredients. This is because of the relatively low inherent activity they exhibit which means even though they might last in the soil for longer, ▶

they aren't strong enough to provide a high level of control. That said, they do contribute to broadleaf weed control at relatively low doses," he explains.

Moving to adsorption, this is an active's ability to bind to soil particle surfaces, particularly clay fractions. This is important because residual herbicides are applied to the soil and then taken up by the weed from the soil moisture.

And how this works is, water is held within the crumb structure of the soil. Following application, the herbicide is held on the soil by its clay content, after which it's gradually released into the soil water where it's taken up by the germinating weed. This also makes soil type and condition significant contributory factors to the efficacy of soil-applied residual herbicides.

"There's a wide range in the ability of herbicide actives to bind to soil. You have products which aren't good binders like flufenacet through to those which have strong adsorption characteristics such as pendimethalin and picolinafen, with the rest somewhere in between. On top of this you also have mobility (how the active moves through the soil profile), which adds another complicating factor to the way in which actives behave," says Stuart.

"Products which don't bind as strongly have the potential to move through the soil profile more freely, particularly if there's high levels of soil moisture. Solubility also plays a role – the greater the solubility, the more the active dissolves into the soil pore water," he explains.

Stuart says this idea is used to consider which products might work better in drier conditions, because they require less available soil moisture to get to the target zone. "Although that's not always true, due to all of the other properties which should also be considered."

As a result, he says it's how the four main properties of residual herbicides work together (persistency, adsorption, solubility and mobility) as a collective, plus overall efficacy, which results in the final grassweed control level.

"Let's take cinmethylin, which sits in a more moderate position in regard to persistency, yet we know that it's highly effective against grassweeds. On the whole it's similar to flufenacet in terms of solubility and persistency, but it binds to soil much more strongly which reduces its mobility within the soil, keeping it in the weed root zone," highlights Stuart.

Herbicides are more effective when there's soil moisture because this is when grassweeds are actively growing.

Unique MOA

Re-focusing on why some herbicides perform better in drier conditions, Bayer's Chris Parsons points out that because aclonifen – which has a unique mode of action – performs differently to most other soil residual options, it could be perceived to be moisture independent.

Gaseous vapour

Also standing out from the way in which most soil residual herbicides work, is tri-allate (as in Avadex Excel and Avadex Factor).

Once applied to the soil surface, the active ingredient becomes a heavy gaseous vapour which then fills the pore spaces in the soil, rather than being released into the soil pore water itself.

This characteristic allows tri-allate to remain below the soil surface, explains Gowan's Dr Will Smith. "Furthermore, the quantity of moisture required to 'activate' tri-allate to become its gaseous state is far lower than what's required for the equivalent process in most other residual herbicides.

"Combined with its extended half-life, this means the active can remain available until weeds begin to emerge for long-lasting control," he says.

Will acknowledges that Avadex shouldn't be used in isolation, instead offering an effective base to build programmes on. "It also helps to add robustness and resilience, particularly across changeable environments."

He adds that this is important while the industry lacks one single product which can provide sufficient control. "We have to utilise the diversity available which can support performance across a range of conditions.

"This includes the soil, which can be highly variable across a field with pH, organic matter content and even soil texture all contributing factors to the interaction of, and hence performance of, residual herbicides," concludes Will.

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Bayer's Chris Parsons says because aclonifen performs differently to most other soil residual options, it could be perceived to be moisture independent.

"Rather than working within the root zone of a weed, aclonifen remains on the soil surface by clinging to the soil organic carbon. This means uptake is through weed shoots rather than roots," he explains.

However, this increases the importance of precise application. "Soil coverage has to be right – whether that's through using the correct nozzles and water volumes or only spraying in optimum environmental conditions. Cloddy seedbeds also don't suit actives like aclonifen or diflufenican.

"But with the right coverage, aclonifen creates a layer on the soil surface which the weed seed then comes into contact with as it emerges. As long as the weed germinates, the product has activity," continues Chris.

"Alconifen also has the added bonus of persistency in the autumn, meaning it captures the protracted germination of weeds such as ryegrass. For those who've opted for earlier drilling, this is an added benefit," he suggests.

With so much to consider, this all makes for a complex picture, says Stuart. "It's very difficult to attribute a single thing to why residual herbicides may or may not work in certain conditions. Furthermore, let's not forget the role of UV light break-down which again won't help certain products to perform in drier situations, which is often when there's more sunlight.

"The main rule of thumb for all soil residual chemistry, is that they prefer a level of moisture to work at their best. There's obviously a sweet spot – avoiding the deluge we had last autumn – but herbicides will be more effective when there is moisture because this is when grassweeds are actively growing.

"When weeds are growing, they're sucking up the moisture from the soil pore water, which is where the chemistry for most of the residual options should eventually be providing there's enough solubility," he explains.

Pre-em timing

According to Stuart, as well as ensuring good seedbed conditions, timing is also a critical part of the weed control puzzle. "You want to make sure you hit blackgrass in its pre-emergence phase because killing it before it gets out the ground is the best thing to do and when residual products are at their most efficacious.

"This means using a holding spray and waiting to use your best chemistry until the blackgrass emerges, could be a risky strategy, particularly if the weather turns," he stresses.

According to Chris, there could be value in devising a grassweed programme which features actives with different physicochemical properties. "Having diversity of chemistry within the programme is a good way to mitigate the risk of poor efficacy from extreme weather, whether that's within the season or across the wider cropping rotation.

"It's also important to recognise products which form the backbone of grassweed control, such as flufenacet. Although there are doubts about its future, it's still available and continues to do much of the leg work," he concludes. ■