

PERSISTENCE OF SULFONYLUREA HERBICIDES ON ALKALINE SOILS.

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Abstract

Sulfonylurea herbicides are widely used in cereal cropping in Australia. These herbicides break down slowly in alkaline soils and can cause damage to following sensitive crops. This paper summarises a major research project, which is defining the problem, understanding the behaviour of these herbicides in alkaline soils and developing management strategies to minimise the problem.

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This paper summarises the background and issues behind a major GRDC funded research project being conducted in south eastern Australia. The project is investigating the persistence of ALS inhibiting herbicides on highly alkaline and highly acidic soils. ALS inhibiting herbicides include the sulfonylurea, the sulfonanilide and the imidazolinone groups. These herbicides are widely used in broadacre cropping but break down slowly on these soils (1). There have been reports of damage in sensitive crops following their use in some paddocks on these soils. This project is to define the problem, understand the residual behaviour of these herbicides on highly alkaline and acidic soils and develop management strategies. This paper will discuss the issue of persistence of sulfonylurea herbicides on alkaline soils only.

What are sulfonylurea herbicides ?

Sulfonylurea (Su) herbicides are members of a group, which control weeds through inhibition of the acetolactase synthase enzyme (a vital enzyme in the synthesis of amino acids). They are a very important group of herbicides in Australia because of their low cost, effectiveness against a large number of weeds (mostly broad leaved plants), good crop and operator safety, and activity at low concentrations. The three most common active ingredients used in cereal cropping in Australia are chlorsulfuron, metsulfuron-methyl and triasulfuron. Each of these three ingredients is now marketed under a large number of product names.

What are the issues ?

An unusual combination of features has created a scenario in south eastern Australia where the use of su herbicides may have detrimental effects on the productivity and sustainability of farming systems in some situations. These features are;

- the cropping zone of south eastern Australia is dominated by alkaline soil types,
- su herbicides break down slowly in high pH soils,
- they are very mobile in water under high pH conditions,
- they are registered for use in cereal crops but many crops grown in rotation are very sensitive to su residues and
- they are used at very low rates of application which makes it difficult to detect residues in the field.

Alkaline soils in southern Australia

Many soil types in southern Australia are alkaline in nature with approximately 8 million hectares occurring within the cropping zone. For many of these soil types pH is neutral to alkaline at the surface and increases with depth. Some of these soils have pH levels below the surface (but within the root zone of crops and pastures) as high as 10. The behaviour of su herbicides under these extreme pH conditions was not tested during their development or registration.

Why don't they break down and why are they mobile in soils ?

There are two pathways for break down of su herbicides. Hydrolysis occurs rapidly under acidic conditions but where the pH is neutral or alkaline this reaction is extremely slow. Half lives for the su herbicides of several months are found under laboratory conditions. The other pathway for break down is microbially mediated. Under field conditions it appears that this reaction is largely restricted to the surface soil layers (where microbial populations are concentrated) so any movement of herbicide residues away from the soil surface means that they are largely "protected" from microbial break down.

Su herbicides are weak acids, which means that under neutral to alkaline conditions the molecules are negatively charged. Negatively charged species react very weakly with soil matrices and organic matter and thus move through soils freely. In addition su herbicides easily dissolve in water and our studies have shown that they move almost at the same pace as water down alkaline soil profiles.

How sensitive are rotational crops ?

Su herbicides are very effective at controlling a wide spectrum of weeds in cereal crops at low rates of application. However, many of the crops and pastures which are grown in rotation with cereals in southern Australia, are very sensitive to su residues. All legume and oilseed crops are sensitive with levels as low as 0.5 parts per billion, or less than 5% of recommended application rates for weed control, causing damage in some plants. Root growth is particularly sensitive to damage from su residues.

What are the findings so far ?

Findings from field work conducted over the last 5 years indicate that small amounts of su herbicides can move rapidly down alkaline soil profiles to levels deep in the profile (2). This movement occurs under relatively low rainfall conditions (less than 400 mm of annual rainfall) but persistence appears to be less under drought conditions. This prolonged persistence in alkaline soil profiles has resulted in damage to sensitive crop plants not covered by current plant back or usage recommendations. Root growth of sensitive plants is very sensitive to herbicide residues.

Project team

This research is currently funded by GRDC and is a collaborative effort between the Cooperative Research Centre for Soil and Land Management and Charles Sturt University and includes staff and resources from Agriculture Victoria (Horsham), the South Australian Research and Development Institute (Adelaide and Port Lincoln), CSIRO Land and Water (Adelaide) and NSW Agriculture (Wagga Wagga). Field trials have been established in SA, Vic and NSW.

References

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