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Farming without glyphosate

CATEGORY weeds | *March 31, 2020*

Model predictions suggest that farming can remain profitable without glyphosate by consistently utilizing key non-herbicidal weed management practices combined with robust pre-emergence soil residual herbicide treatments. However, maintaining low weed seed banks will be challenging.

The possibility of farming without glyphosate is an important issue facing the agri-food research and development sector. In this review, the researchers outline possible alternatives to glyphosate in Australia and perform bioeconomic model scenarios of southern Australian broadacre cropping systems without the herbicide. Western Canadian farmers may be able to learn from this modelling.

Alternatives in fallow/pre-seeding/in-crop

In Australia, the vast majority of glyphosate is used before seeding in fallow situations. It is used alone or a tank-mix with other herbicides to improve broadleaf weed control of dicotyledon weed species such as those from the *Brassicaceae* (cabbage), *Asteraceae* (daisy) and *Fabaceae* (pea) families.

Farmers typical waited for a significant rain before seeding in May and June. However, in the past decade, farmers are now typically 'dry seeding' earlier in April or early May, which can produce higher yield. This requires good pre-seed weed control.

With reduced glyphosate use, even greater reliance on pre-emergent herbicides will be required. Soil residual pre-emergent herbicides such as trifluralin, triallate, atrazine, prosulfocarb or pyroxasulfone are commonly applied just before or at seeding to control key weeds, such as annual ryegrass, wild radish and bromegrass.

A ‘double knockdown’ strategy with paraquat/diquat applied as a second knockdown herbicide is also recommended as part of a strategy to manage herbicide resistance in pre-emergent applications.

The use of post-emergent grass herbicides to replace glyphosate in pre-seed applications is unlikely to be used because of widespread herbicide resistance, especially Group 1 and 2 herbicides. Alternatively, precision tillage equipment could be used –sensors detect weeds and rapidly engage hydraulically controlled cultivator shanks/sweeps for shallow, ‘targeted tillage.’

Heavily grazing pastures to prevent weed seed set will become important. Targeted grazing with the legume *Biserrula pelecinus* could also help manage pasture weeds because the legume is unpalatable at certain growth stages and livestock preferentially graze weeds instead.

Tillage for weed control may also be required. Mouldboard ploughing about every 10 years to reset the weed seed bank to a low level may be considered, especially if combined with lime incorporation. Rod-weeding at less than 2 inches could be used to leave sufficient crop residue on the soil surface to prevent erosion while controlling weeds.

Mapping of weed patches will provide a powerful tool to target weeds with pre-seed, in-crop and post-harvest control. Weed maps would allow stacking of chemical and non-chemical control methods. For example, identified weed patches could have higher rates and/or more diverse mixtures of pre-emergent herbicides, very high crop seeding rates (even broadcast in the patches), inter-row tillage, targeted post-harvest herbicide applications, and reduced harvest height to ensure weed seed interception for harvest weed seed control (HWSC). More expensive herbicides may be justified because of the reduced area being treated.

Crop-topping – the late application of herbicides – with paraquat/diquat, especially in pulse crops, will control weed seed set from escapes, and desiccate the crop.

Harvest weed seed control is already an important weed control strategy, and will become even more important without glyphosate. But like herbicide use, HWSC can select for biotypes that avoid seed capture at harvest, and will need to be monitored for effectiveness.

Fewer weed-competitive pulse crops will be grown but with greater attention to late season weed control via weed wiping or clipping above the crop canopy. There may also be a move to wider broadleaf crop rows with inter-row tillage or shielded spraying.

Alternatives in glyphosate resistant crops

Since the release of glyphosate-resistant cotton in Australia in 2001, the crop is now used on 99% of cotton acres. However, as a result of glyphosate overreliance, glyphosate resistance has evolved in populations of annual sow thistle, flaxleaf fleabane, and awnless barnyardgrass. Without glyphosate, farmers could choose from alternative herbicide resistant varieties, such as glufosinate, dicamba and/or 2,4-D. This trend is already occurring in the United States to control glyphosate-resistant weeds.

Glyphosate-resistant canola was first released in Australia in 2008. These varieties are grown on only 18% of canola acres, mainly on fields where weed control is a challenge. Triazine-resistant canola (hybrids and open-pollinated) is grown on almost 80% of canola acres in western Australia and imidazolinone-resistant (Clearfield) varieties are grown on about 1% of acres.

Without glyphosate, farmers would likely rely upon triazine- and imidazolinone-resistant varieties. Because glyphosate-resistant canola varieties yield 18% more than triazine-resistant open pollinated canola and 10% more than triazine-resistant hybrids, farmers may also choose to grow glyphosate-resistant varieties in a conventional manner using pre-emergent trifluralin for weed control, but this depends on the yield advantage, weed spectrum present and herbicides available.

Economic impact without glyphosate

A bioeconomic simulation model (RIM, Ryegrass Integrated Management) was used to assess weed control (major weed annual ryegrass), crop productivity and profitability in southern Australia broadacre cropping scenarios with and without glyphosate.

Simulations were run for 10 years with glyphosate or without knockdown and pre-harvest glyphosate treatments in a two-year wheat-canola rotation. The average annual gross margins for the glyphosate simulation was AUD $256/ha, and the no-glyphosate simulation was higher at AUD $347/ha. The higher gross margin with no-glyphosate was mainly achieved with higher yields from earlier seeding.

However, average post-harvest weed density was greater in the no-glyphosate than control simulation (4.6 vs. 0.4 plants/m^2). The average residual seed bank density was also higher in the no-glyphosate simulation at 17.0 seeds/m^2 compared to the glyphosate simulation at 2.4 seeds/m^2.

In a diverse rotation of wheat-canola-barley-lupin, average annual gross margins for the glyphosate simulation was AUD $225 and the no-glyphosate scenario was AUD $303. However, residual weed densities and weed seed banks were also much higher without glyphosate weed control.

Back to the future

An entire generation has farmer with only glyphosate-based conservation-tillage cropping systems. The loss of glyphosate could be quickly followed by the loss of paraquat, diquat or 2,4-D. As a result, farming without these herbicides will require new strategies that will focus on ecologically-based weed management tactics, strategies and systems. This goal will require research to develop viable alternative solutions to manage weeds effectively and profitably, both in the short- and long-term. In some cases, the strategies will mean a return to farming in the days before glyphosate was introduced.

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