A new look at the economics of weed control

The cotton industry has a new decision support tool for the management of glyphosate resistant barn yard grass.

BYGUM (BarnYard Grass Understanding and Management) gives growers and consultants new ways to look at the economics of summer weed control in Australian cotton/grains systems. Developed by CRDC and David Thornby from Innokas Intellectual Services, this weed management scenario testing tool combines biological, agronomic and economic factors to examine the economics of farm managers' current summer grass management strategies, and compare them to new tactics – which could be what your neighbours are doing, what your agronomist recommends, or new ideas from elsewhere.

"BYGUM can let you test changes in crop prices, rotations, weed management costs, herbicide availability or efficacy, and more," David says.

It is free to download, use, and share, only needing a copy of Microsoft Excel, preferably on a Windows computer (BYGUM does run on many Mac systems but won't run on an iPad or android device at present). BYGUM is designed to be simple to use but with powerful possibilities for planning and learning about summer weed management.

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Weeds researcher David Thornby.

BYGUM is based on RIM (Ryegrass Integrated Management), a long-established tool for testing ryegrass management strategies in winter-cropping systems in western and southern Australia. RIM was developed by Australian Herbicide Resistance Initiative in conjunction with the University of Western Australia, with support from GRDC.

"BYGUM takes the well-tested framework of RIM and extends it to northern subtropical Australian farming systems, where summer and winter crops are both used, and fallows are an important part of the system," David says.

"Running a simulation in BYGUM is a two-step process: first, set up the parameters of the system. Second, design a rotation and specify your summer grass management practices.

"BYGUM's five-year rotation results update with every change – there is no need to 'run' the model or collect output files.

"At any time, BYGUM can give a comparison between the current setup and one other scenario, meaning users can always see how the current strategy compares to their benchmark."

The user-definable parameters for the system include:

- weed control products, prices, and efficacies including knockdowns and pre-emergents, used in different crops, in fallows, and in different phases of the crop;
- weed-free crop average yields and prices for several different crops;
- seeding rates (standard and 'high'); and
- non weed-control costs per crop per hectare.

"BYGUM isn't designed to tell you exactly how much you'll make every year," David said.

"What it does do is allow comparisons of the likely bottom line, for your given set of inputs, between different possible weed management and cropping scenarios."

BYGUM allows growers to save several scenarios and to compare two at a time, side by side. With it you can compare:

- crop yields with weed competition factored in;
- gross margins;
- weed seedbank densities and adult plant numbers; and
- the effects of different rotations and weed management strategies.

For more

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BYGUM is free to growers and consultants and is available now on the CottonInfo website at www.cottoninfo.com.au/barnyard-grass-understanding-and-management-bygum

SCENARIO #1:

Ask BYGUM: the value of glyphosate

What's the remaining value of glyphosate in rotations with glyphosate-resistant awnless barnyard grass?

BYGUM developer David Thornby has developed a series of scenarios to demonstrate this new decision support tool.

Since the first confirmation of glyphosate resistance in awnless barnyard grass, many other resistant populations have been found, and these populations don't all display the same level of resistance.

While glyphosate is no longer effective as a stand-alone control measure against any of them, some populations are less strongly resistant than others. In the case of the first-confirmed population, field rates still had around a 40 percent efficacy on small seedlings. For other more recently confirmed populations, efficacy even on small seedlings is much lower.

Given that glyphosate is going to be applied to these populations anyway, it's important not to overstate the usefulness of glyphosate by hoping to be able to rely on it for some level of control. BYGUM can test the difference for us, between populations with strong resistance and those with moderately strong resistance.

David said he used a simple irrigated rotation, with modest use of non-glyphosate options in an otherwise glyphosate dominated system. He varied the effectiveness of glyphosate from around 40 percent ('moderate' resistance) to around five percent ('strong' resistance).

Key outcomes

The results show two key things.

First, both systems are still making money after five years. High levels of crop competition keep seed production per escaping weed low, and the addition of a few effective tactics reduces the number of surviving plants to moderate/know levels of between six and 14 plants per square metre at the end of the fifth season.

Secondly, however, both systems are heading towards failure. Weed and seedbank numbers are increasing, however slowly. And while gross margins are the same at the end of season one, there is a predicted difference of around $500/ha between the gross returns in season five.

David says there are three lessons here.

"First, strong crop competitive effects might mask the seriousness of resistance issues in irrigated cotton, should they be present.

"Second, there are good reasons to determine just how strongly resistant your resistant awnless barnyard grass population is, if you're going to be sticking with a system that is predominately about the use of glyphosate.

"And third, allowing a slow decline with somewhat-inadequate weed management looks likely to have a substantial cost as the years pass by.

"We've made many assumptions in this example – in particular, that irrigated cotton is planted and provided with resources to allow for strong competitiveness against the weed.

"We've also made assumptions about crop and herbicide costs, average yields and prices.

"You could run BYGUM with a different set of assumptions that fit your experiences, and see if the results change."

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SCENARIO #2:

JEFF WERTH

LEFT: Cover crops allow growers to maintain some competition even in non-crop seasons.

Testing the value of a cover crop

In a one-in-one-out rotation of dryland cotton, summer fallows offer a chance to get on top of weed populations through vigorous use of non-crop herbicides.

However, with no crop competition present, they can also offer weed escapes an opportunity to set a lot of seed, especially when the key herbicide in both crop and fallow, glyphosate, is no longer effective.

"Cover crops allow growers to maintain some competition even in non-crop seasons," David Thornby says.

"A good stand of millet (as simulated in BYGUM), sprayed out before seed set, allows for a combination of late season herbicide use to clean up survivors and mid-season competition with glyphosate-resistant barnyard grass, reducing seed set per plant."

There is more than one way to protect future yields in a dryland rotation.

The first scenario is a basic one-in-one-out rotation. This contains the assumption that the barnyard grass population is resistant to glyphosate, and that an early season residual and mid-season inter-row cultivation are used to provide some control in crop: summer fallows use two cultivations and a double knock.

In scenario 2 David replaced the second summer fallow with a cover crop. The cover crop includes cultivation, a double knock, spray out (assuming this is with a non-glyphosate product effective on glyphosate, such as paraquat), and a late application of paraquat over the now-dead millet.

"The cover crop is more expensive than the summer fallow, and actual plant numbers per square metre are not reduced all that much (1.1 to 0.8 per square metre)," David says.

"But there is a substantial difference in seeds returned to the seed bank."

The comparison scenario shows a substantial increase in the yield from the final cotton crop, due to the strong reduction in seed bank numbers at the end of the cover crop season.

"The benefits of the cover crop come due, as expected, in the following crop, where the seed bank has been driven down and emerging weed numbers are low," David said.

"Over the course of the whole rotation, incorporating one cover crop every second summer fallow is predicted to be worth almost $200/ha in increased yield.

"There is more than one way to protect future yields in a dryland rotation, but using cover crop competition certainly seems to bear looking at.

"We've made many assumptions in this example – in particular, that planting time and summer rainfall are conducive to good cover crop growth, resulting in high competition, that the barnyard grass population is strongly resistant to glyphosate, and that the cover crop doesn't reduce moisture availability to the following cotton crop.

"We've also made assumptions about crop and herbicide costs, average yields and prices.

"Once again, users could run BYGUM with a different set of assumptions that fit their experiences, and see if the results change."

SCENARIO #3:

Residual answers to resistance

Can you control a glyphosate-resistant grass by adding a residual in irrigated cotton?

In situations where a glyphosate-resistant summer grass starts to cause yield losses in cotton, growers obviously need to add some non-glyphosate options to their system to protect yields and prevent further weed blowouts. The questions then become where to add non-glyphosate tactics, to get most benefit, and how many are needed?

David Thornby used BYGUM to investigate this question. First he compared a system with glyphosate-resistant barnyard grass where only glyphosate is used with the same system with an early-season (pre- or at-planting) residual added.

Residuals tripled gross margins

The yield results of adding a single residual are striking.

The glyphosate-only system is still producing some yields (Figure 2 – primarily due to the competitiveness of irrigated cotton), but end-of-season weed numbers are very high and the potential of the system is being seriously under-utilised.

"Adding a single residual can reduce early-season weed numbers dramatically, and because this is when most of the competition effects occur, this has a huge benefit for the bottom line," David said.

"Gross margins are almost tripled compared to glyphosate alone when the weed population is strongly glyphosate resistant.

"However, end-of-season weed numbers (and seedbank density, see bottom line Figure 1) are still unacceptably high, so a single residual doesn't appear to be enough of an addition, despite the dramatic effect.

"A single year of poor control from the residual (rather than the average of around 85 percent efficacy) would certainly result in a blowout."

Adding a mid- or late-season tactic provides some insurance against weed blowouts and seed production. Because late weed germinants in vigorous cotton stands don't produce a lot of seed per plant, the effects on yield aren't so dramatic. However reducing surviving plants and especially reducing the seed bank size are critically important insurance against future blowouts and selection of resistance for other modes of action.

David tried two different tactics in BYGUM, adding either a layby residual to each crop or a mid-season knockdown.

Adding a layby reduces the seed bank somewhat, and cuts surviving plants at end-season down to around 25 per square metre. This still appears to be too many survivors for comfort, but it does represent a substantial improvement over an early-season residual alone, and offers insurance against future blowouts.

BYGUM predicts that it can be sustained at least for the five-year rotation. This comes at a cost, however: the reductions in late-season weed numbers are offset by the price of the extra residual and BYGUM includes a penalty due to phytotoxicity.

In comparison with the layby system, a system with a mid-season knockdown, rotating between options including Group A herbicides, shielded paraquat and inter-row tillage improves the gross margin (due to a combination of taking out some weed competition and having some options with lower phytotoxicity-related yield penalties), but leaves more end-of-season survivors.

"So this is not an ideal system either – but is certainly an improvement in all ways over a single-residual system," David said.

"These analyses show that while a single early-season residual can do a lot of heavy lifting in terms of reducing weed competitiveness, it's not enough on its own for long-term sustainability.

"Late or mid-season tactics provide some insurance.

"BYGUM predicts that while good returns can be sustained at least for five years with this 'plus two' strategy, more non-glyphosate tactics would be needed to drive the seed bank to very low levels.

"We've made many assumptions in this example—in particular, that irrigated cotton is planted and provided with resources to allow for strong competitiveness against the weed, that resistance to glyphosate is quite strong, and that good efficacy is generally the case for residual applications.

"Pre-simulation weed numbers are assumed to be moderate and we've also made assumptions about crop and herbicide costs, average yields and prices."

Choose enterprise and control options:	Sum 1	Wint 1	Sum 2	Wint 2	Sum 3	Wint 3	Sum 4	Wint 4	Sum 5	Wint 5
	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow
Time of sowing	Average		Average		Average		Average		Average	
Soil preparation										
Knock-down / Double-knock	Glyphosate	Paraquat	Glyphosate	Glyphosate	Glyphosate		Glyphosate	Paraquat	Glyphosate	Tillage
Early season residual	[A residual]		[A residual]		[A residual]		[A residual]		[A residual]	
Sowing method	No-till		No-till		No-till		No-till		No-till	
Crop seeding rate	Standard		Standard		Standard		Standard		Standard	
Weed control 1	Glyphosate		Glyphosate		Glyphosate		Glyphosate	Group A	Glyphosate	Glyphosate
Weed control 2										
Weed control 3										
Layby weed control 4										
Weed control 5	Glyphosate									
Weed control 6	Glyphosate		Glyphosate		Glyphosate		Glyphosate		Glyphosate	
Harvest options - Grains										
Harvest options - Other crops	Defol Drop		Defol Drop		Defol Drop		Defol Drop		Defol Drop	
Mature BYG setting seed:	96.543		86.688		87.658		87.741		87.748	
Seeds in soil next spring (/m²):	8808		8907		8915		8916		8916	

Figure 1: Irrigated cotton rotation with an early-season residual. While using 'a residual' in the notation here, a rotation of suitable products from different modes of action should be used in the field. The glyphosate-alone system is the same as this one, without the early season residual.

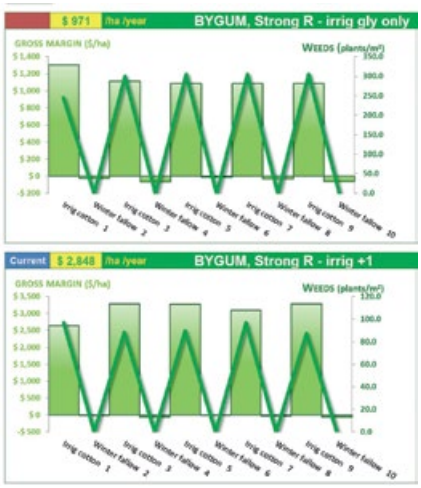

Figure 2: A comparison of gross margin and barnyard grass numbers at end-of-season between glyphosate alone (top) and glyphosate plus a single, early-season residual.