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WEED MANAGEMENT
case study

Managing herbicide resistant barnyard grass

South East Queensland farmer Engelbert Krampl first encountered glyphosate resistant barnyard grass in his cropping system in the summer of 2008-09.

Engelbert (pictured) has since developed a successful strategy for managing herbicide resistance, based on both mechanical cultivation and the strategic rotation of chemicals to destroy the weed seedbank.

2008-09: Suspected resistance

Glyphosate resistant barnyard grass emerged on Engelbert property in the summer of 2008-09.

Surviving barnyard grass plants were found in a field in the fallow phase of a non-irrigated Roundup Ready cotton rotation.

After glyphosate had been applied, survivors were found adjacent to dead awnless barnyard grass plants and other dead weed species.

The problem was largely confined to an area of approximately 300 acres of hard setting sodic soils, on a 1,300 acre farm.

“At first we didn’t realise the problem was resistance. It was a complete surprise and we were struggling to understand how these plants had survived,” said Engelbert.

Initially it was thought the problem may have been rain affecting the efficacy of the herbicide spray. Other mitigating factors such as poor chemical application, or stripping due to blocked nozzles, were also considered then ruled out, and lab tests later confirmed low level glyphosate resistance was present.

However in the early stages of growth, Engelbert found that applying Glyphosate 450 herbicide at five to six times the normal rate of 1.2 litres per hectare during the fallow period would kill the barnyard grass survivors.

“We could kill the early seedlings up to two leaves, but as the plant grew bigger they become more difficult to kill,” reported Engelbert.

Due to the low-level resistance of this population, higher rates of glyphosate could still provide control to small plants under ideal conditions, according to Jeff Werth, Senior Research Scientist in Weed Management with the Queensland Department of Agriculture and Fisheries (DAF).

“However, if plant size increased and/or conditions weren’t favourable, the highest rate of Roundup Ready® herbicide allowed in Roundup Ready Flex® cotton (1.5 kg/ha) would struggle to provide effective control,” said Jeff.

It was critical that the effectiveness of chemical applications was monitored and survivors controlled to ensure seed production was stopped.

2009-10: New patches of resistance emerge
In the following season after glyphosate resistant barnyard grass was confirmed, Dual Gold (S-metolachlor) was applied as a pre-emergent chemical on the area where the problem had emerged the previous summer.

An in-crop spray consisting of metolachlor mixed with glyphosate was also applied mid way through the season on specific patches.

"That strategy worked but barnyard grass is a prolific seeder and the seedbank still in the soil was huge," said Engelbert.

Survivors were also now found on heavier soil types on the farm. Rain delayed chemical application on these areas, so mechanical cultivation was implemented.

"Mostly we used a mix of chemical sprays and cultivation, after we had done a round of spray over the top," said Engelbert.

2010-11: Getting on top of the problem
By the 2010-11 season, herbicide resistance was suspected in approximately 600-700 acres of the property.

Diuron, a Group C chemical, was applied as a pre-emergent herbicide throughout the cropping system.

In patches where resistance occurred Verdict (haloxyfop) or Select (clethodim), both Group A herbicides, were applied midway through the cropping season.

"That was almost 100 per cent effective, so that became our preferred strategy. It not only got rid of the barnyard grass, it also stopped the emerging fleabane problem. The diuron can successfully wipe out at least 90 per cent of emerging barnyard grass, and other weeds as well," said Engelbert.

"Traditionally we hadn't used a pre-emergent herbicide. We had instead used several over the crop sprays. After initially moving to a pre-emergent on about half the cropping area to tackle resistance, we then decided to switch to using the pre-emergent strategy across the whole farm to reduce the seed bank."

In late 2010 another block of land was bought next door that had previously been cropped to sorghum using a zero till farming system. Cotton had not been grown on this country, and there had been minimal history of glyphosate use.

"But there was still a big seed bank on that block, so we found using the diuron was a good way of knocking back the weed seed bank, including fleabane," he said.

Pictured below left: Surviving glyphosate resistant 'awnless barnyard grass' plants surrounded by dead susceptible plants.

Pictured below right: Awnless barnyard grass survivors after glyphosate application.

Breaking the cycle: Residual herbicide alternatives for minimising awnless barnyard grass emergence

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The threat of glyphosate resistance has been present since glyphosate become the weed management tool of choice in crop and fallow.

The introduction of glyphosate-resistant (Roundup Ready/Flex®) cotton increased this threat by making it very easy to use glyphosate in crop. The identification of glyphosate-resistant (awnless) barnyard grass populations in glyphosate-resistant cotton rotations has made that threat real.

In response, research has focused on determining suitable residual herbicides that can be applied before glyphosate-resistant cotton is planted, in order to reduce subsequent barnyard grass emergences and thereby lessen the selection pressure on potential glyphosate resistant individuals.

Field trials carried out by DAF researchers at the 2009 site of resistant barnyard grass emergence found that 'metolachlor provided the highest level of weed control, with a total emergence of 0.27 plants per square metre (plants/m2).

This compared to the "nil" herbicide treatment that resulted in a total of 2.67 plants/m2 emerging over the duration of the trial.

Pendimethalin and fluometuron also showed some effect in minimising barnyard grass emergence in this field trial, however researchers found the results were not statistically significant.

Further research trials were conducted at a DAF research site at Dalby and in glasshouse experiments (using seed collected from the original field site of suspected resistance), and found similar results with the exception of diuron (which was found to be more effective in the research site trial).

Pendimethalin was by far the most consistent across all situations and is likely to provide control longer into the season. This characteristic should be beneficial, particularly for barnyard grass which has scattered emergences throughout the season.

Metolachlor is also very effective at reducing barnyard grass emergence. However its persistence was lower than the other herbicides, particularly in higher rainfall situations.

Overall the research found there are number of herbicides capable of reducing barnyard grass emergence that can be incorporated into a glyphosate-resistant cotton program to reduce reliance on the use of glyphosate.

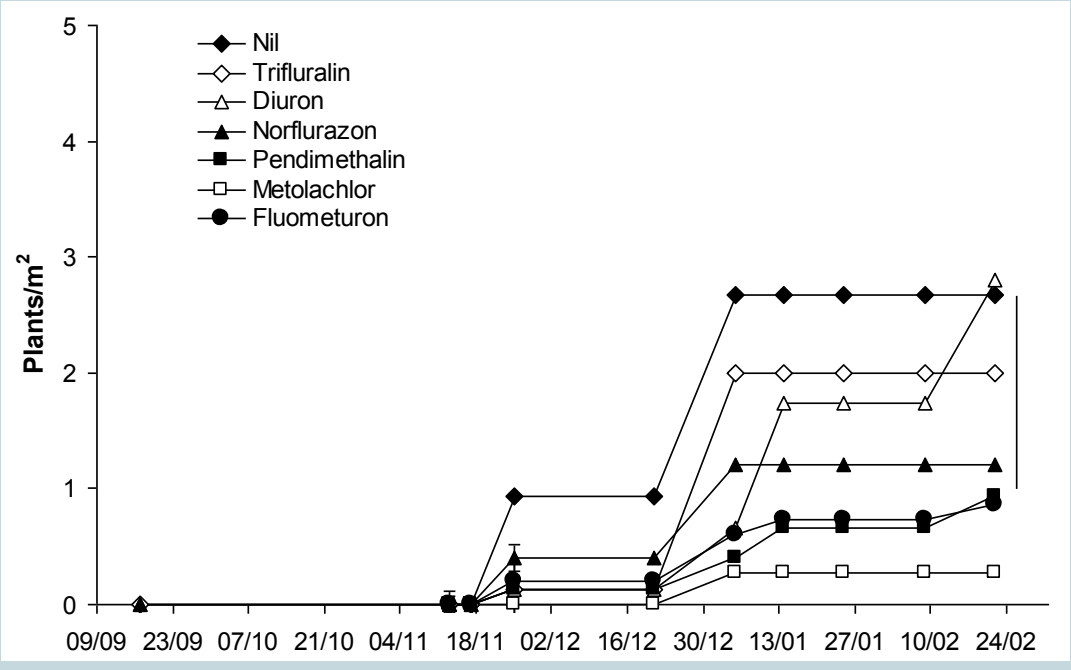

Figure 1. Effect of residual herbicides on barnyard grass emergence at the site of glyphosate resistant barnyard grass in southern Queensland in 2009. The vertical bar represents the standard error of the mean for total emergence.

2012-15: Successful control

An ongoing strategy combining mechanical cultivation and the strategic rotation of chemicals, enabled Engelbert to successfully manage the emergence of glyphosate resistant barnyard grass.

"There are significant extra costs in the farm budget but the increased yields due to a lower weed burden are certainly worth it," said Engelbert. "My current concern is not to over use the Group A herbicides, as resistance to Group A herbicides is likely to develop more quickly than other chemical groups.

"We are looking at using Stomp (pendimethalin) or Dual gold in the 2015-2016 season, and we'll have to implement an ongoing strategy of using alternative groups of herbicide."

Mechanical cultivation is also an integral aspect of the resistance management strategy. "We mechanically cultivate twice during pupae busting. Then early in spring we incorporate fertiliser and cotton stubble using off set discs.

"As a weed control measure we use inter row cultivators across the whole farm. Although in a wet season we are more likely to supplement the inter row cultivation with an inter row chemical spray. We haven't wiped out glyphosate resistant barnyard grass, but we now have it under control and it no longer causes me any headaches."

However, according to Engelbert there will be an ongoing focus on herbicide management in the farming system: "It's always on our mind, and we are always looking at new options."

For more:

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Pictured below left: Engelbert Krampl credits his son, farm manager Phillipp, with the successful implementation of weed control strategies on the family farming operation.

Pictured below right: By 2012, herbicide resistant survivors were no longer present in the fields.