CAWS Early Career Weed Scientist Travel Award

In February 2013 I attended the Global Herbicide Resistance Challenge conference in Fremantle, Western Australia. This conference was 5 years in the planning and was hosted by the Australian Herbicide Resistance Initiative. This was a highly relevant conference for me to attend because my thesis topic was about the discovery of herbicide resistance in an economically important pasture weed in New Zealand dairy pastures. My poster which I presented at the conference gave the results of my work which detailed the first example of a pasture weed (giant buttercup, *Ranunculus acris*) in the world resistant to an ALS Inhibitor herbicide. This was an important discovery because the weed is now resistant to all mode-of-action (MOA) groups that are currently available to control it and therefore it is essential to develop better alternative ways to manage the weed. The conference provided a timely opportunity to learn about ways to better manage resistant weeds in NZ, based on overseas experience.

Delegates to the conference came from 32 countries, totalling about 400 people in all, from a diverse range of backgrounds. The conference delegates included the world's leading scientists on the topic of herbicide resistance, for example Ian Heap (Convenor of the Int. Survey of Herbicide Resistant Weeds website), Stephen Powles (Scientific Chair and Convenor, AHRI), and many scientists with extensive international publications on herbicide resistance. In addition there were many delegates from chemical companies, universities and research institutes and also some farmers. A large number were young students because the conference had a clear focus on the future and the importance of fostering research into the resistance problem which will become more critical.

There were many interesting and valuable papers presented covering a wide range of topics including management of resistant weeds, new discoveries, modes of action and the biochemistry, genetic and physical attributes of resistant weeds. There were papers detailing testing for resistance using a variety of methods but the most relevant to my work were those using seed or seedling based quick tests. Important issues discussed at the conference were the rapid increase in incidence of multiple resistance coupled with the lack of new herbicide mode-of-action groups being brought onto the market means there are few herbicide options left for farmers. Another major problem discussed was the over-reliance on glyphosate in Roundup-ready crops resulting in the rapid increase in the number of glyphosate resistant weeds. Ryegrass resistant to glyphosate has recently been confirmed for the first time in New Zealand. The reason put forward for the lack of new MOA groups was because the older herbicides such as glyphosate were so successful that no research was done into new products and MOAs because it was economically unjustified. However, since resistant weeds are now becoming so widespread there is an urgent need for new chemistry to be developed and the cost of this is now possibly justified. There are currently 397 unique cases (species x site of action) of herbicide resistant weeds globally, with 217 species (129 dicots and 88 monocots). Weeds have evolved resistance to 21 of the 25 known herbicide sites of action and to 148 different herbicides. Herbicide resistant weeds have been reported in 63 crops in 61 countries.

Although most of the papers focused on weeds in cropping systems, and the main focus of our work at AgResearch is in pastoral systems, the management of resistant weeds is still applicable. Some useful points that I found most relevant for managing resistance in NZ were using integrated techniques which rely on a range of tactics, both chemical and non-chemical. This involves rotating herbicide MOA groups where possible, minimising the number of weed seeds in the soil by preventing seeding and

using techniques to destroy seeds (eg. Harrington seed destructor) and by paddock rotation. The important principle is to alternate as many different tactics as possible and not rely on one method even if it is working well. This is because the build-up of resistance is most rapid when one tactic (chemical or non-chemical) is used repeatedly. It was also pointed out that resistance will remain as long as there are resistant weed seeds in the seed bank so that tactics designed to deplete weed seeds are most useful. Many practical steps were discussed that were designed to help the early identification of resistance by monitoring for surviving weeds, and steps to ensure that survivors are destroyed early on before they seed. There was also much discussion about when herbicides are used that the rates and timing of applications are optimal to ensure a high kill of weeds.

For the future, it will be important to find out the extent of herbicide resistance in giant buttercup (and other weeds) and we plan to develop quick tests for resistance to enable this. Also, it is envisaged that we will develop alternative methods to control this weed, such as rotation of pasture with crop, biocontrol using fungi and other herbicide MOAs that have shown effectiveness but are not currently used in NZ. This management advice will be communicated to farmers to ensure that herbicides remain useful tools for as long as possible.

I wish to thank CAWS for providing the opportunity and support to enable me to attend this extremely valuable conference. I came away with a greatly expanded knowledge of the global problem of herbicide resistance and the most up-to-date knowledge of how to manage the problem from countries that have had decades of experience on larger geographic and economic scales.

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Giant buttercup (*Ranunculus acris*) can develop resistance to both phenoxy and ALS inhibitor herbicides in New Zealand dairy pastures

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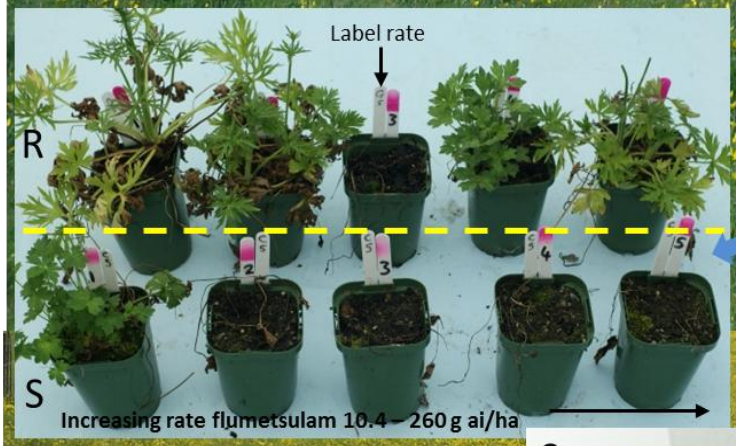
Introduction: Giant buttercup is a serious weed of dairy pastures in NZ causing substantial economic losses from reduced pasture productivity. By the 1980's it had widely evolved resistance to the phenoxy herbicides MCPA and MCPB (Bourdôt & Hurrell, 1988). Since then farmers have been using two ALS inhibiting herbicides, flumetsulam and thifensulfuron-methyl, but a farmer survey in 2009 indicated that these herbicides are becoming less effective.

Aim: Two dose-response experiments were carried out to determine if the poor performance of these ALS inhibiting herbicides was due to evolved resistance.

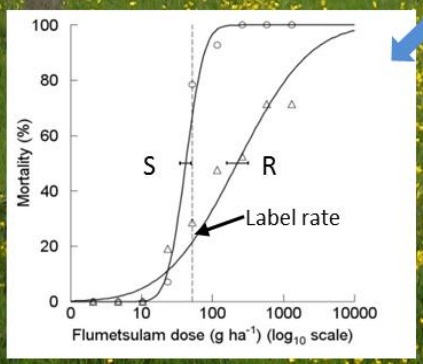


Experiment 1 Plants grown from seed collected from 15 dairy farm populations and one roadside population which differed in their historical exposure to these herbicides, were compared. These were sprayed with a $\log_{10}$ series of 5 doses of flumetsulam (plus nil) ranging from 10.4 g to 260 g ai/ha.

Results: A wide variation in LD_{50} values resulted but these could not be reliably estimated for some of the populations because the mortalities were higher than expected and the expected relationship between the LD50 and historical exposure could not be determined. The responses of the most resistant (**R**) and most susceptible (**S**) population are shown in the photo with increasing rate of flumtsulam L – R.

Experiment 2: Plants grown from the same seed as before, from the R and S populations, were sprayed with a log series of 9 doses of flumetsulam (plus nil) ranging from 2.1 g to 1300 g ai/ha.

Results: The population with highest past exposure to flumetsulam (**R**) had an LD_{50} 5.3 times that of the population with no previous exposure (**S**) and 30% of its plants survived a dose of 25 times the field rate of flumetsulam. These results support the hypothesis that resistance has evolved due to repeated exposure to flumetsulam. This is the first example of ALS-inhibitor resistance in a pasture weed.



Conclusion: These experiments confirm that giant buttercup can evolve resistance to both phenoxy and ALS inhibiting herbicides, the only two MOA groups currently available for selective control in pastures in New Zealand. This supports the implementation of herbicide resistance management strategies on dairy farms and the need to develop alternatives to synthetic herbicides for managing giant buttercup.

Reference
BOURDÔT GW & HURRELL GA (1988) Differential tolerance of MCPA among giant buttercup (*Ranunculus acris*) biotypes in Takaka, Golden Bay. In: Proceedings of the 41st New Zealand Weed and Pest Control Conference, Auckland, New Zealand, 231-234.

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