Glyphosate resistance in Wild Radish

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2014 Agribusiness Crop Updates

AHRI AUSTRALIAN HERBICIDE RESISTANCE INITIATIVE

GRDC Grains Research & Development Corporation

THE UNIVERSITY OF WESTERN AUSTRALIA

Stripe Rust

Weed Science, 52:920–928. 2004

Multiple herbicide resistance in a glyphosate-resistant rigid ryegrass (*Lolium rigidum*) population

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Surviving rigid ryegrass plants were collected from a cropping field at Pindar, Western Australia (population WALR 50), after inadequate control by glyphosate applied at the normal field rate. Plants were grown to maturity in pots and seeds were collected. Glyphosate dose–response experiments with known susceptible and resistant control populations confirmed the resistant status of the WALR 50 population. The glyphosate rate resulting in 5% mortality (LD_{50}) and GR_{50} (the glyphosate rate required to reduce mean growth of individuals to 50% of the untreated control) values for this population were 1,069 and 217 g ae ha^{-1}, respectively, corresponding to R:S ratios of 3.4 and 1.9 for mortality and growth. In addition, a novel root growth–based assay of glyphosate resistance was developed and validated, giving a root growth GR_{50} R:S ratio of 3.4. A resistance profile was established by assessing population-level survival of WALR 50 after applications at recommended rates of a range of herbicides commonly used for rigid ryegrass control in Australia. High levels of resistance to the acetolactate synthase (ALS)–inhibiting sulfonylurea herbicides chlorsulfuron and sulfometuron, moderate resistance to the acetyl coenzyme A carboxylase (ACCase)–inhibiting herbicide diclofop, and low levels of resistance to the imidazilinone herbicide imazethapyr were found. More detailed dose–response experiments confirmed resistance to chlorsulfuron, sulfometuron, and diclofop. In vitro enzyme-inhibition studies demonstrated that ALS resistance in WALR 50 is due to an insensitive target enzyme and that ACCase resistance is due to a nontarget site–based mechanism. WALR 50 is the first glyphosate-resistant weed population with confirmed resistance to ACCase- and ALS-inhibiting herbicides.

Nomenclature: Chlorsulfuron; diclofop; glyphosate; imazethapyr; sulfometuron; rigid ryegrass, *Lolium rigidum* Gaud. LOLRI.

Key words: Acetyl coenzyme A carboxylase, acetolactate synthase, multiple herbicide resistance.

Glyphosate is the world's largest selling and most important and widely used herbicide (Baylis 2000). In Australia, its predominant use is for total vegetation control before crop sowing. In recent years, glyphosate use for this purpose has increased substantially because Australian growers have adopted crop establishment systems with no or very little soil cultivation. Concomitantly, resistance to selective herbicides has rapidly proliferated, particularly in rigid ryegrass, such that in some instances glyphosate is one of the few herbicide options remaining for rigid ryegrass control (Llewellyn and Powles 2001). In North and South America, the introduction and unprecedented adoption of glyphosate-resistant crops has resulted in a massive increase in the volume of glyphosate used. Glyphosate-resistant cotton (*Gossypium hirsutum* L.) varieties are currently grown in Australia, and commercial production of glyphosate-resistant canola (*Brassica napus* L.) has been recently approved.

Rigid ryegrass is the most widespread and severe weed in Australian grain production systems (Alemseged et al. 2001) and at the same time is the world's most herbicide resistant–prone weed. In a random survey in Western Australia, 46 and 64% of rigid ryegrass populations were resistant to diclofop and chlorsulfuron, respectively, and 37% were resistant to both herbicides (Llewellyn and Powles 2001). The first confirmed cases of evolved resistance to glyphosate in the world were in rigid ryegrass from Australia (Powles et al. 1998; Pratley et al. 1999). There now exist 41 confirmed glyphosate-resistant rigid ryegrass populations from agricultural, horticultural, and viticultural situations across Australia (C. Preston, personal communication). Extensive characterization and resistance profiling of two glyphosate-resistant rigid ryegrass populations from Australia have identified population-level resistance to diclofop and susceptibility to all other herbicides commonly used for rigid ryegrass control (Powles et al. 1998; Pratley et al. 1999). Given the very widespread occurrence of rigid ryegrass populations with resistance to acetyl coenzyme A carboxylase (ACCase)– and acetolactate synthase (ALS)–inhibiting herbicides in Western Australia, and the resulting heavy reliance on glyphosate for their control, the appearance of rigid ryegrass populations with resistance to glyphosate and multiple selective herbicides seems inevitable.

Globally, glyphosate-resistant *Lolium* spp. have also been reported in Chile (Perez and Kogan 2003), South Africa, and California (Heap 2004). Glyphosate resistance has also been confirmed in populations of goosegrass [*Eleusine indica* (L.) Gaertn] from Malaysia (Lee and Ngim 2000) and more recently in a large number of populations of horseweed [*Conyza canadensis* (L.) Cronq.] in the United States (Van Gessel 2001).

The potential for evolved resistance to glyphosate in weed populations has been the subject of a good deal of debate

Some things are a call to action.....

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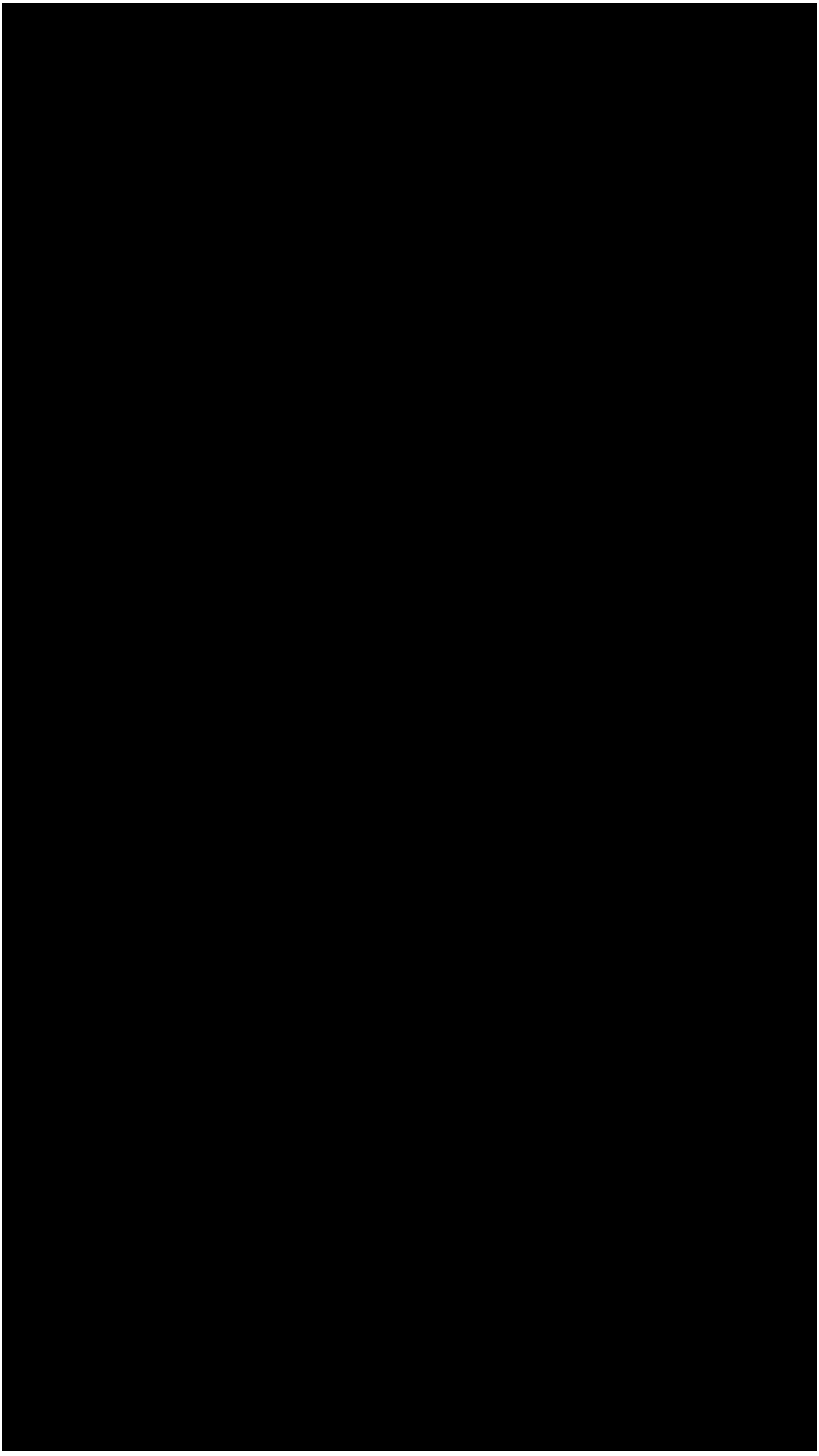


Roundup
PowerMAX
Herbicide by Monsanto

Wild Radish in Summer

More glyphosate

Glyphosate tolerant canola

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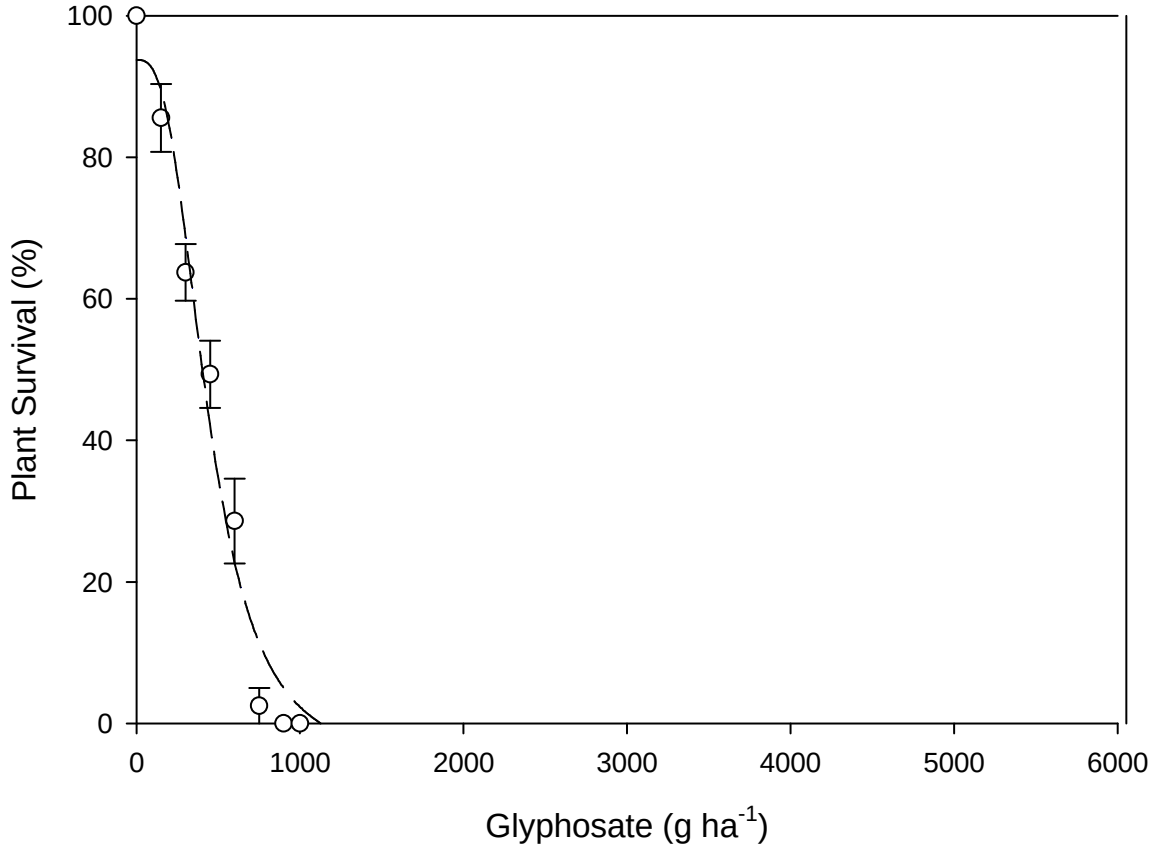
Susceptible Wild Radish.



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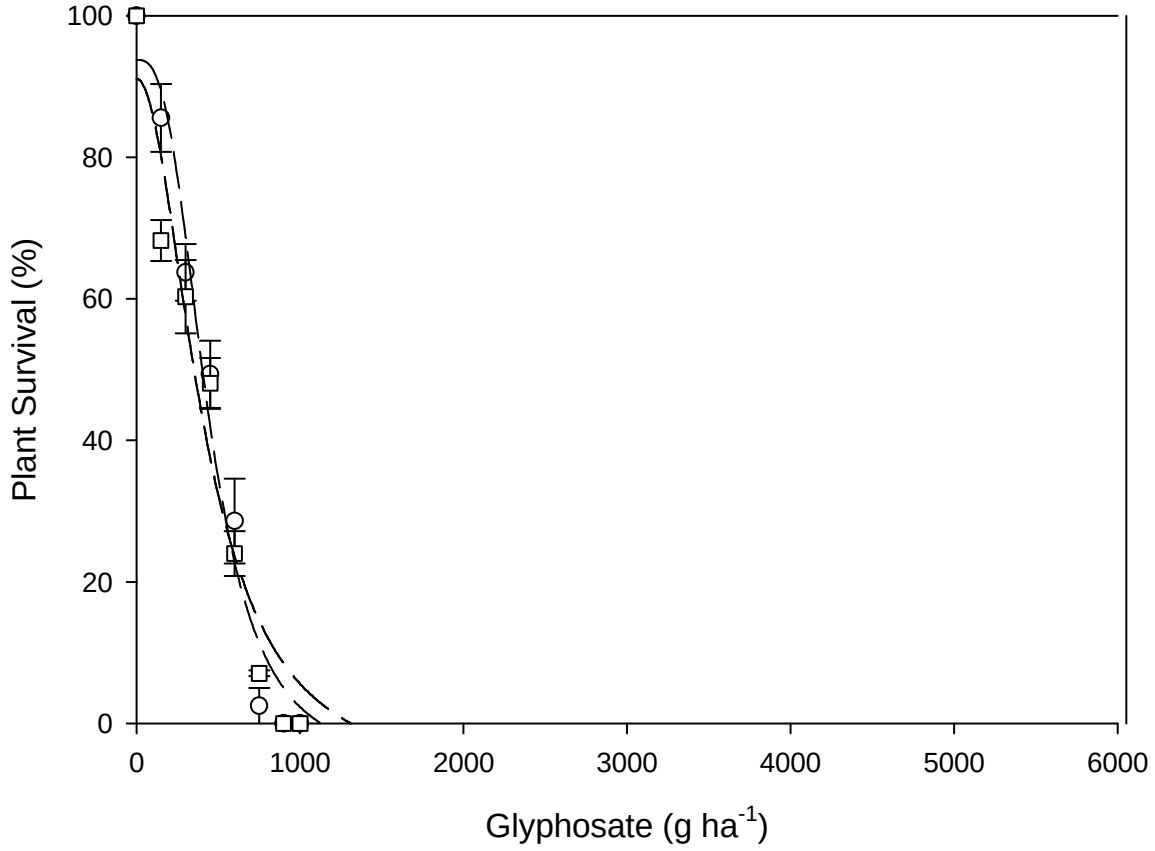
Susceptible Wild Radish.



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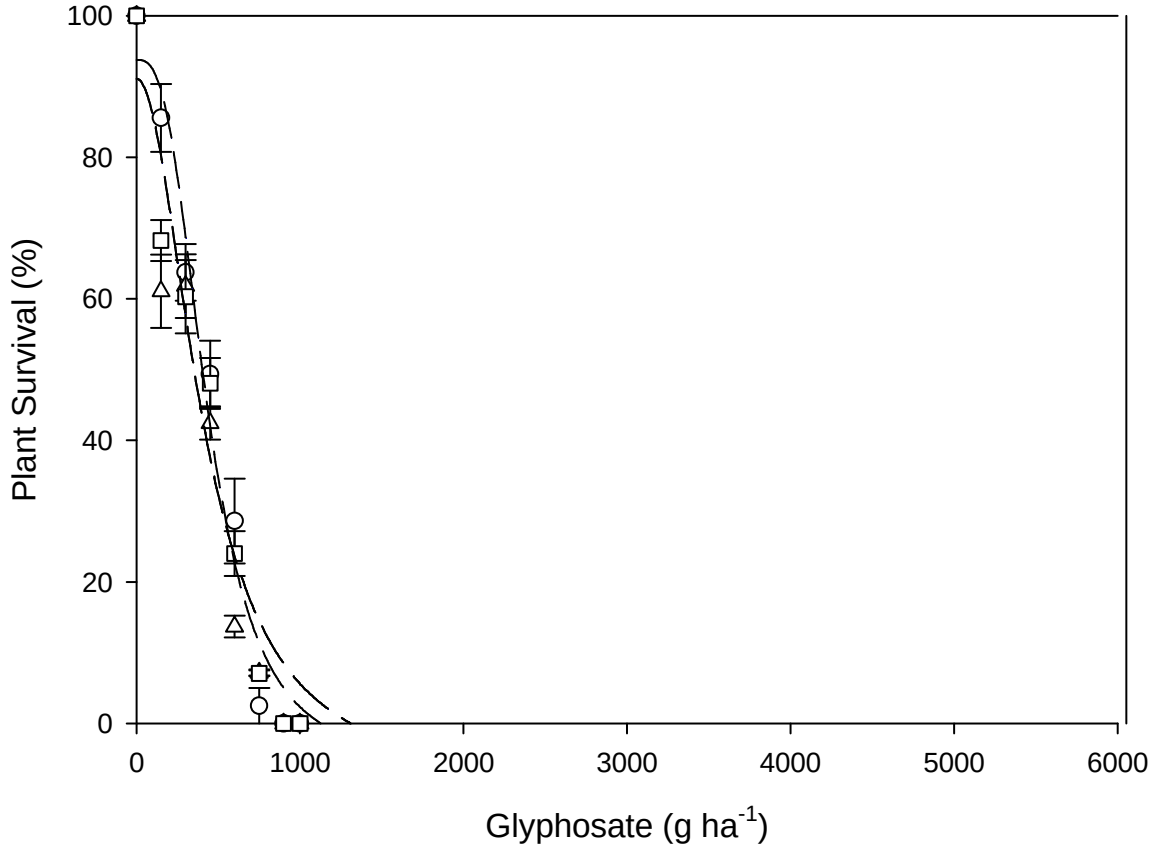
Susceptible Wild Radish.



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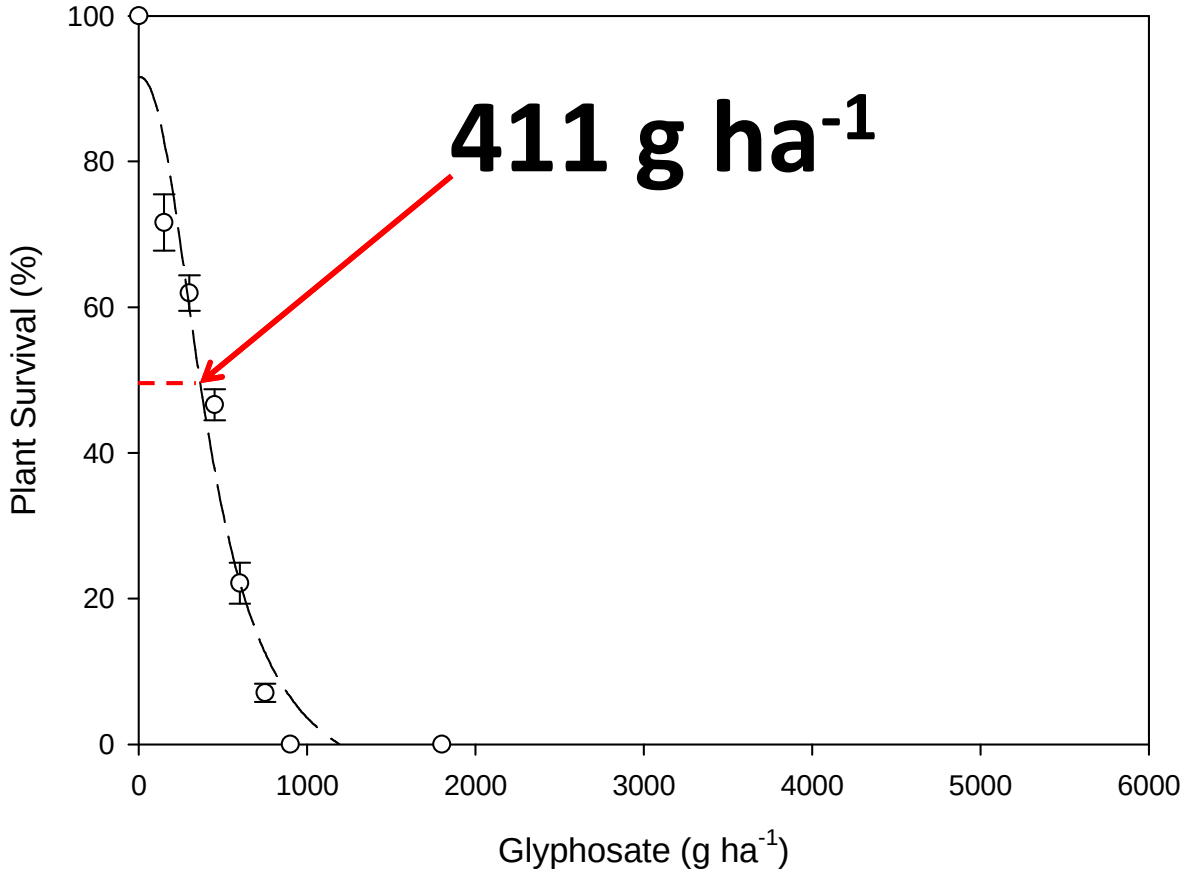
LD_{50} Rate



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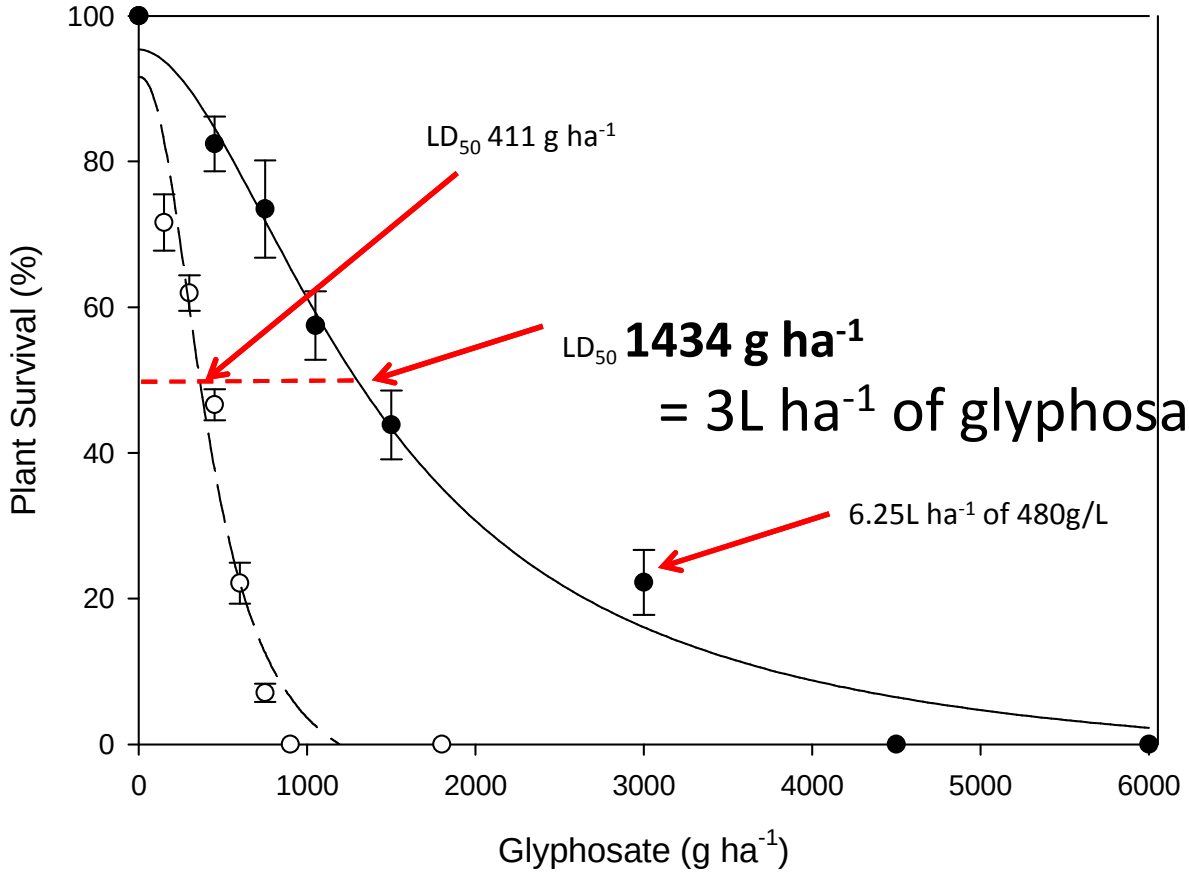
Glyphosate Resistance in Wild Radish



3.5 fold more resistant

= 3L ha^{-1} of glyphosate 480g/L

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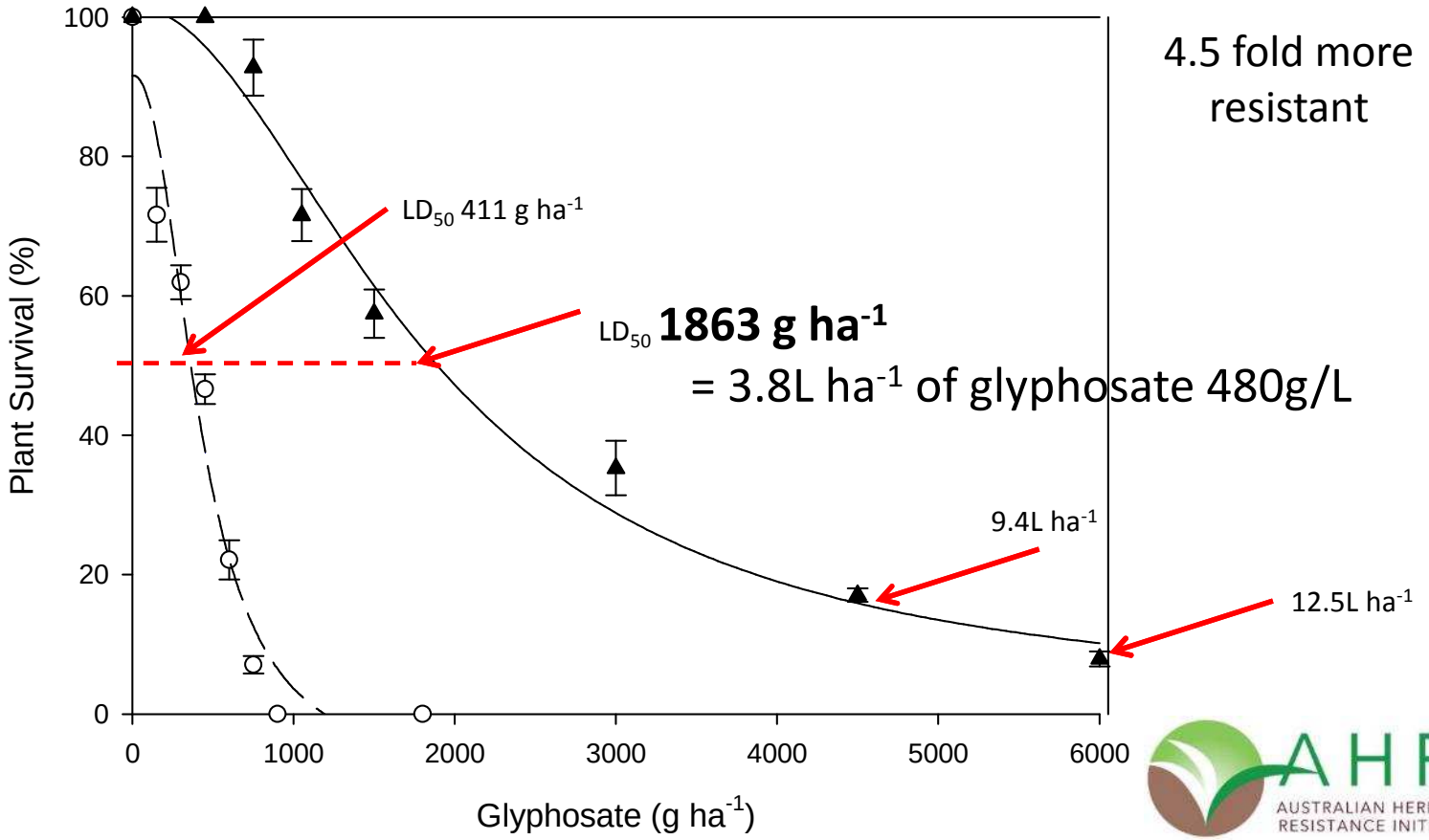
Glyphosate Resistance in Wild Radish



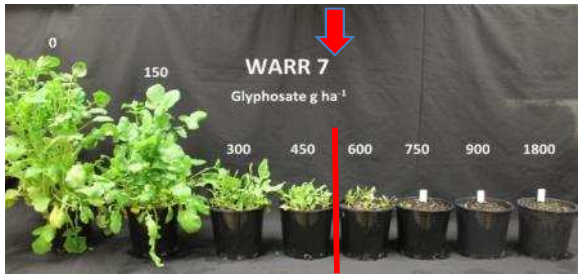
Glyphosate resistance in Wild Radish

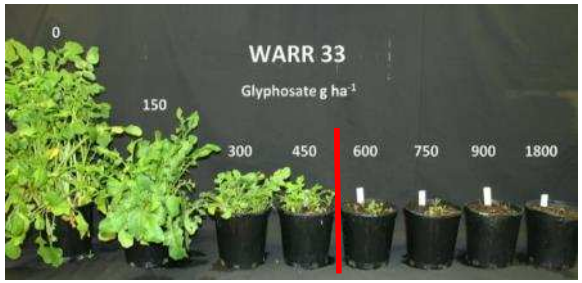
Glyphosate 450g ha^{-1}

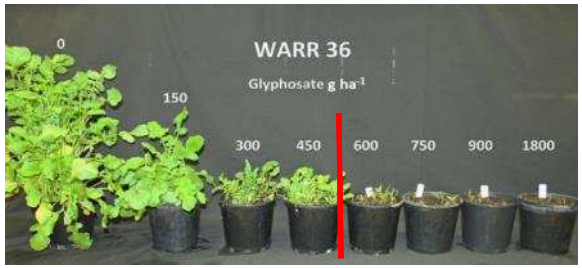
Glyphosate 750g ha^{-1}

Population dose response

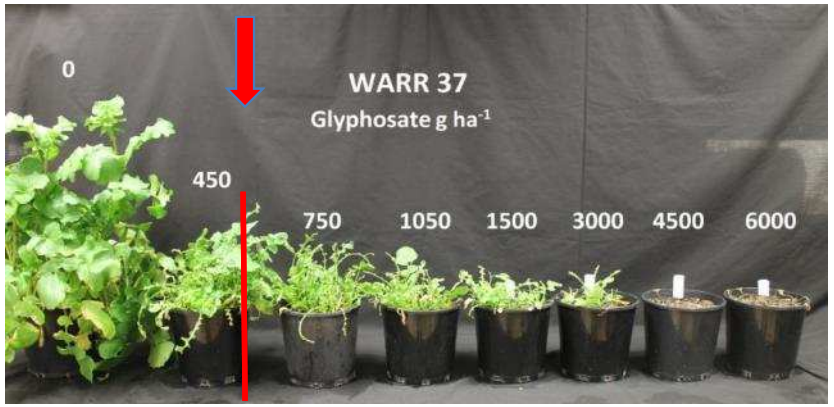
Label rate

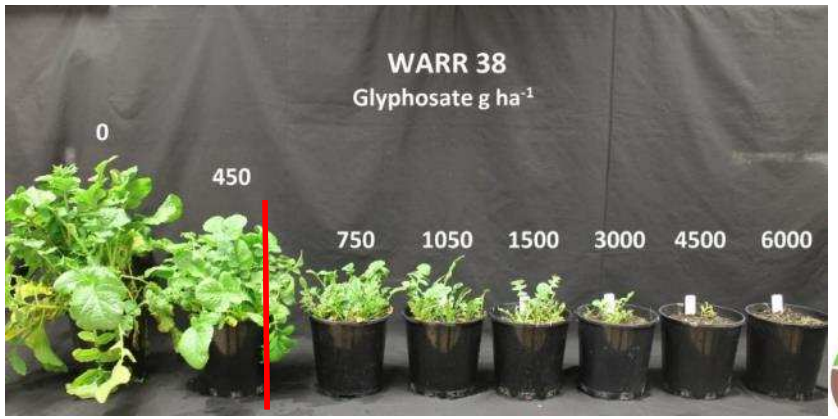






Label rate





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Multi- resistance

Resistant to:

- ALS inhibitors (SU)
- PDS inhibitors (Diflufenican)
- Synthetic auxins (Phenoxies)
- Glyphosate

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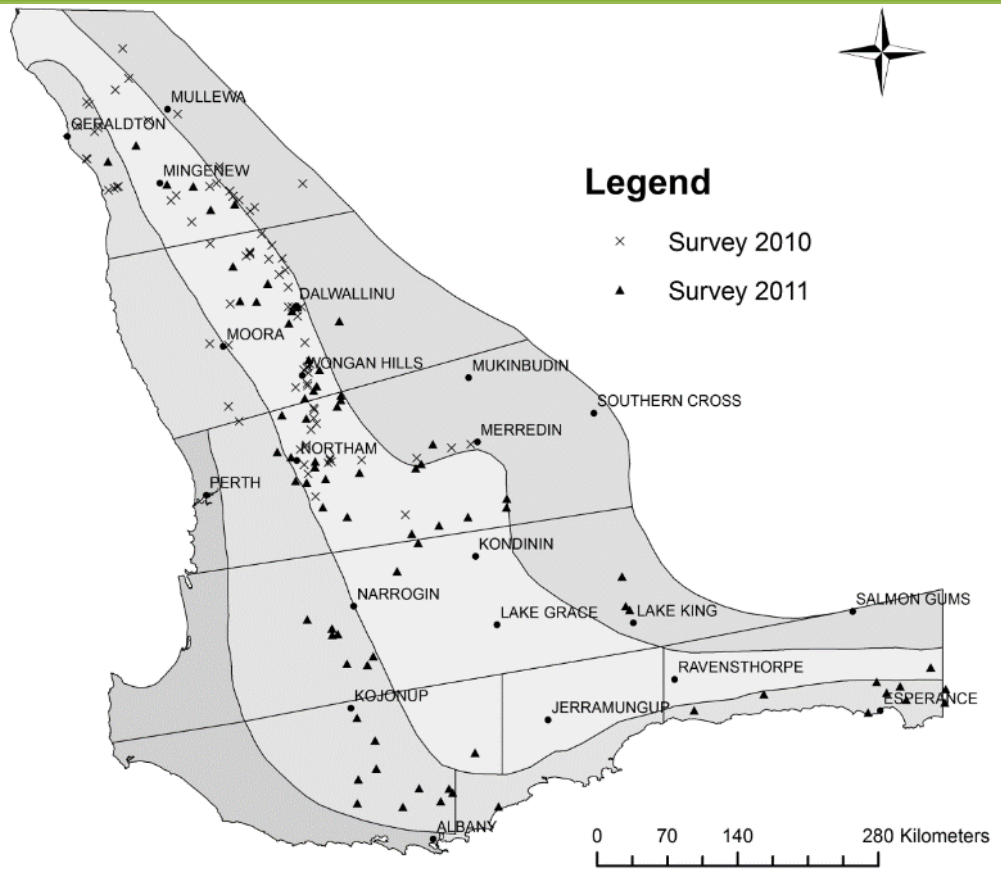
Survey



- 239 GM canola fields.
- 70 WR populations sampled.
- 1 surviving sample.
- 3 fold resistance.

"Still an extremely rare trait!!"

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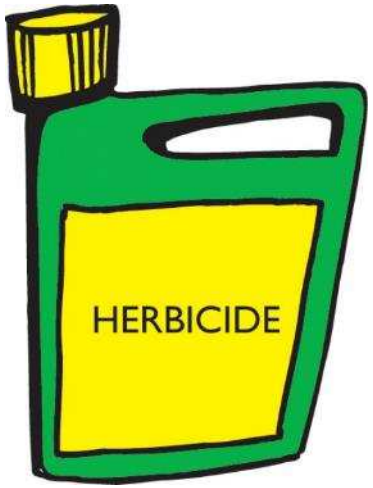
Herbicide application is a giant selection for resistance!!



Herbicide Resistance!

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Maximise crop competition!

40 kg/ha

160 kg/ha

Peter Newman, GRDC funded DAFWA research 2012

The Achilles heal

Wild Radish retains its seed at harvest.

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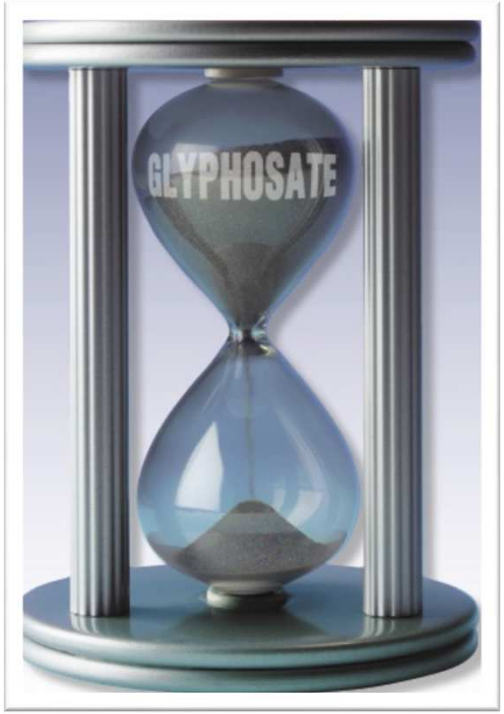
Action



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AHRI*insight* #10

AHRI Mythbusters - can 2,4-D induce resistance in ryegrass?

What if you accidently sprayed the wrong herbicide? Agronomists of yester-year developed a handy trick. They found that if they accidently sprayed an oat crop with Hoegrass® (diclofop-methyl), they could stop crop damage in its tracks if they quickly applied 2,4-D. The grand question is...does it actually work? The 'myth' says yes. What does the science say?

The AHRI Mythbusters team got the answer!

In this latest AHRI research, Dr Heping Han and others found that when they pre-treated ryegrass with 2,4-D amine it became resistant to Hoegrass®. This is likely due to 2,4-D causing a spike in P450 activity

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