Herbicide Resistant Wild Radish: Take Back Control

Herbicide resistance in wild radish is developing fast!

Effective management to control wild radish populations is imperative to protect your productivity; prevent herbicide resistance and avoid its spread.

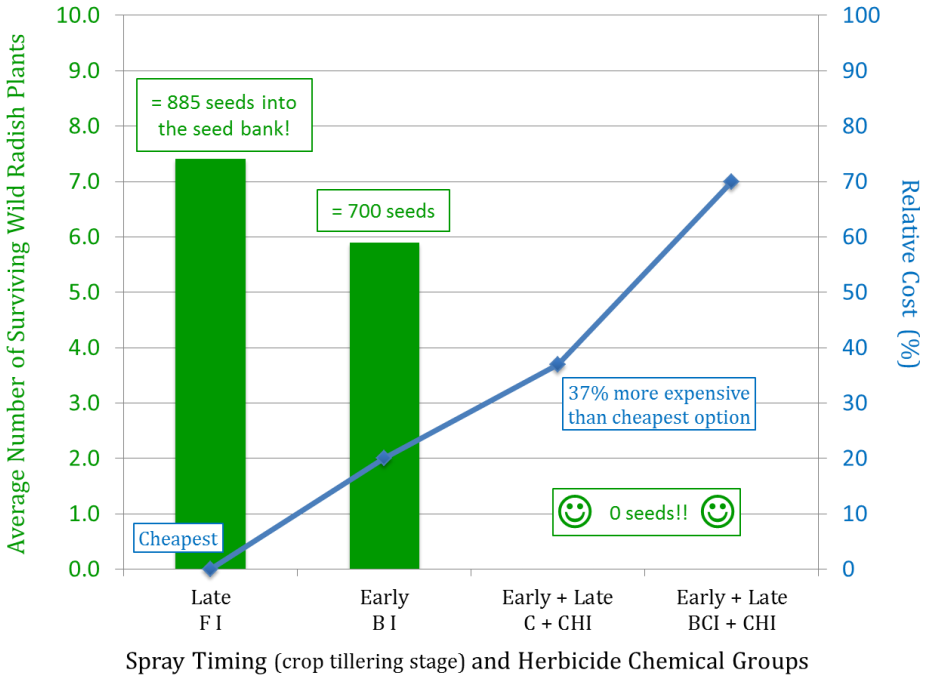
Key Message

- Implement an effectively timed 2-spray herbicide strategy
- Wild radish size when treated greatly affects herbicide efficacy; always spray small plants
- Using multiple mode-of-action chemical groups will delay onset of herbicide resistances
- Prevent wild radish seed set. Deplete soil seed banks to wipe out herbicide resistant populations and impede the development of resistance

What is the best strategy to control wild radish in a cereal dominated crop rotation?

This question was the focus for 2014 research field trials at Pira, Victoria (northern Mallee) on herbicide resistant wild radish. The trial paddock contained populations with confirmed Group B resistance and tolerance to Groups F and I mode-of-action (MOA) herbicides.

2 herbicide applications was most effective: Spray at early and mid-late tillering crop stages.



Several herbicides and application timings were assessed for efficacy against wild radish. The ultimate outcome of zero seed set was achieved from dual herbicide applications made at different cereal crop stages. Details of herbicides and application timings: (note how multiple MOA were always included!)

Spray Timing	Herbicide:Rate (mL/ha)	MOA Groups
Mid-late tillering (standard)	Tigrex®:750	F I
Early tillering	Midas®:900	B I
Early & mid-late tillering	Jaguar®:500 & Precept®:1000 + Lexone®:100g/ha	C H I
Early & mid-late tillering	Midas®:900, Jaguar®:500 & Precept®:1000 + Lexone®:100	B C H I

An effectively timed 2-spray strategy was necessary to achieve complete control.

A 2-spray strategy may be more expensive now but stopping seed production avoids expensive future management tactics that must continue for several years.

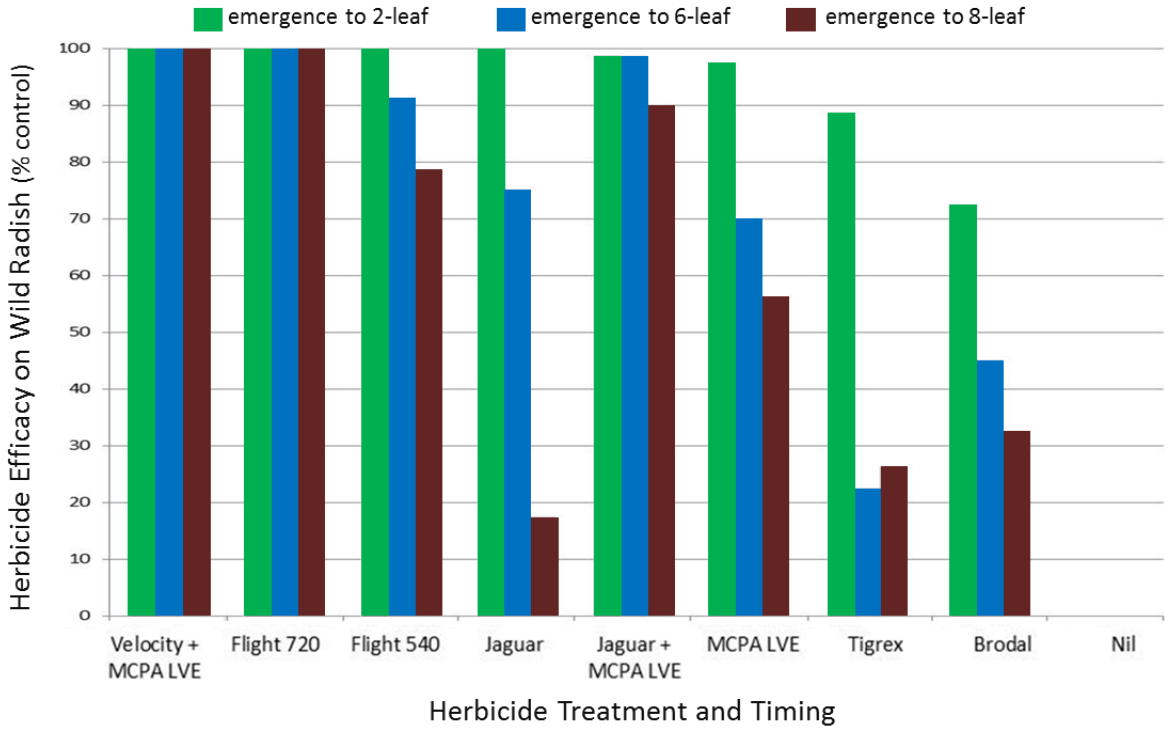
Kill all germinating wild radish to shorten your weed battle and avoid resistance

A double knock pre-sowing then an early in-crop spray of Jaguar®(+/- Midas®) followed by a later application of Precept® + Lexone® (Metribuzin) mix, achieved 100% prevention of seed set.

- Early in-crop application of Jaguar® achieved 90% control of the wild radish population.
  - Jaguar® is especially effective against smaller plants because it's a contact herbicide.
  - Don't ignore survivors as they will add to seed banks: more radish to battle for another year!
- A follow-up spray with Precept® + Lexone® at the mid-late tillering stage killed all plants that survived the 1st spray pass as well as those that germinated after the first spray.
  - Lexone® provides residual action to stop later germinations: very helpful in a wet spring
- 1 application alone of Midas® (early) or Tigrex® (mid-late) gave unacceptable levels of control, killing 93.7% and 89.4% of the existent wild radish.
  - 6 plants/m^2 surviving by the time of crop maturity equals 700 fresh seeds into the seed bank!
  - Later application of Tigrex® targeted more wild radish plants (more germinations), BUT without an early spray some had grown too large for the herbicide to work effectively.
  - Surviving plants often displayed stunted growth but set viable seed. Such situations may be contributing to group F and I tolerant populations.

Does the timing of herbicide application improve wild radish control?

A field trial in 2013 examined the effectiveness of 12 different herbicide treatments at 3 different application timings. The extent of control was examined on dense populations of wild radish growing in a cereal crop in sandy loam soils at Corack, Victoria. Some results are compared in the graph below and highlight the impact of herbicide application timings. Treatment effectiveness was assessed 28 days after herbicide application. Wild radish sizes when sprayed are colour coded, with 'emergence to 6-leaf' and 'emergence to 8-leaf' being 19 and 47 days older, than the 'emergence to 2-leaf' stage.



Wild radish size when treated matters: herbicides are most effective on young plants.

- Velocity® was the fastest acting product with excellent control of wild radish
- Flight® EC at 720mL/ha gave excellent control but 520ml/ha was inadequate against larger plants
- Herbicide efficacies were reduced when spraying later; most are ineffective against larger plants
- Where Group B resistance is present: Velocity® and Flight® EC 720 are good choices, especially as they are effective products on wild radish plants as large as 8 leaves in size

Herbicides containing multiple modes of action, sprayed at robust rates, are most effective.

Velocity® is a contact product so very good coverage is required to achieve effective weed control. Therefore high water rates are needed with application onto actively growing weeds. If lower water rates are necessary adding MCPA may help offset coverage problems. MCPA mixed with Velocity® provides a systemic effect and an additional MOA, although little residual activity. Like Velocity®, addition of MCPA to Jaguar® improved control of wild radish over 6-leaves in size. However, on its own MCPA was very slow acting and relatively ineffective.

Flight® EC has 3 MOA (C, F & I), which helps combat stacked resistance - when a weed population develops resistance to multiple herbicide MOA. However, be aware that if your paddock has Groups F and I resistance, using Flight® EC will put pressure on the bromoxynil (Group C) component.

Bromoxynil is useful in mixes to control wild radish: use wisely to preserve this chemistry.

Brodal® (diflufenican) only gave reasonable control if radish plants were very small. Those larger than 2 leaves can survive. Jaguar® contains bromoxynil as well as diflufenican but is still most effective for small wild radish plants.

Multiple wild radish germinations occurred in 2013 due to frequent rainfall events. This highlighted the benefit of treatments that provide residual control for later germinating wild radish; those in MOA Groups B, F and C. As always, keep in mind that overuse can speed resistance development and limit future use of residual herbicides.

Targeting Group B resistant wild radish: herbicide efficacy demonstration

Examined alongside the Pira field trial was the effectiveness of several new and existing herbicides on Group B (sulfonylurea) resistant wild radish, in a Clearfield wheat dominated system. Herbicides with bromoxynill (Group C) and pyrasulfotole (Group H) performed best. Currently, the only herbicide options available past early tillering until booting are 2,4-D Amine, Logran® and other Group B's that are being lost to resistance. This highlights the need to preserve Group B chemistry!

Are peas a viable break-crop?

A pea rotation was included in the 2014 field trial to answer this question because a pulse rotation can provide a break on grass weeds. It was clear that peas are far less competitive with wild radish compared to wheat, making complete control essential if you growing peas! Poor management will greatly increase seed banks, as evident by the amount of seed that surviving plants produced.

	Wheat Plot	Pea Plot
No. of wild radish seed pods produced (on average)	22	850

Adopt a 'no wild radish survivors' attitude to keep future crop rotation options viable and to help delay the development of herbicide resistance.

Take advantage of opportunities to reduce weed seed banks

The Pira trial experienced summer rain that germinated approximately 30% of the wild radish seed bank - an excellent chance to easily decrease the seed bank before the growing season began. Whilst this doesn't happen every year, seize such opportunities if they arise!

Summary of research findings

- Timing of herbicide application matters
- Most herbicides are much less effective on larger wild radish plants.
- Robust herbicide rates are required to control wild radish larger than 2-leaves in size.
- Wheat is far more competitive - wild radish plants produced many more seeds in pea crops.
- Herbicide mixes containing multiple mode-of-action groups improve control of wild radish.

Research Trials were conducted by Cameron Taylor and Simon Craig from Birchip Cropping Group.

Management strategies and considerations

The current situation demands use of herbicides encompassing several different MOA groups, to act as 'backup' if resistance to one or more is present in targeted wild radish populations. There's also a clear need to use herbicides with alternative MOA or use them differently, to delay the onset of resistance.

Trial results indicate a 2-spray strategy using less expensive chemistries may be as effective as, and probably more sustainable than, a single late spray with a more expensive product.

A 2-spray approach means small wild radish plants are targeted; initially and again for later germinating plants. If a grower waits until 'all' radish plants have emerged so as to spray just once, then many of the plants are likely to be too large for the herbicide(s) to work effectively! The efficacy of chosen herbicides at different growth stages, residual effects and their costs must be considered.

Key Strategies

- Use a 2-spray strategy to target small wild radish and avoid battling large plants.
- Include multiple MOA and contact herbicides. Provided they are effective, their use should also help delay the onset of herbicide resistance.
- Grow competitive crops in paddocks with herbicide resistant wild radish populations.
- Manage escapes to prevent spread of resistant populations and delay the onset of resistance.
- Aim for complete control of wild radish each year to prevent adding to the seed bank.
- Identify the herbicide groups previously applied in the paddock and rotate chemistries wisely.
- Keeping accurate records will help you greatly in the future.

Cautions

If Group I use is to continue into the future, these chemicals need to be protected by being used alongside those with a different MOA, to ensure 100% control of the weeds. Using products such as Flight® and Velocity® will take the pressure off Group I (and B) applications later in the season.

To improve Velocity®and bromoxynil efficacy, spray during the day when crop shading is less of an issue and use a high water rate. These products are very sensitive to such conditions.

If products like Flight® or Paragon Xtra® become more commonly used in a wheat phase of cropping, resistance to diflufenican (Group F) could occur, making wild radish more difficult to control in pulses.

Metribuzin (e.g. Lexone®) is registered for use with barley. Carefully consider its suitability for your soil type. When using metrbuzin do not use oil; ammonium sulfate is the safest substitute.

Do not rest easy after a successful year or two!

Remember, wild radish seeds will continue to germinate for around 6 years. This means that gaining control in a year (zero radish survivors) does not mean you have defeated your wild radish invasion.

Rotating herbicide groups every year may not be the best strategy to control wild radish. You could be spraying the same herbicide on the same plant generation as 2 years ago. Instead, herbicide treatments encompassing multiple MOA in a single season are likely to be more beneficial.

The nature of wild radish - why it's tough to defeat

Wild radish (*Raphanus raphanistrum*) is very competitive. When present in high numbers it can greatly affect crop yields: 40% yield losses have been recorded for wheat (Walsh *et al* 2007).

- Grows quickly
- 5000 hard seeds can be produced per plant
- Viable seeds can remain in topsoil for 6 years
- Germinates all year round if moisture is available
- Typically emerges in more than one flush

Growers often delay herbicide application to maximise the number of wild radish plants sprayed at one time. However, this approach results in many large plants that are rarely controlled effectively by typical herbicide treatments currently employed. Instead, spray twice at different times.

Wild radish resistance problems and causes

Resistance to multiple herbicide Groups is developing quickly in wild radish populations. They have exploded in Western Australia and there is now widespread resistance to Group B, C, F and I herbicides (Walsh et al. 2007). Research field trials in the Victorian Mallee continue to highlight that resistance to Groups B (lots), I (increasing), C and F is continuing to develop across north western Victoria.

In the past, Group B herbicides and consistent use of MCPA ester and amine formulations (Group I) products have provided an effective and relatively cheap means of controlling wild radish. However, overuse of these herbicides is increasing selection pressure on wild radish for resistance. Continued reliance will undoubtedly lead to more resistances, limiting herbicide options in the near future.

As grass weeds are usually the main problem most rotation options are chosen to control these, not because they offer good alternatives for wild radish control. Rotations allowing better management of broadleaf weeds may be required to slow the development of further herbicide resistance.

Herbicide Mode of Action Groups

2,4-D Amine: I	Avadex Xtra®: J	Brodal: F	bromoxynil: C	Flight EC: C, F, I	Glyphosate: M
Hammer®: G	Jaguar®: C	Logran®: B	MCPA LVE: I	Metribuzin: C	Midas®: B, I
Paragon Xtra®: C, F, I	Precept®: H, I	Pyrasulfotole: H	Tigrex®: F, I	TriflurX®: D	Velocity®: H, C

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Further Information: www.grdc.com.au/GRDC-FS-WildRadishManagement

Walsh, M.J., Owen, M.J. and Powles, S.B. (2007) Frequency and distribution of herbicide resistance in *Raphanus raphanistrum* populations randomly collected across the Western Australian wheatbelt. Weed Research, 47 (6), 542-550.

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