Controlling herbicide resistant Wild Radish in wheat in the Northern Agricultural Region of WA with a two spray strategy

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Introduction

Wild radish is widely regarded as one of the most difficult weeds to control in the cropping dominant systems of the Northern Agricultural Region of Western Australia.

Growers in the Northern Agricultural Region (NAR) are faced with significantly higher radish control costs due to herbicide resistance issues with many of our major herbicide groups. Herbicide modes of action in groups B, C, F and I are struggling on many radish populations and growers are now increasingly turning to pyrosulfatole (group H) found in products like Precept and Velocity to control these hard to kill populations. This has meant some growers are using two shots of this active in the one season in some paddocks, and if they are in a wheat/wheat rotation then pyrosulfatole could also be used in the following season meaning as much as 4 applications in 2 years. There is no doubt this increased selection pressure will lead to resistance issues occurring much earlier than perhaps they would have otherwise.

There is some anecdotal evidence suggesting that older chemistry such as 2,4D if used at the right timing and sequence may provide adequate radish control if used in sequence with our new chemistry.

Anecdotal evidence suggests that high rates of 2,4 D are still very effective on small seedling wild radish and can give excellent control of late germinating radish.
Do other lesser used actives such as pyraflufen (eg Ecopar), diuron, metribuzin and linuron used in conjunction with main line products like Velocity, Precept, 2,4 D amine or Ester, MCPA and Tigrex improve weed control when used as mixing partners?

Objectives

1) To assess how effective a two spray strategy in wheat is on hard to kill wild radish populations (i.e. group I resistant).
2) Within a 2 spray strategy can we avoid using more than 1 application of pyrosulfatole and still achieve high levels of wild radish control with a 2 spray strategy on highly resistant wild radish populations?

Methodology

Four experiments were conducted in 2012.

1) Trial 1 at Chapman Valley. Multiple weed counts after spray applications. Trial taken through to yield. 2 times of spraying. 2-3 leaf stage of wheat crop and 3 weeks later. 4 early treatments. 16 later treatments (see Table 1 for details). 3 replicates.
2) Trial 2 at Naraling. Two times of spraying. 2-3 leaf of wheat crop and 3 weeks later. Ten early treatments. 10 later treatments. (see Table 2 for details). 2 replicates. Percentage visual ratings were made to determine herbicide combination efficacy.
3) Trial 3 at Yuna. Same trial design as Trial 2.
4) Trial 4 at Tenindewa. Only 1 time of spaying. 10 spray treatments which were the same as the first 10 spray treatments shown in table 2. 3 replicates. Percentage visual ratings were made to determine single spray herbicide efficacy.

First spray application was applied with a 76 litres/ha water volume at 12 kph using XR11002DG nozzels. Second spray was made with a 100 litre/ha water volume at 6 kph.

Table 1: Herbicide treatments used in Trial 1.

	1st spray	timing 2-3 L		2nd spray	timing 3 weeks after 1st spray
1	nil		1	nil	
2	Tigrex	750 ml/ha	2	Amicide 625	1.15 l/ha
3	Flight	720 ml/ha	3	Amicide 625 + diuron	1.15 l/ha + 220 g/ha
4	Velocity	500 ml/ha	4	Amicide 625 + Ecopar	1.15 l/ha + 400 ml/ha
			5	Amicide 625 + diuron + Ecopar	1.15 l/ha + 220 g/ha + 200 ml/ha
			6	Amicide 625+ linuron	1.15 l/ha + 850 ml/ha
			7	Precept 150	2 l/ha + 0.5% Uptake
			9	Precept 150 + Ecopar	2 l/ha + 200 ml/ha + 0.2% wetter
			10	Velocity + Tigrex	670 ml/ha + 500 ml/ha + 0.5% Uptake
			11	Ester 80%	500 ml/ha
			12	LV680%	800 ml/ha
			13	Velocity	1 l/ha + 0.5% Uptake
			14	Ester 80% + BromMA	500 ml/ha + 1 l/ha
			15	BromMA	2 l/ha
			16	BromMA + diuron	2 l/ha + 165 g/ha
			17	BromMA + Precept 150	1 l/ha + 0.5% Uptake

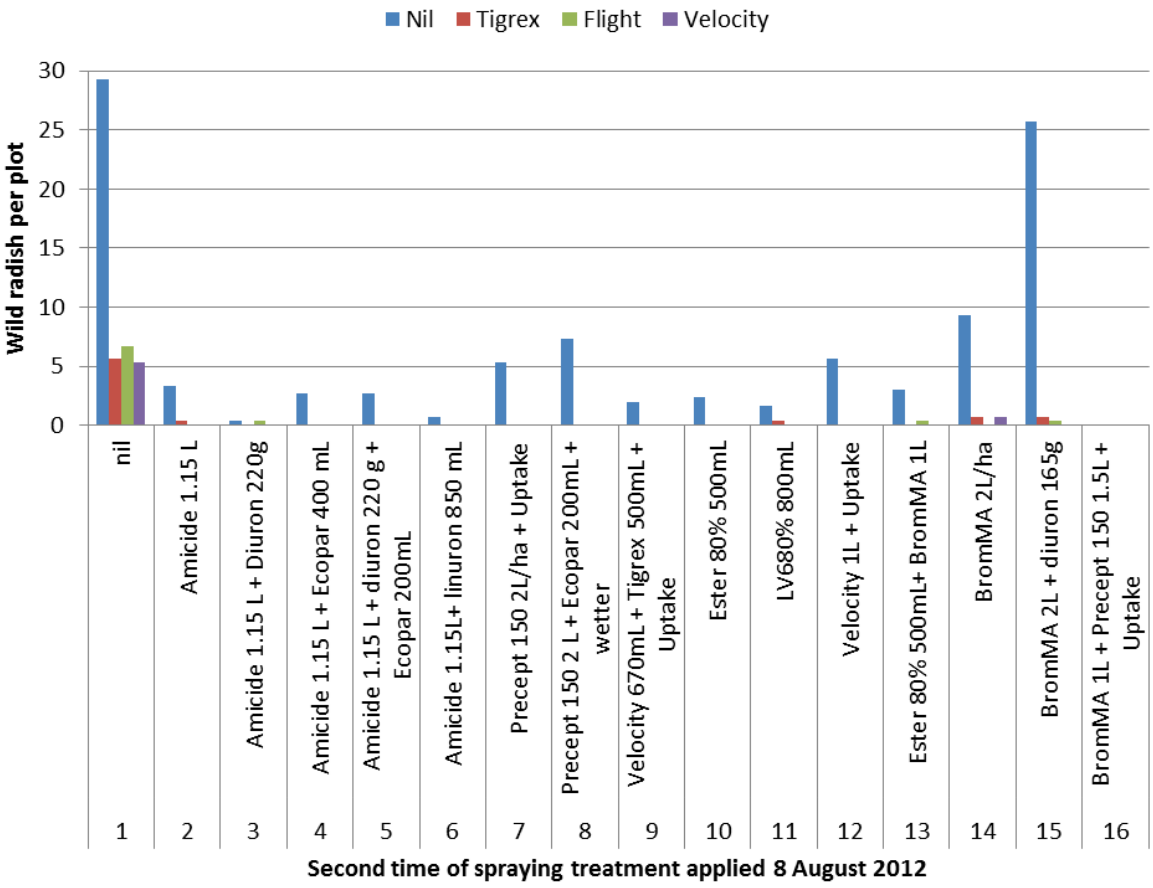
Table 2: Herbicide treatments used in Trials 2, 3 and 4 (note only 1st herbicide spray treatments used in Trial 4).

	1st spray	timing 2-3 L		2nd spray	timing 3 weeks after 1st spray
1	nil		1	nil	
2	Velocity	670 ml/ha + 0.5% Uptake	2	Amicide Advance 700	1.15 l/ha
3	Velocity + diuron	500 ml/ha + 220 g/ha + 0.5% Uptake	3	Amicide Advance + diuron	1.15 l/ha + 220 g/ha
4	Velocity + metribuzin	500 ml/ha + 100 g/ha + 0.5% Uptake	4	Amicide Advance + Ecopar	1.15 l/ha + 400 ml/ha
5	Velocity + Ecopar	500 ml/ha + 200 ml/ha + 0.2% wetter	5	Amicide Advance + diuron + Ecopar	1.15 l/ha + 220 g/ha + 200 ml/ha
6	Flight	720 ml/ha	6	2,4-D Ester 80	500 ml/ha or 1 l/ha
8	Ecopar + MCPA amine + diuron	400 ml/ha + 500 ml/ha + 220 g/ha	8	Precept 150	2.0 l/ha + 0.5% Uptake
7	Tigrex + Ecopar	750 ml/ha + 200 ml/ha	7	Precept 150 + Ecopar	1.0 l/ha + 200 ml/ha + 0.2% wetter
9	Tigrex + diuron	750 ml/ha + 220 g/ha	9	Tigrex + Ecopar	1.0 l/ha + 200 ml/ha
10	Tigrex + linuron (500 gai/kg)	750 ml/ha + 500 g/ha	10	Velocity + Tigrex	500 ml/ha + 500 ml/ha + 0.2% wetter

Results

Trial 1: Located in Chapman Valley on a yellow loamy sand. Stubble had been burnt and Mace wheat sown at 80 kg/ha. Trial sown into wet soil in mid June after a knockdown herbicide had been applied.

Figure 1: Surviving radish plants/plot rated 16 October 2012 at Trial 1.

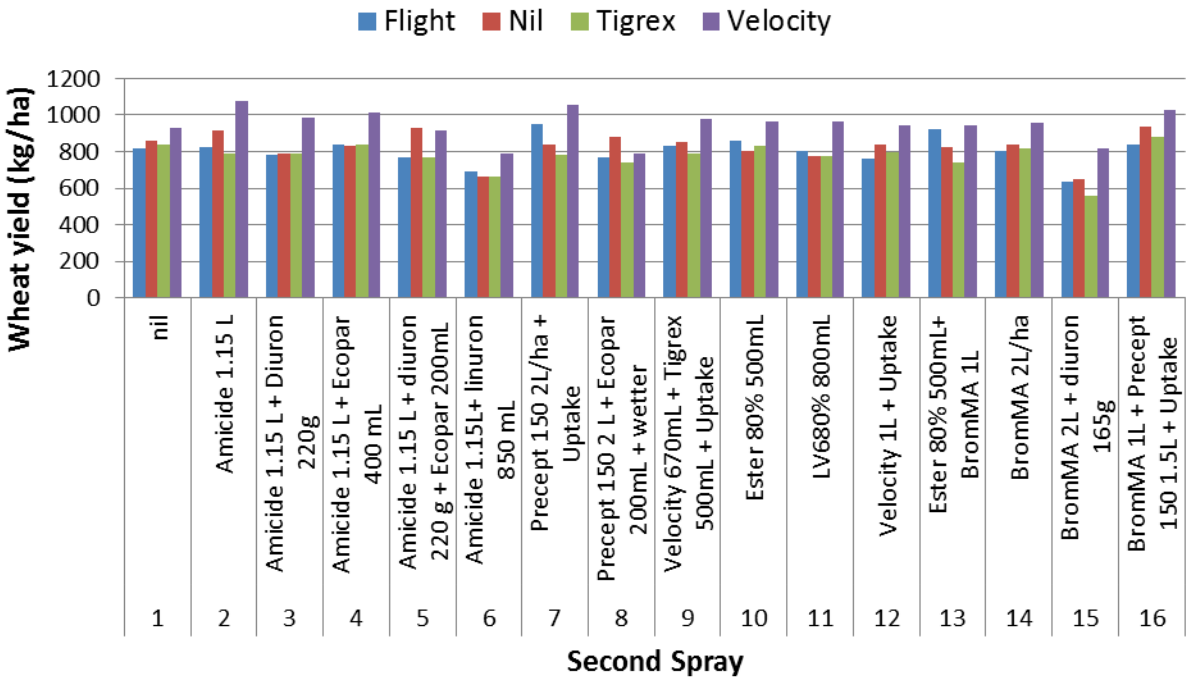


l.s.d for 1st spray 1.5 plants/plot. l.s.d 2nd spray 3.0 plants/plot. l.s.d for both sprays 6.1 plants/plot.

Key herbicide efficacy results from trial 1:

- Only one single spray treatment provided acceptable wild radish control. This was the BromMA + Precept + Uptake mix applied at 5-6 leaf stage of wheat.
- All two spray treatments provided acceptable control of wild radish.
- All early spray treatments i.e. Tigrex, Velocity or Flight required a follow up spray to achieve acceptable control. Another way of saying this is that a one spray strategy applied early was ineffective in achieving acceptable wild radish control.
- The efficacy of 2,4 D and 2,4 D mixes applied at the later timing suggest that the level of group I resistance or phenoxy resistance at this site in this year was not as high as was anticipated.

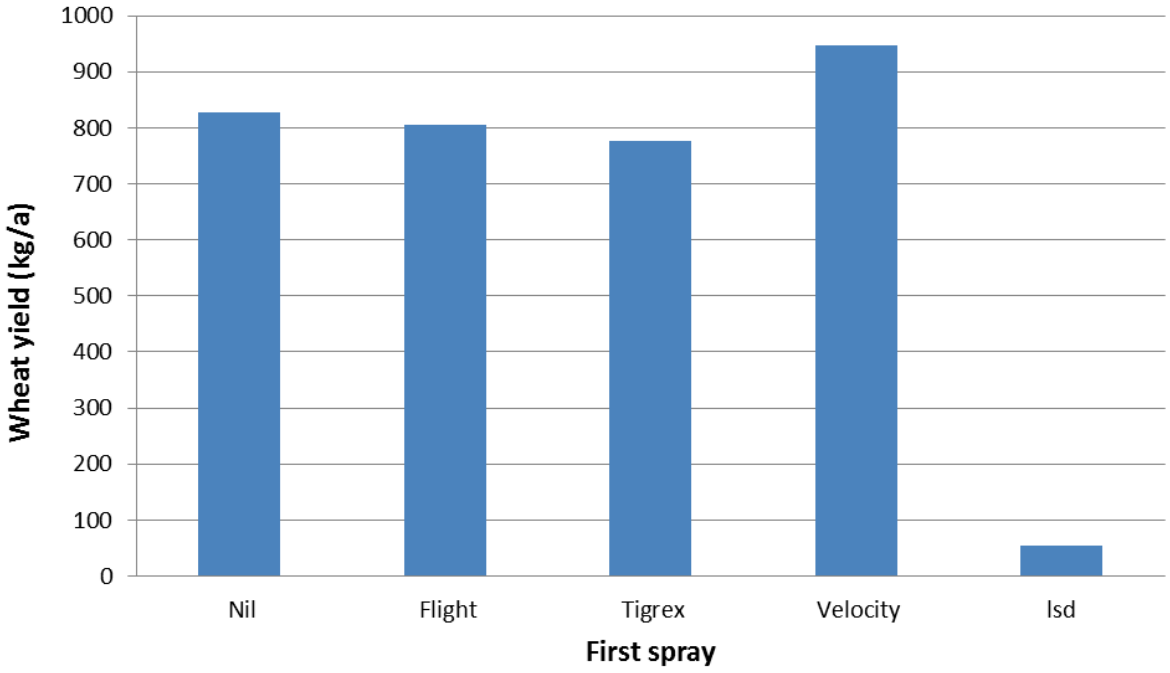
Figure 2: Wheat yields (kg/ha) for trial 1.



Key wheat yield results from trial 1:

- As a first spray Velocity always gave a higher yield compared to nil, Tigrex or Flight (also see Figure 3).
- Velocity as a first spray at the 2-3 leaf stage of the wheat crop gave a 15% yield increase above nil, Tigrex or Flight (See Figure 3).
- BromMA + diuron and Amicide + linuron as second spray treatments appear to have led to yield loss even though wild radish control was acceptable. Interestingly Amicide + diuron or Amicide + diuron + Ecopar did not reduce wheat yield.

Figure 3: Wheat yields (kg/ha) for first spray treatments when averaged across all second spray treatments.



Trial 2: Located at Naraling on a yellow loamy sand. Stubble had been retained and Mace wheat was sown at 80 kg/ha sown into marginal soil moisture in early May with no knockdown herbicide applied.

Table 3: Percentage visual control ratings at trial site 2, Naraling.

	2nd spray										
1st spray	nil	500mL Ester 80	1 l/ha ester 80	Amicide	Amicide + diuron	Amicide + diuron + Ecopar	Amicide + Ecopar	Precept 150	Precept 150 + Ecopar	Tigrex + Ecopar	Velocity + Tigrex
Ecopar + MCPA + diur	82	97	98	84	96	96	99	100	100	100	100
Flight	91	100	100	100	99	100	100	100	100	100	100
nil	0	60	70	64	70	72	74	79	94	100	98
Tigrex + diuron	80	99	100	90	98	95	98	100	100	100	100
Tigrex + Ecopar	92	96	95	98	100	95	96	100	100	100	100
Tigrex + linuron	100	100	100	100	100	100	100	100	100	100	100
Velocity	100	100	100	100	100	100	100	100	100	100	100
Velocity + diuron	79	95	98	95	94	99	96	100	100	100	100
Velocity + Ecopar	85	95	99	88	95	92	99	100	100	100	100
Velocity + metribuzin	84	94	100	96	92	100	88	100	98	100	100

l.s.d for 1st spray 3.7%. l.s.d 2nd spray 3.9%. l.s.d for both sprays 12.2%.

Key herbicide efficacy results from trial 2:

- Several one spray treatments worked very well. These included Tigrex + linuron or Velocity applied early. Tigrex plus Ecopar or Tigrex plus Velocity applied late was also very effective as a single treatment.
- Tigrex plus Ecopar was a very good treatment either early or late and perhaps has a role to play as a new mix that will shift selection pressure away from pyrasulfatole. More work especially from a crop tolerance perspective is required before this mix could be endorsed.
- Adding diuron, Ecopar or metribuzin to Velocity did not improve wild radish control but rather detracted from it.
- The poor control achieved by 2,4D and 2,4D mixes as a single spray applied later would suggest that group I resistance is present at this site. However when an early spray was combined with a later spray of 2,4D or 2,4D mix acceptable control was achieved in many cases. This result would indicate that even though as a single later spray 2,4 D is not effective it can still be used effectively in a two spray regime as the second spray treatment.
- A two spray strategy was also very effective at this site with most combinations of herbicides working well, even though the site does appear to have significant levels of group I resistance.

Trial 3: Located at Yuna on a red sandy loam. Stubble had been retained and Mace wheat was sown at 80 kg/ha sown into marginal soil moisture in early May with no knockdown herbicide applied. This site had the highest wild radish density (see photo below) out of all 4 sites and was the most challenging site in our 2012 trial program.

Table 4: Percentage visual control ratings at trial site 3, Yuna.

	2nd spray									
1st spray	nil	Amicide	Amicide + diuron	Amicide + Ecopar	Amicide + diuron + Ecopar	500 ml/ha Ester 80	Precept 150	Precept 150 + Ecopar	Tigrex + Ecopar	Velocity + Tigrex
Ecopar + MCPA + diuron	57	70	82	89	86	62	90	99	97	88
Flight	84	97	95	95	97	92	96	100	98	96
nil	0	60	55	69	55	45	80	81	86	71
Tigrex + diuron	57	77	76	80	76	72	94	99	100	85
Tigrex + Ecopar	77	94	87	89	93	77	99	98	99	100
Tigrex + linuron	55	77	90	91	84	69	96	100	98	90
Velocity	90	97	99	100	92	88	100	99	100	99
Velocity + diuron	92	91	94	95	94	88	98	99	100	100
Velocity + Ecopar	97	99	99	100	100	100	100	100	100	100
Velocity + metribuzin	95	100	98	100	100	99	100	100	100	100

l.s.d for 1st spray 3.8%. l.s.d 2nd spray 3.8%. l.s.d for both sprays 11.9%.

Key herbicide efficacy results from trial 3:

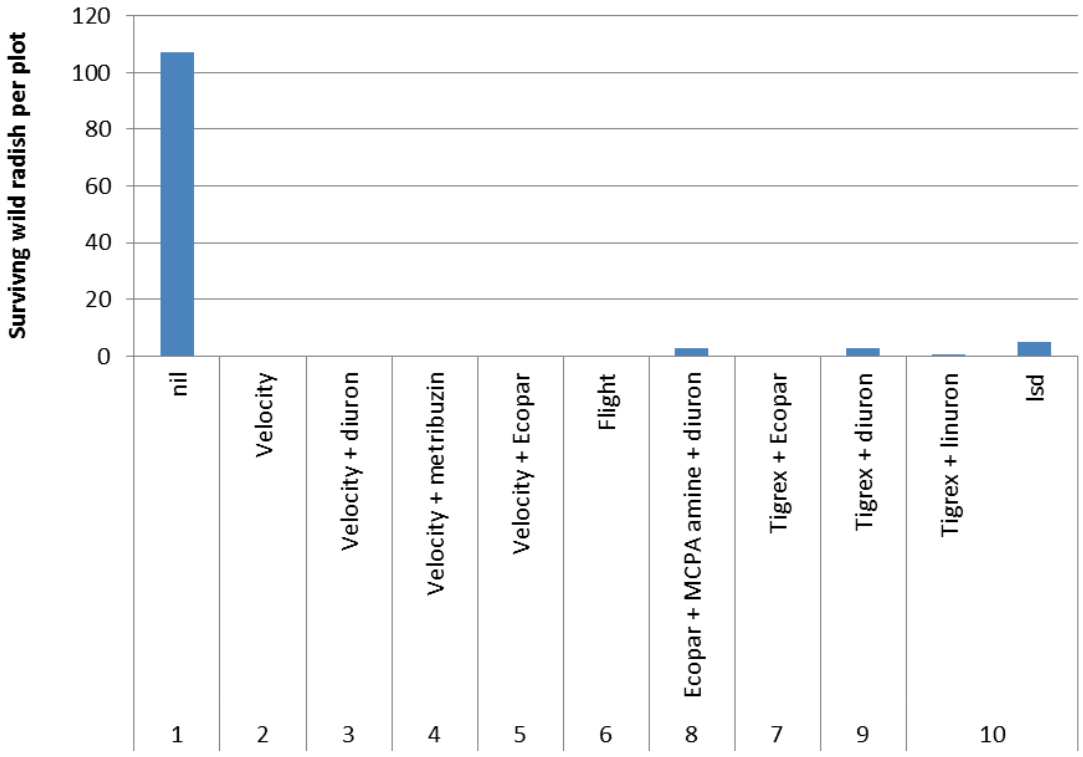
- The poor control achieved by 2,4D and 2,4D mixes applied as a single spray applied later would suggest that significant group I resistance is present at this site.
- Far fewer 2 spray treatments worked at this site compared to the other 2 trial sites. However it was still possible to achieve excellent control without having to resort to

using 2 applications of pyrasulfatole. For example Velocity followed by Tigrex + Ecopar, Flight followed by Precept plus Ecopar or Velocity followed by Amicide plus Ecopar all gave 100% control.

- Tigrex plus Ecopar once again stood out as a strong second spray treatment and has the advantage that it does not contain pyrasulfatole.
- Adding Ecopar to Precept or Amicide improved wild radish control. Ecopar demonstrated that is was a very useful addition to other products to improve control.
- Adding metribuzin, diuron or Ecopar to Velocity appeared to improve control. This is in complete contrast to what happened in trial 2.
- No one spray strategy worked at this site and a 2 spray strategy was required to achieve acceptable control.

Trial 4: Located at Tenindewa on a deep loamy sand. Stubble had been retained and Mace wheat was sown at 50 kg/ha sown into marginal soil moisture in early May with no knockdown herbicide applied. This site had the lowest wild radish density out of all 4 sites and this site only received a single spray.

Figure 4: Surviving wild radish per plot.



Key herbicide efficacy results from trial 4:

- All single spray treatments gave acceptable control of wild radish.
- A two spray strategy was not required at this site to achieve acceptable control.
- This population of wild radish would appear to not be that difficult to control, which would no doubt be a comforting result for the land owner at this site.

Discussion of Results

The results from our trials in 2012 very clearly demonstrate that a 2 spray strategy is highly effective in controlling wild radish including those populations exhibiting significant levels of group I resistance. It should be pointed out that our first spray was targeted at a 2-3 leaf wheat crop which is 7-14 days earlier than standard industry practice. Most growers in the NAR are applying their first wild radish spray at 3-5 leaf stage of the wheat crop. Our follow up second spray was 3 weeks later, which once again is far earlier than what most growers would achieve when implementing a 2 spray program in cereals.

Our trials also demonstrate that at these sites growers and agronomists do not have to use more than one application of a product containing pyrasulfatole to achieve acceptable control in any one year. This result is particularly important because at present some paddocks in some years in the NAR are been treated with multiple applications of pyrasulfatole which will likely lead to a faster onset of resistance.

The herbicide active 2,4D which is found in products such as Amicide and Ester still has a role to play in wild radish control in the NAR when used to target small radish as a second spray 3-4 weeks after an earlier spray.

Ecopar, and we would strongly suspect other similar products, such as Affinity, do appear to have a role to play in supporting the older chemistries like group I (e.g. 2,4 D, MCPA) and group F (e.g. diflufenican).

Novel mixes such as Tigrex plus Ecopar need further investigation as this mix did work very well both as an early treatment or later treatment.

Velocity is very safe to use on crop and is a very effective herbicide for controlling wild radish. In our 4 trials Velocity early followed up with a range of second treatments consistently gave the best control, and the harvest results taken at trial 1 showed a clear yield advantage to using Velocity as the first spray treatment.

Implications

Industry needs to adopt a 2 spray strategy for wild radish control in cereals where herbicide resistance is present or suspected. Shifting spraying windows forward to target smaller wild radish plants has been shown to be highly effective in controlling hard to kill populations of herbicide resistant wild radish. Older actives such as 2,4D, MCPA and diflufenican still have a role to play in wild radish control even on those populations that have resistance to group I and suspected tolerance to group F modes of action.

Industry does need to acknowledge the importance of protecting new modes of action such as pyrasulfatole (group H) to ensure long term survival of their cropping dominant rotations. Other actives such as pyraflufen (e.g. Ecopar) in some cases does appear to improve control when added to products such as Amicide, Tigrex and Precept.

Recommendations

This work needs to be replicated at different sites in the NAR to ensure that the key messages are indeed robust and can be widely extended to industry. Crop tolerance research is required to validate the use of novel mixes such as Tigrex plus Ecopar or Precept plus Ecopar. Additional timing work is required to assess at what point 2,4D does in fact fail on group I resistant populations. For example is 2,4D highly effective on cotelydon to 2 leaf wild radish but less effective on 4-6 leaf radish if the population is developing resistance to group I?

Extension Activities

Bayer Crop Science and growers/agronomists group from Vic and NSW. 17/7/12 A Sandison
Yuna farm improvement group 23/7/12 A Sandison and P Newman
Landmark field walk with South Australian grower group 27/8/12 A Sandison
Yuna farm improvement group 14/9/12 P Newman
Planfarm Agronomy field walk 25/9/12 A Sandison
Radio interview ABC 15/5/12.A Sandison
Workshop to discuss trial results with NAR agronomists 19/11/12 A Sandison and P Newman
Great Northern Rural breakfast update meetings Peter Newman
Liebe Group Crop Update, March 2013, Peter Newman
Eastern states resistance management meetings in conjunction with Bayer CropScience at Horsham, Birchip, Yarrawonga, Wagga Wagga 18-22/3/2013 A Sandison
Mingenew-Irwin Group Crop Update, Mingenew, 8/03/2013, P Newman

Northern Agri-Group Update, Binnu, March 2013, P Newman
SEPWA Crop Update, Esperance, March 2013, P Newman

Acknowledgements

GRDC Northern Regional Cropping Solution Group, Cameron Weeks Planfarm , Leigh Nairn Great Northern Rural, Owen Mann Great Northern Rural, Peter Eliot Lockhart Planfarm, Chris Pinkney Agrarian Management, Grant Thompson Landmark, Les Wheeldon, Tony Critch, Roland Labuschagne and Simon Smart

Publications

Ground Cover article: Spray early, spray twice: local wild radish research. By GRDC western regional panel member Paul Kelly. Media Release Natalie Lee GRDC.
Herbicide resistant wild radish. Spray small weeds and make sure you hit them. Peter Newman AHRI
Herbicide sequences target wild radish control. Media release Natalie Lee, GRDC.
New research in NAR targets wild radish. Media release Natalie Lee, GRDC.