



Department of
Agriculture and Food



Glyphosate resistant weeds – beat them before they beat you

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The bad news/the good news

The bad news

There are five weed species that have documented glyphosate resistant populations in Western Australia (WA)(August 2014). Annual ryegrass, wild radish and red brome have all been found in winter grains.

Weed species	WA	Australia
Annual ryegrass (<i>Lolium rigidum</i>)	Many	Many
Wild radish (<i>Raphanus raphanistrum</i>)	3	3
Windmill grass (<i>Chloris truncata</i>)	1	11
Barnyard grass (<i>Echinochloa colona</i>)	1	98
Red brome (<i>Bromus rubens</i>)	1	1
Liverseed grass (<i>Urochloa panicoides</i>)	Nil	4
Fleabane (<i>Conyza bonariensis</i>)	Nil	58
Great brome (<i>Bromus diandrus</i>)	Nil	5
Sowthistle (<i>Sonchus oleraceus</i>)	Nil	4
Sweet summer grass (<i>Brachiaria eruciformis</i>)	Nil	1

See the Australian Glyphosate Sustainability Working Group website for more details glyphosateresistance.org.au/database

Annual ryegrass has the largest number of documented resistant populations.

- A recent GRDC-funded targeted survey across WA wheatbelt found that out of 175 ryegrass samples taken before harvest in 2013, 40% had some glyphosate resistance (30% had weak (or developing) resistance and 10% had intermediate resistance) to the lower glyphosate testing rate (1.5 litres per hectare (L/ha) of 540 grams of active ingredient (g a.i.)). 10% of the samples also showed some resistance to the high rate of glyphosate (3L/ha of 540 g a.i.). The survey, coordinated by Sally Peltzer of the Department of Agriculture and Food, Western Australia (DAFWA), focussed on weedy paddocks, proposed by growers, agronomists and growers groups for seed collection.
- In 2014, Landmark facilitated testing 273 annual ryegrass samples for a range of chemicals including glyphosate. They found that approximately 25% of them had developing glyphosate resistance with a greater percentage in the northern agricultural region (up to 50%).

Three glyphosate resistant wild radish populations were discovered by Australian Herbicide Resistance Initiative (AHRI) PhD scholar Mike Ashworth, all were from the northern wheatbelt of WA. Two populations were from winter chemical fallow and one was discovered in a glyphosate tolerant Canola crop.

The good news - act sooner rather than later

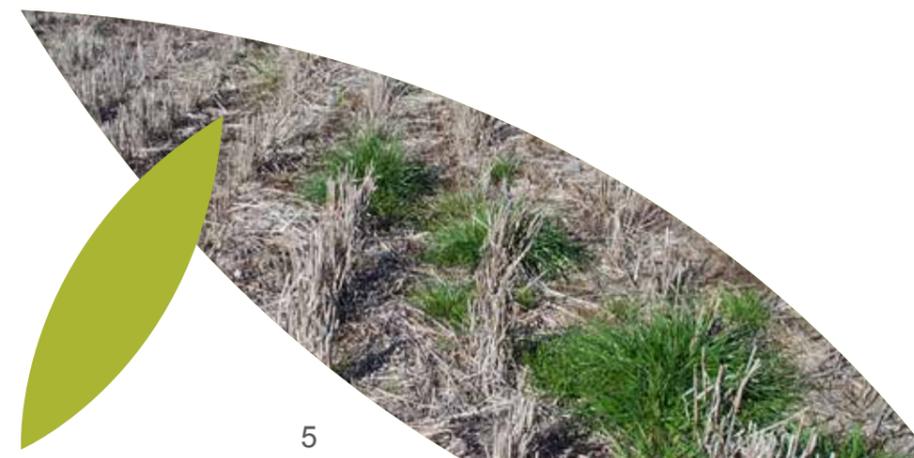
Many of the resistant populations found in WA have only weak resistance to glyphosate. Controlling these populations now with higher herbicide rates or other control methods before they set seed, will prevent glyphosate resistance from developing further. Acting while resistance is still weak provides the best chance of delaying resistance.

What to look for

When glyphosate resistance first occurs it will typically appear as small patches of resistant individuals surviving treatment, while surrounding individuals are controlled.



Patch of glyphosate resistant weeds not controlled by glyphosate knockdown application



What to do

No weeds = no weed seed set = no resistance

Herbicide resistance develops if the weeds exist in the population and set fertile seed. Being vigilant, keeping weed populations low and stopping seed set is the best way to prevent glyphosate resistance development:

- know the herbicide use history of each paddock. If glyphosate has been the dominant knockdown and spray-topping product used, it's time to change
- conduct herbicide resistance testing to determine what herbicides are effective on key weeds
- aim for maximum control
- establish a more diverse rotation to increase the number of control tactics available
- use non-herbicide control tactics at every opportunity
- always monitor the success of each control tactic
- rotate between herbicide moa groups
- ensure survivors do not set seed to replenish the soil seed bank
- avoid introduction or spread of weeds by contaminated seed, grain, hay, stock or machinery
- manage weeds in surrounding non-crop areas (e.g. fencelines, tracks, silos and sheds)
- review the control achieved, and adjust future management strategies accordingly.

There are no right and wrong weed control tactics. Choose the tactics that fit with your farm and develop a weed management plan to suit. As Chris Reichstein from Esperance says "You don't have to be clever about managing glyphosate resistance, just vigilant."

See the IWM hub and the new IWM manual (2014) for the latest in weed control tactics on the GRDC website grdc.com.au/Resources/IWMhub, grdc.com.au/IWMM

Control the survivors of glyphosate applications

Controlling the survivors of every glyphosate application is the only way to manage and prevent resistance. The closer control is to 100% of glyphosate survivors, the longer the time to detectable glyphosate resistance.

Residual herbicides and alternate knockdown products

Residual herbicides will give some level of control on more than one flush of weeds. Knockdown alternatives to glyphosate do not provide control over multiple germinations, but they can provide higher levels of control. A combination of the two is the best.

A double knockdown with paraquat applied pre-seeding (particularly prior to the cereal crop and after Roundup Ready® canola) is gaining favour in some parts of WA. This gives glyphosate a break with a negligible cost difference. In some seasons only a single knock of paraquat is required.

Crop competition

Improving the crop's competitiveness can reduce weed numbers, weed biomass and seed set.

- use a competitive crop and variety. Grow the crop type and variety best suited to your paddock
- use a higher seeding rate and the narrowest row spacing possible. Outnumber the weeds
- use optimal sowing depths to ensure a uniform crop with early vigorous growth
- use good agronomy. Growing the best crop you can (matching the crop to soil type and climate, using appropriate fertilizers and managing pests and diseases) will result in the most competitive crop.

Mic Fels from Esperance rates his most significant tactic on the war against ryegrass as the increased crop competition he gets with narrow row spacings (see his case study in this publication). Mic decided to change to narrow row spacing after trawling DAFWA and the Grains Research and Development Corporation (GRDC) research results and believes that 'trial after trial after trial' showed huge yield benefits. (1% yield increase for every 2.5cm reduction in row width for winter cereals – Scott BJ, Martin P, Riethmuller GP (2013)). Graham Centre Monograph No. 3: Row spacing of winter crops in broad scale agriculture in southern Australia. Eds T Nugent and C Nicholls. NSW Department of Primary Industries, Orange. Available at: grahamcentre.net)

Crop sequencing and stacked rotations

Some weed management tactics rely on specific crop types or the sequence of the cropping rotations. It is important to think about what weed control tactics can be used when designing your rotational sequence.

Chris Reichstein in Esperance used a stacked rotation of two broadleaf crops in a row after he bought a property with glyphosate resistance ryegrass on it. He believes that two consecutive crops pay off because he can change the herbicide mode-of-actions and optimise the effectiveness of remaining MOA Group A herbicides while giving him the opportunity to crop-top in either the lupins or the peas. This strategy has given a fantastic result driving his annual ryegrass numbers down (see his case study in this publication).

Excellent tables of 'crop choice options to aid weed management' including the relative competitiveness, sowing time, maturity, available herbicide options and difficult to control ('no go') of the different crop species are available in the IWM manual - Section 3 Agronomy to enhance the implementation and benefits of weed management tactics - grdc.com.au/IWMM

Crop and pasture topping

Plants that are resistant to glyphosate as seedlings are also resistant to glyphosate when setting seed. Crop topping with glyphosate will not be effective in controlling glyphosate resistant plants.

Winter fallows

Winter fallows are becoming more popular in Western Australia especially in the drier areas. The Critch brothers in Mullewa, fallow one-third of their property each year for 12 months to reduce weeds (wild radish and annual ryegrass) and retain moisture profiles. They have a zero seed set policy in their fallows and their weed numbers are so low that the crops can be dry sown (see their case study in this publication).

Geoff Fosbery and his clients have been looking into 10 month fallows. These suit either 100% cropping enterprises or those with stock where there is value in grazing early feed. In this system, the first spray is not applied until there is stem elongation and some woodiness. This achieves soil stabilisation and a mulch effect to reduce summer evaporation provided the fallow is not grazed afterwards. Geoff has found that growing canola after the fallow increases the reliability of the canola and broadens the opportunity for good weed control. This can extend the cropping phase for a further three to five years. Fallows also give an opportunity to do deep-ripping or liming on those paddocks while they are out of cropping.

Fencelines, firebreaks and other non-crop areas

Weeds in fencelines have no competition from the crop and are often sprayed later in the season (August/September) when they are big and hard to kill. They are sometimes sprayed repeatedly with glyphosate, making them vulnerable to resistance. This resistance can then travel from the fenceline into the crop.



A fenceline trial at East Wagin in 2014

After three years of trialling alternatives to glyphosate in fencelines across WA, the GRDC-funded Northern and Esperance Advisor Groups have found that:

- A two spray or double knock strategy (can be a cultivation or something else) is usually required for complete control in fencelines with the first application early in the season followed by another one later in the season (after the seeding and post-harvest operations are over).
- Tank mixes of residual herbicides plus a knockdown give the best control for the first application.

- A single application with bromacil and paraquat as the first residual spray may give sufficient control throughout the season. This herbicide is highly residual and damaging to trees so can only be used where there is no remnant vegetation. Care must also be given around water courses. DO NOT apply or drain or flush equipment on or near desirable trees or other plants or where their roots may extend. Movement of soil from treated areas should be avoided because damage to off-target species may occur.
- The addition of Alliance® (mixture of amitrole and paraquat) as the knockdown gives good broadleaf control.
- Glyphosate can still be used BUT intensive monitoring and complete seed set is required to prevent resistance from developing.
- Carefully monitor fencelines and areas where fencelines have been removed. Ensure that these areas are regularly inspected to identify surviving weeds. These areas often have high weed numbers that have been exposed to multiple glyphosate application and therefore a resistance 'hotspot'. Remember that seed from these areas may have been spread over a wider area than the original fenceline.

Harvest weed seed management



Making windrows at harvest

As a high proportion of seed can be retained on two of our major weeds at crop maturity (annual ryegrass and wild radish), weed seed control at harvest can reduce the number the seeds going into the seedbank.

- The longer harvest is delayed past weed maturity the greater the proportion of weed seeds that will shed, shatter or lodge prior to harvest, reducing the total proportion of seed able to be collected.

- In 14 trials across southern and Western Australia, Michael Walsh (AHRI) found that harvest weed seed collection tactics resulted in a reduction in annual ryegrass the following season of between 30-90%.
 - Harvest height is crucial to maximise the seeds collected - harvest low to maximise collection – beer can height (15cm) is a popular measure.
 - Other weeds such as wild oats and brome grass are likely to have shed a large proportion of seed before harvest unless these paddocks are targeted for prompt harvest.
 - Every system of harvest weed management has its pro and cons. Many growers modify existing methods to suit their farms. (see “The effectiveness of on-farm methods of weed seed collection at harvest time: Case studies of growers in the Albany Port Zone”.
- grdc.com.au/CaseStudy-WeedSeedHarvest-Albany for some interesting case studies).



Chaff dumps

Tool	pros	cons	Comments
Windrow burning	<ul style="list-style-type: none"> - cheap to setup - no loss of harvest efficiency - very effective - simple home constructed chutes can be created to concentrate residue into narrower bands. 	<ul style="list-style-type: none"> - involves burning - wind erosion risk - time consuming in autumn - nutrient banding - grazing will reduce effectiveness. 	<ul style="list-style-type: none"> - move the windrows each year to distribute the potassium across the paddock. - Doug Smith (Pingrup) successfully burnt > 5 tonnes per hectare (t/ha) crops in 2013/14 destroying the myth that only crops below 3t/ha can be wind rowed and burnt (see his case study).
Chaff Cart	<ul style="list-style-type: none"> - minimises area of paddock burnt - can provide feed source for livestock. 	<ul style="list-style-type: none"> - cost - reduces harvest efficiency - burning heaps in autumn is very time consuming - they can burn/ smoulder for days. 	<ul style="list-style-type: none"> - Mark Pearce from Tarin Rock has not needed to provide supplementary feed to his stock since chaff carting. The sheep get enough from the heaps. (see grdc.com.au/CaseStudy-WeedSeedHarvest-Albany for more information).
Chaff diversion onto tramlines	<ul style="list-style-type: none"> - cheap to setup - no burning - no loss of harvest efficiency - reduces dust during summer spraying. 	<ul style="list-style-type: none"> - must have fully matched tramline system - unproven - high weed density on tramlines. 	<ul style="list-style-type: none"> - Mic Fels (Esperance) uses chutes on the back of the headers to drop chaff into the middle of the header pass (rather than on the tramlines) and spreads the remaining straw back onto the paddock.
Harrington Destructor	<ul style="list-style-type: none"> - no burning - nothing to do after harvest - very robust machine – can handle house bricks! 	<ul style="list-style-type: none"> - capital cost - extra piece of complex machinery. 	<ul style="list-style-type: none"> - One of the best things about the Destructor is that there is no nutrient or residue loss from the paddock.
Baling everything – Glenvar system	<ul style="list-style-type: none"> - no burning - potential additional income from bales. 	<ul style="list-style-type: none"> - cost - extra nutritional drain on soil - need a market for bales - handling of bales - complex machinery. 	<ul style="list-style-type: none"> - See glenvar.com/ for more information.

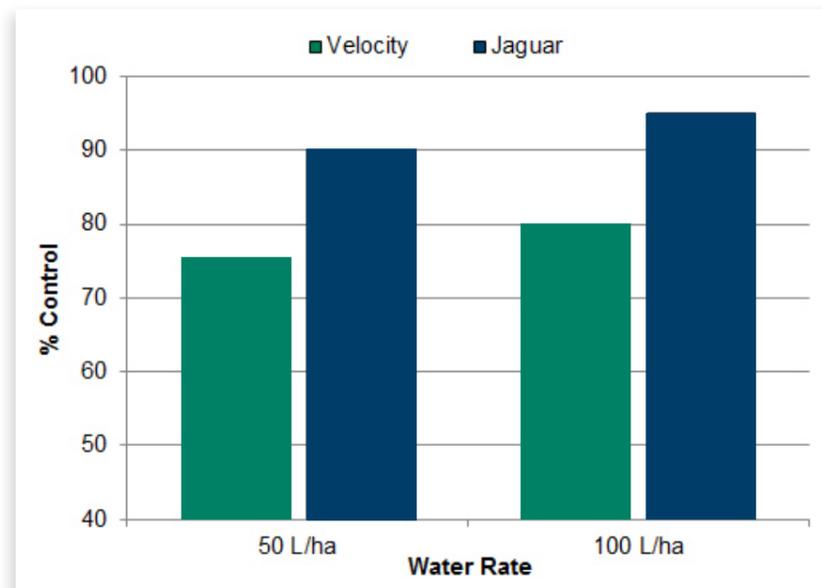
Individual weeds – extra tips

As stated before, no weeds = no resistance. Here are some extra control tips to keep the weed numbers low.

Wild radish

Grant Thompson conducted several trials on multiple resistant (but not resistant to glyphosate) wild radish populations in the Geraldton district in 2013. The trials highlighted the benefits of a two spray strategy – early post emergent when the crop was two leaf followed by a second post emergent treatment at 4-5 leaf, which gives highest level of weed control and crop yield. Velocity® followed by Velocity® gave highest level of weed control, but crop yield wasn't significantly different to bromoxynil or Jaguar® followed by Velocity® (less likely to cause resistance to Velocity), Regardless of the first herbicide used, the two spray strategy gave a 400-500 kilogram per hectare (kg/ha) increase in yield.

Spray application is critical to maximise control with these herbicides. Work by Darren Chitty (see Figure below) shows at least 15% increase in control going from 50-100L/ha. Correct nozzle selection, boom height and ground speed are also important.



Brome grass species

Using IT (imidazolinone – tolerant) crops to control brome grass is only a short term answer due to brome's increased resistance to Group B herbicides. For the longer term, growers need to look at rotations that give them more opportunities for control such as pastures, manuring, hay freezing etc. Seed set should be prevented for two consecutive seasons.

Fleabane

There are glyphosate resistance fleabane populations in New South Wales (NSW), Queensland (Qld) and South Australia (SA) but none in WA as yet (only a matter of time). Fleabane will generally germinate in late winter/early spring after a fall of 10-15 millimetres (mm) in WA and go onto to become a problem over summer after the crops have been harvested. Fleabane growing in the summer fallow can reduce soil moisture substantially and delay seeding. As with all weed species, fleabane is easier to control when it is small (<5cm rosette) rather than waiting until mid-summer when it is hairy, woody and stressed. Control in-crop with late post emergent herbicides such as 2,4-D or clopyralid (e.g. Lontrel®) in spring. Control after harvest but before the Christmas break with a double knock treatment of glyphosate plus 2,4-D followed by a robust rate of paraquat (if required).



Two species of fleabane (flaxleaf on the left and tall fleabane on the right)

Resources

- 1) GRDC website
 - Latest IWM manual grdc.com.au/IWMM
 - IWM hub grdc.com.au/Resources/IWMhub
 - "The effectiveness of on-farm methods of weed seed collection at harvest time: Case studies of growers in the Albany Port Zone" grdc.com.au/CaseStudy-WeedSeedHarvest-Albany
- 2) Glyphosate Sustainability Working Group Website - glyphosateresistance.org.au/
 - Giving a RATS Newsletter - agronomo.com.au/giving-a-rats/
- 3) Department of Agriculture and Food WA Website - agric.wa.gov.au/
 - eWeed Newsletter - agric.wa.gov.au/newsletters/eweek
 - Weed Seed Wizard - agric.wa.gov.au/weed-seed-wizard-0
- 4) WeedSmart - weedsmart.org.au/
- 5) Australian Herbicide Resistance Initiative (AHRI) - ahri.uwa.edu.au/
- 6) Resistance Resting – Peter Boutsalis, Plant Science Consulting, [plantscienceconsulting.com.au;](http://plantscienceconsulting.com.au/) John Broster, Charles Sturt University: t: +61 (0)2 6933 4001 e: jbroster@csu.edu.au



“You don’t have to be clever about managing glyphosate resistance, just vigilant.” –

Chris Reichstein (Esperance)

While many growers are coming to terms with the prospect of glyphosate resistance developing on their property, one grower in the Esperance region of WA bought a property which already had glyphosate resistance on it.

Chris Reichstein from Mt Burdett Farming Company purchased ‘Warekila’ six years ago. It is an 860 hectare property, 45 kilometres north-east of Esperance (420mm annual rainfall, 290mm growing season rainfall) with soil types that are typical of the area (2/3 duplex soil and 1/3 Esperance sandplain).

Test for resistance and know what works

Chris was aware that the property had herbicide resistance prior to purchase, although no resistance testing had been done. Chris believes that the best thing to do is to regularly test for resistance and has been sending samples from this property every year since purchase. His motto is ‘make sure you are measuring, if you can’t measure it you can’t manage it’.

In the first year, Chris did some summer knockdowns on the sand-plain soils with glyphosate and some annual ryegrass survived. He did a Quicktest® for glyphosate resistance which came back positive and then commercially tested each paddock.

The property also has an annual ryegrass resistance profile of Fops 100%, Axial® (a den - pinoxaden) 55%, Select® (a dim - clethodim) 40% and Factor® (a dim - butoxydim) 0%.

This shows the value of testing for resistance. By knowing what his resistance status was Chris could pick out what chemicals he could use, for example, in the lupin and pea phases, he could use Factor® (butoxydim 250 grams per kilogram (g/kg) rather than clethodim and save clethodim for the canola phase.

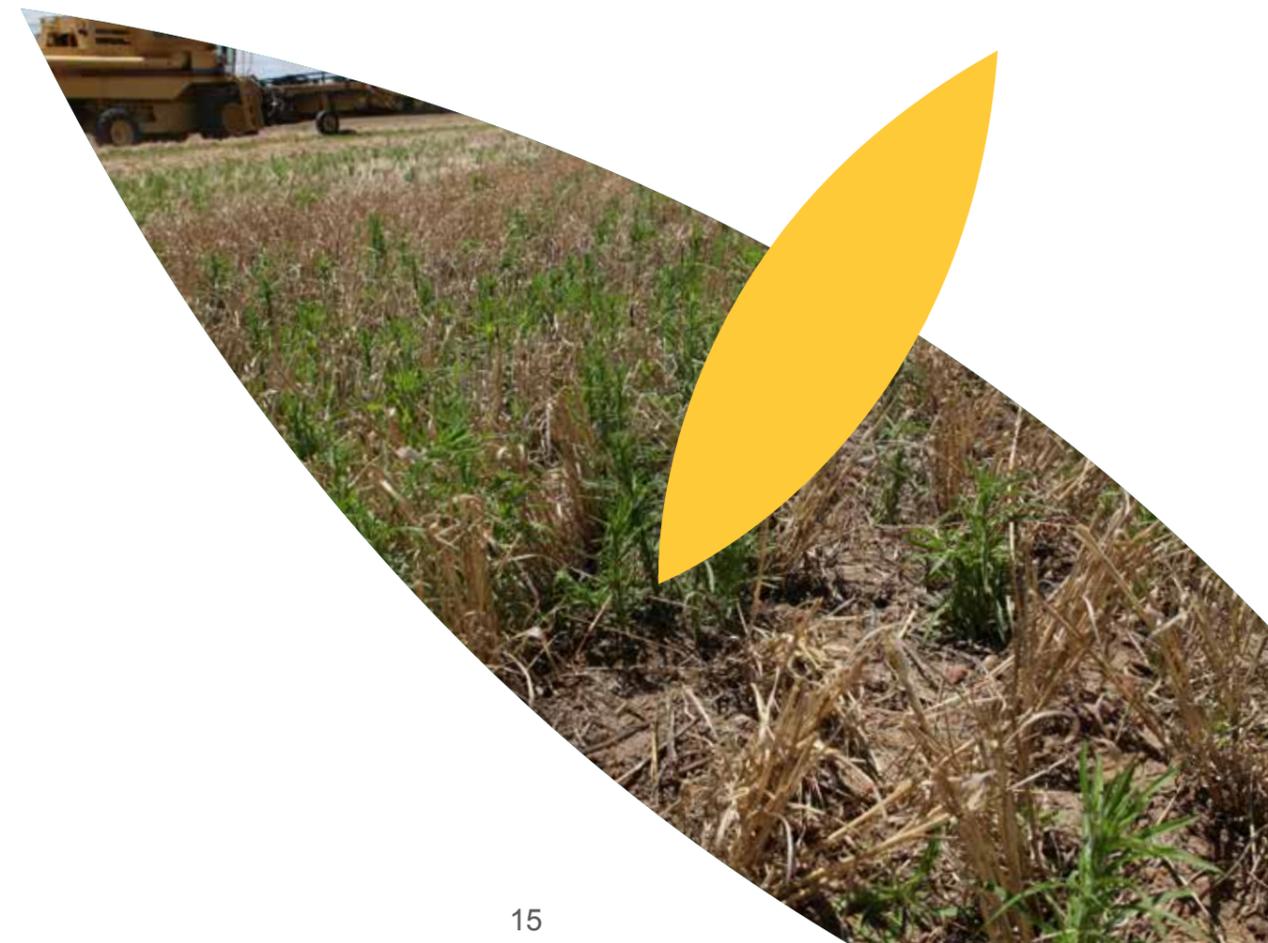
Use robust rates in good conditions

By testing, Chris knew that he had glyphosate resistance in small areas across the property (some of them were in old fencelines). His adopted strategy is to spray with high rates glyphosate in perfect conditions with high rates of water (100L/ha) and then to come back with high rates of Gramoxone®. He makes sure there are no survivors to set seed.

Use rotations

To increase his IWM options, Chris used a rotation of two broadleaf crops in a row. In the lighter country he grew canola then lupins then back to canola again and in the heavier country, canola then peas. In the TT canola, he used atrazine and clethodim, swathed at the end of the season then windrow burnt after swathing. He used Factor® in the pea and lupin rotations. He believes that two consecutive broadleaf crops pay off because he can change the herbicide mode-of-actions (MOA) and optimise the effectiveness of remaining MOA Group A herbicides while giving him the opportunity to crop-top in either the lupins or the peas. This strategy has given a fantastic result driving his annual ryegrass numbers down.

Due to the presence of glyphosate resistance, Chris will not grow Roundup Ready® canola on this property.



Use different mode-of-action herbicide groups

In 2011, the annual ryegrass numbers were so low that Chris grew wheat in 2011 and used 1.8L/ha trifluralin and no post emergent ryegrass sprays. In 2012 he used Boxer Gold® with fabulous results. This was partially due to a fear of trifluralin resistance but also so he could get a better result on the gravel soils due to less volatilisation. Boxer Gold® is also another MOA (Groups J and K) rather than MOA Group D for trifluralin. Chris may also incorporate Sakura® (MOA Group K) and trifluralin with Boxer Gold® into the double broadleaf rotation.

In 2010 (2nd year of managing the new farm) Chris planted canola and because of concerns of resistance to clethodim (Select®), delayed sowing and used trifluralin and atrazine. However, there was heavy rain prior to crop emergence which gave a poor establishment of canola and a good germination of annual ryegrass. Due to knowledge of the existence of resistance, the paddock was then sprayed with 1.5L/ha Gramoxone® to reduce numbers and the paddock was then resown. Short term cost for a long term gain.

In 2011, 70 hectares (ha) of wheat was infested with annual ryegrass. This was sprayed with Axial® giving reasonable (approximately 70% control). Although there was some resistance to Axial®, Chris thought it was better to control numbers and then windrow burn before going into barley (delayed sowing) with high sowing rates (90kg/ha seed) and Boxer Gold®.

Harvest weed management

Chris used to narrow windrow burn his canola (after swathing), barley and wheat phases. Even before he purchased the property, he worked with the vendor to swath the canola. He now uses chaff carts (mulch) in preference to windrow burning and now has two chaff carts. Chaff carts burn less organic matter, help maintain soil health and reduce the concentration of potassium when compared to windrow burning.

Farm Hygiene

Chris is vigilant about keeping the annual ryegrass numbers low in all areas of his property. He concentrates on keeping the old fencelines clean as this is the most probable source of his glyphosate resistance.

He is also very particular about machinery hygiene. Any machinery used on this property gets a thorough clean before moving it to the home farm. All grain from that farm also goes to CBH (WA's grain receival, storage and handling group) and none is saved for seed.

Be vigilant

Chris believes that getting the glyphosate resistant annual ryegrass numbers down may have cost him more money due to his crop choices and robust herbicide rates but that it will pay off in the long run. When he first saw those survivors of the first summer knockdown, he was worried about what he could do. He now believes it is easy - a short term economic cost driving the weed seedbank down makes him a long way ahead in the future.

It all about keeping annual ryegrass numbers low.

In 2012, Chris did not spray any post-emergent grass herbicides in cereal crops across all his properties due to the extremely low numbers of annual ryegrass.

Case study

2



Mic Fels with his new 18 m seeder

One grower's war on ryegrass –

Mic Fels (Esperance)

Mic and Marnie Fels, farm a 6000ha property just north of Esperance on the south coast of WA that they bought in 2002. The property is 100% cropping with no livestock.

Mic is serious about managing annual ryegrass and it dominates most decisions made on the farm. With an annual rainfall of 450mm and an often mild finish to the season, ryegrass will germinate numerous times over the season and set lots of seed.

Mic realised the major weed potential of ryegrass in 2003, the second year after buying the property. It was a very wet year (600mm over the growing season) and large parts of the farm became dominated with ryegrass with little or no crop (the property had a long history of pasture).

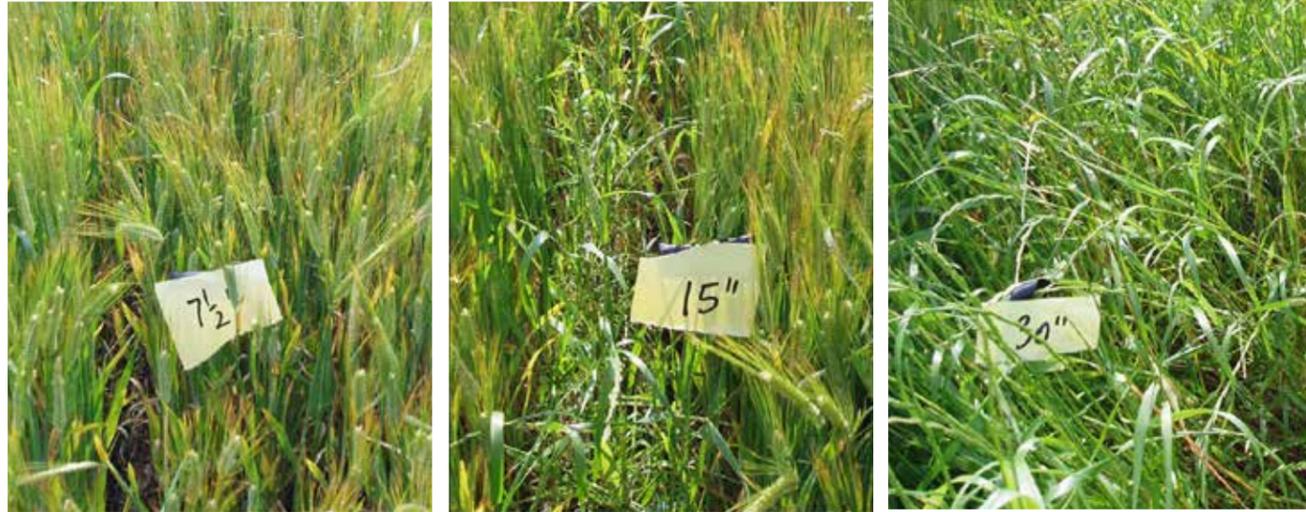
The worst areas were cut and baled but there were also some less affected areas that received no seed set control. Three years later (2007) when Mic was applying a knockdown spray before sowing, he noticed lines of ryegrass germinating 9 inches (23cm) apart. He had not used nine inch row spacing since 2003 as he had converted to 12 inch (30cm) spacings in 2004. These ryegrass seedlings had to come from plants that had dropped and landed in the furrows three years earlier. This brought home to him the need for at least two consecutive clean years (break crops) to reduce the seed bank. The traditional one year break was definitely not enough. Following this, he has incorporated a series of stacked rotations into his program;

- Triazine Tolerant (TT) canola
- Roundup Ready® (RR) canola
- two years of wheat
- two barley years.

Mic now has ryegrass densities of less than one plant per 40 square metres across the whole farm.

Narrow row spacings

Mic rates his most significant tactic on the war against ryegrass as the increased crop competition he gets with narrow row spacings. He changed to 7.5 inch (19cm) spacings in 2011 after designing his own disc seeder with wavy (or fluted) discs to get improved soil throw for the pre-emergent herbicides, press wheels and robust high quality bearings. Mic thinks most disc seeders have poor quality bearings and become very high maintenance. This system has worked so well that he has setup a new 18 metre machine.



In 2012, Mic had a pre-emergent trial on one of his paddocks which produced lots of ryegrass in the patch. In 2013, the air seeder drivers (backpackers) had some blocked runs for two paddocks. The blocked runs across the old trial site produced an excellent row spacing trial – 19 (left), 38 (middle) and 76 (right) cm row spacing.

Mic decided to change to narrow row spacing after trawling DAFWA and GRDC research results and surmises that “trial after trial after trial showed huge yield benefits with narrow rows (1% extra per inch making 5% for a reduction from 12-7 inch) and with this yield increase you can pay for the machine in the first season – it was just a no brainer. We were previously doing all these great things and still on 30cm row spacing. To me it felt like I was giving the ryegrass a free kick”.

Another advantage of narrow rows comes at harvest where the ryegrass stands tall making it easier to catch.

He thinks many growers do not want to reduce their row spacings due to the higher costs for the machinery, the perceived difficulties with stubble at seeding and the problems associated with the traditional disc machines. Mic feels that many growers are just not aware of the size of the yield and weed competition benefits from narrow rows.

Mic does not have any extra disease issues with the narrow rows and practices canopy management by managing his nitrogen inputs. He has also had very few issues with non-wetting as the new crop rows are always very close to the old ones (where the moisture band is).

Harvest weed management - Mic style

Another innovation Mic uses against ryegrass is a hybrid of two conventional tactics - dropping weed seed on tramlines and narrow windrow production. Mic uses chutes on the back of the headers to drop chaff (about one foot or 30cm wide) into the middle of the header pass (rather than on the tramlines) and spreads the remaining straw back onto the paddock. Whatever goes into the header goes back to the same spot each year. He does not plan to spray out the weed lines, assuming that all the seeds that do come up will compete with each other, and any that set seed will just go back into the same line where they came from. He also expects the mulch effect of chaff to minimise weed emergence.



The 'foot wide' chaff lines in March 2014

The advantages of this system include:-

- one row of chaff instead of two (every 40 feet)
- not driving on the chaff row. You plant the seeds by driving on it, and you add an inhibiting layer of mulch by not driving on it
- no need for fancy or expensive equipment (about \$200 for the chute)
- doesn't affect harvest efficiency
- if he wants to change the tramlines or if he has collected lots of weeds that year or if they are starting to spread out, he can add the straw onto the chaff line in the canola phase then burn in autumn.

Previously Mic dropped straw windrows (for burning) but found numerous problems with this system. He would swath the barley (one year in five) as early as he could and cut low to make windrows for burning in autumn. Like many others, he found it very hard not to burn the whole paddock with barley. He chose not to windrow canola or wheat for burning because he felt:

- canola could not be cut low enough to catch all ryegrass
- wheat maturity is too late and a lot of the weed seeds have dropped by harvest.

Other weed control tactics

Another tactic Mic uses regularly is the 'doubleknock'. He doubleknocks every paddock if there is time, using paraquat at 1.5-2L/ha as the second knock. As he grows Roundup Ready® canola, he is mindful of the risk of developing glyphosate resistance. Because of this, Mic only uses paraquat as a knockdown in the RR canola, keeping two shots of glyphosate for use during the season. This means that glyphosate is not used more often than in any of the other crops. He desiccates his TT canola prior to harvest with glyphosate.

Mic also monitors his fencelines and uses high water rates and low drift air-induction jets (so he can use paraquat) when spraying them. And of course, annual ryegrass gets special attention if it is found on fencelines.



Glyphosate resistant ryegrass on a South Australian fenceline

Case study

3



Why fallow and not crop? –

Daniel and Tim Critch
(Mullewa)

Brothers Daniel and Tim Critch (pictured) and their respective wives, Penny and Jen together with parents Tony and Judy, farm 13 000ha in WA's north east at Mullewa. Their property gets 325mm annual rainfall and 250-280mm growing season rainfall (although last 10 years it has decreased to 200mm). They put one third of their farm into fallow each year and think that "putting paddocks into fallow can sometimes seem wrong, especially when there is a good start to the season, but there are many associated benefits. You need to be disciplined and keep to the paddock plan".

Historically fallow was selected to try to reduce the number of lupin rotations. Growing lupins often caused a major blowout in weed numbers leading to a need for expensive chemicals in the subsequent crops in the rotation. "While lupins were fixing nitrogen, they were also fixing weeds". The brothers also did not want to grow continuous wheat due to diseases such as crown rot and their associated yield reductions. They also stopped keeping sheep about the same time. Introducing fallow was basically a default to fill the void of these rotation options.

Now, fallow is selected to reduce weeds and retain moisture profiles:

- the weed numbers are going down on the Critch farm and crops can be dry sown because of it
- there is retention of soil moisture. They have noticed that the wheat after fallow yields better than wheat after canola probably due to increased soil water
- there are reductions in root disease
- there is a possible increase in soil mineralisation of nitrogen and phosphorous due to the increased soil moisture. Soil testing after fallow came back the same as after lupins
- it is simpler to monitor herbicide resistance development. In fallow, it is easy to see a green patch in the bare paddock and be aware of what's working and what's not.



How does a fallow work on the Critch farm

The Critch brothers grow wheat and canola (both Roundup Ready® and triazine tolerant). Their rotation is fallow/wheat/canola/wheat and approximately 1/3 of the farm goes into fallow each year (4000ha), not just a few paddocks. The weed control steps throughout the year consist of:-

1. High rates of atrazine which are sprayed early before the break. This holds the weeds from getting too big while the cropping program goes in. Their crops (wheat and canola) are all dry-sown when the need arises or in absence of May rainfall.
2. A second spray goes on once the post-emergent sprays have been completed on the cropping paddocks.
The timing is critical here as it is imperative to hit the weeds when they are small, easy to kill and use less chemical. This means controlling wild radish at the small rosette stage before it has woody stems and before the annual ryegrass and brome grass gets too big.
 - The timing is so critical that the brothers will employ a contractor to do the spraying if their cropping program is not finished
 - This spray usually occurs in early June with a mixture of glyphosate, 2,4-D ester and metsulfuron with high water rates (80L/ha). This will also take out any volunteer Roundup Ready canola
 - This spray is usually a blanket spray but the WeedSeeker® can be used if the weed numbers are low.
3. A third spray is usually done using the Weedseeker® in mid-July with a mixture of glyphosate, 2,4-D ester and Ecopar at water rates of 100 L/ha and coarse droplets. Another similar spray may be done later if needed.
4. There are also two spray times over summer for melons, caltrop and tar vine to protect moisture. "If you have saved all that moisture over winter, you do not want it used up by the summer weeds".

Tips:

- The first application after the season break is the most important - always hit small weeds.
- In the first few years of fallowing, you may need to do multiple herbicide applications. This is especially true for wild radish control as it keeps germinating due to the soil staying wetter. Once you have the weeds under control, you can get away with less applications.
- Follow a fallow after wheat and retain the stubble straight after harvest. It needs to sit there for over 12 months so do not want wind erosion. Protect the stubble so do not graze or rip the paddock.

What about protecting glyphosate:

Glyphosate is the mostly used chemical on the Critch farm and they are extremely dependent on it. Any short-term cost and control measure will be considered to keep glyphosate in the system. As most crops are dry sown (90%), there is little glyphosate usage in the triazine-tolerant canola and wheat rotations. The sowing window has got narrower, so the time to use glyphosate has also reduced. Their biggest worry is glyphosate resistant wild radish and annual ryegrass in the Roundup Ready® canola rotation.

To protect glyphosate they are looking at using different chemicals over the farm, using the fallow to stop any seed from setting and using harvest weed seed management. The brothers windrow burn most of their cropping paddocks to decrease weed numbers and reduce the pressure on chemicals.

Case study



Doug with his old header set up for windrowing

Windrow burning – Busting the myth that it cannot be done in big crops?

- Doug Smith, Pingrup

Doug Smith and his wife Kerry are from Pingrup (250-275mm growing season rainfall). Doug crops 2500 hectares of wheat (50%), barley (20%) and canola, field peas and lupins (30%) and has had no sheep for the last 10 years. All his crops are sown no-till with one-pass knife points and press wheels. He also has an on-farm agricultural supply business where he plans and supplies chemical and fertiliser programs for 60 clients.

Current attitudes to narrow windrow burning

Windrow burning first started in the northern section of the Western Australian wheat belt around Geraldton. It was developed as a cheap and easy way to keep the lid on multiple resistant annual ryegrass and wild radish.

This area has a relatively short growing season and higher temperatures than more southern Australian cropping areas so windrow burning was a natural fit for this area. Cereal crop yields are generally less than 3t/ha and this has led to the idea that once crops are bigger than this, windrow burning isn't possible.

The 2013-14 harvest has shown this is not true. Doug successfully burned windrows of crops over 5t/ha.

Doug windrows every year, even in paddocks with low weed numbers. He windrows all his crops, including pulses. Canola stubble is easy to burn and the fire stays in the windrows, generally burning hotter compared to other stubbles. Doug saves the canola stubble for burning in more difficult conditions as it is more predictable and always burns well.

Why windrow burn?

- need to bring weed seed numbers down and keep them down
- chaff carts – burning in autumn is socially unacceptable (lot of fires escape 2-4 days after lighting) and harrington seed destructors are very expensive (and new and a little untried)
- it is cheap to set up \$300-\$400 per harvester and can be done to any harvester
- it doesn't slow down harvest
- paddocks are left with residue levels that stop wind erosion but do not cause trash flow problems at seeding
- reduced stubble levels are proven to reduce the risk of frost damage to flowering crops

How to set up windrows - size and type of windrows and over-threshing:-

- aim to keep rows to about 500-600mm wide
- make sure chutes capture all chaff and weed seeds into windrow
- do not over thresh crops. This leads to rows with little or no airflow making rows smoulder rather than burn. Rows that smoulder do get hot enough to kill weed seeds
- make sure your chute does not restrict air flow from the cleaning fan of the harvester. Most chutes need to open back and front and closing the front leads to reduced harvest capacity in 4t/ha plus crops
- try not to run over rows with headers/chaser bins etc. as this crushes the rows giving the same result as over threshing
- slow the harvester ground speed at the end of the runs so you empty the sieves at the same time as the rotors. This prevents tails of seeds with no straw mixed in to burn
- the use of stubble mats to protect the front tyres of the harvester can help in forming a mini fire breaks along each side of the rows. The mats tend to lay down stubble at harvest when it is hot (generally it does not stand back up) so it is less prone to light up due to radiant heat coming from the rows when burning
- make sure the header knife is in good condition. This is very important if crops are lodged because blunt knives tend to pull and lay ryegrass down in cool conditions rather than cut
- harvest the same direction the crop is sown. This is very important in heavy crops because the fire will carry down the individual rows that run away from the windrows
- the exception to the above rule is if using old stubble rows to guide seeder bar steering (i.e. when using I-TILL, you need to harvest at about 15 degrees to the way the crop was seeded. This is so you don't end up with any rows left for the paddle to work with for a full run
- wider header fronts allow you to get better windrows in lighter crop years but can prove challenging when it comes to burning 5t/ha crop windrows. But the results are worth the effort.

Varieties and crop types

- Wheat varieties vary greatly in the type of residue that comes out of headers.
 - Yitpi produces excellent rows with good retained straw size
 - Gladius produces finer residue that requires careful harvesting to achieve a reasonable burn.
 - Wyalkatchem produces very poor windrows of almost powder like residue making it unsuitable for windrowing
 - Mace if treated right with the harvester will produce good rows, but is susceptible to over threshing in the heat of the day.
- Canola produces rows that will burn at the highest temperature for the longest period of time. Great results
- Lupins also produces good row that will burn hot for the required length of time
- Barley while some types produce good rows it can be tricky not to burn the whole paddock. The low fluffy flag can carry the fire between the rows
- by changing from Gardiner to Hindmarsh, which produces a much better straw out of the back of the header, there are fewer issues with flat burning paddocks. This is because the rows are better suited to night time burning. The bigger windrows aren't smashed allowing the straw to burn hot enough to kill seeds even when the FDI gets low so the fire won't spread between rows

- Doug has learned that even 4-5t/ha Scope and Buloke barley crops can be burnt very successfully, but you need to do everything right. With barley the conditions are the most important factor, with the humidity needed to be at 75%, the wind <12kms/hr and temperature around 12°C. In our area these conditions generally occur between 9pm-3am. One 120ha paddock on Doug's mate's place this year took six hours to burn. There was a fair bit of stopping-starting waiting for the conditions to be right.

Burning and lighting

Doug uses the FESA McArthur Index, a scale used to calculate the fire danger in grassland using temperature, humidity and the wind speed to calculate an index. The scale gives a guide to the best windrow-burning conditions. As a rule of thumb, a Fire Weather Index of:

- less than 15 will give a reasonable burning result, but there is a risk of burning inter-row if windy
- 8-10 is good and probably ideal
- two and lower will not give a good result as it is too cold and humid. At this level the rows smoulder and will flare up when conditions warm up the following day burning the paddock bare.
- greater than 15 carries the risk of the fire getting out of control
- **there is no magic number it changes every year depending on fuel load**
If you don't measure conditions and determine if you need a higher or lower FDI you are going to very disappointed with the outcome (flat burnt paddocks, smouldering rows and still viable weed seeds)
- the FDI is a tool that Doug uses after he has determined what number he needs to aim for. (This year most of the burning took place between FDI of 2-8)
- remember each of the three variables (wind, temperature and humidity) affect the fire danger index (FDI) in different ways, some more than others
- you can use 'Meteogram' weather forecasts for your area. Meteograms predict weather variables such as wind, temperature and humidity up to seven days ahead. There is a range of internet sites you can subscribe to. Doug has found the most accurate to be willyweather.com and the BOM met eye site, and both are free

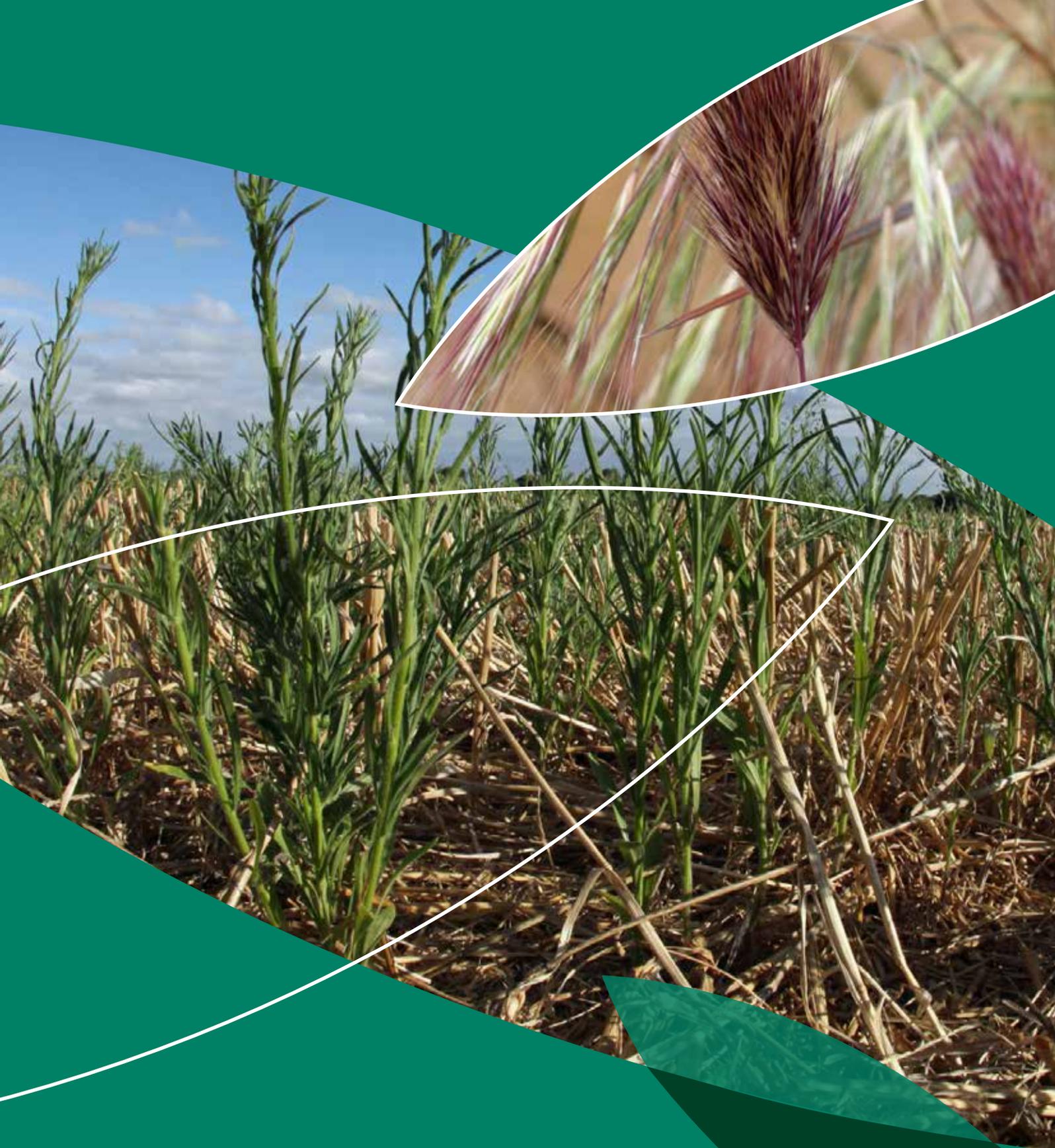


- don't guess the conditions, measure them and take a note of the result (every year is different so you may need to use a lower or higher fire index to get the right burn)
- there is a weather sweet spot for 2-3 hours each 24 hour period you must be prepared to use this even if it is late at night
- doug has observed that shorter crops on lighter country often have lower, fluffy flag leaves which help the fire to spread outside the windrows
- always check burnt paddocks the next morning and put out anything left smouldering, this will reduce the chance of flare up when the day warms up
- as a fire control officer Doug has found that nearly all fires that require attendance are from rows left smouldering from the night before
- doug generally won't burn when the forecast is for adverse condition the next day. (As it is his responsibility to issues burning permits he tends to cancel all burning permits when this is the case anyway)
- light windrows at 90 degrees across or diagonal to the windrow, rather than along the row as this prevents the fire developing a face which can carry between the rows. Ideally rows should burn to meet each other in 75 metre segments. In good conditions this only takes 25-30 minutes
- light up across the windrows every 75 metres in good conditions and plan to light much closer as conditions cool down. The fires will burn to meet each other
- best burning conditions are in the second half of March
- plan to commence burning just on dark when it is cooler but also plan to be finished burning when the dew falls (this limits stubble smouldering and subsequent flare-ups during the next day)
- this time constraint means that only 200-300ha (per team) can be burnt each night
- invest in a good fire lighters Doug uses a gas/diesel powered unit mounted on a 650cc quad bike with a lighting speed of 30-40 kilometres per hour (km/hr).

A final note: you cannot control all the weed seeds by windrow burning because you cannot get them all into the windrow. But done correctly you can keep weed numbers down even when things haven't gone as well as you planned in crop.



FESA scale (there are also both Apple and Android apps that can do the same thing for phones and tablets)



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