Report on the 2014 GOA Herbicide Resistance Survey

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Keywords

Herbicide, resistance, weeds, survey, testing, resistant, GOA

1 Background

Herbicide resistance could possibly be one of the greatest threats to the sustainability of our current grain production systems. Minimum or zero tillage systems have evolved to place a heavy reliance on herbicides with, in many cases, no other alternate methods or modes of weed control being employed. This reliance on herbicides has already led to the development of resistance in many cropping regions of the world with Australia being no exception.

So it leads to reason that the Central West of NSW is not immune to the development of resistance either. However, prior to a similar survey conducted by GOA at the end of 2013, the extent of resistance in the region had not been previously quantified. Before these surveys were undertaken the only formal confirmation of resistance was through ad-hoc testing by advisors or growers often only in situations where herbicides had previously failed. More informally, resistance was primarily diagnosed only by "gut feel" or an educated guess by advisors. Prior to these GOA surveys there was no publicly available data on the levels and types of resistance in this region.

In contrast, many of Australia's other main cropping regions have already conducted a number of public surveys which have started to form a strong picture of the level and types of herbicide resistance present.

This lack of empirical evidence has done nothing to change the belief by many growers in the region that resistance is not common or that the region was somehow not susceptible to the development of resistance. Local advisors have gone so far to suggest that some growers were actively in denial to the severity of this threat and as such, often not prepared to act to prevent, slow or combat resistance.

The results from the first survey undertaken by GOA in 2013 were damning and it could be argued they showed the regions resistance Status® to be much worse than expected. All of the annual ryegrass samples that were submitted were resistant to at least one herbicide tested with 54% of the populations tested expressing resistance to four or more herbicide groups or subgroups[1]. It also showed alarming levels of resistance to clethodim and a number of populations with resistance to

[1] Subgroups refer to Fop, Dim or Den herbicides which are all Group A herbicides and SUs or Imidazolinones which are both Group B herbicides.

glyphosate. The results on the wild oat samples also showed significant levels of resistance and cross resistances.

As a result of the positive response from growers and advisors in the GOA region, the survey was run again in 2014 to increase the size of the data set and to fill in some of the geographical sampling gaps missed in the 2013 survey. This report details the findings from the 2014 survey.

2 Aims

The aim of this project was to build on the findings from the 2013 herbicide resistance survey and to continue to raise awareness of the level and types of herbicide resistance in the GOA region. This will in turn motivate the growers and advisors for the GOA region to take positive action to combat the further development and spread of herbicide resistance in the region.

3 Methodology

In November of 2014, all growers and agronomists on the GOA contacts list were offered the opportunity to submit seeds of the two main resistant weed species found in the GOA region for testing for resistance to a range of common herbicides. The two weed species were:

- Annual Ryegrass (ARG)
- Wild or Black Oats (BO)

If growers submitted two or more samples, the cost of one was met by GOA. Samples were taken from cropping paddocks in the GOA region with no stipulation of their suspected resistance Status®. That is that they could be taken from paddocks regardless of whether they were suspected resistant or not.

Samples were to be collected in accordance with commercially accepted sampling instructions provided by Plant Science Consulting[2]. This commercial service conducted the herbicide testing and were employed to conduct the 2013 testing. The herbicide testing was carried out to industry accepted standards in calibrated spray cabinets with control populations introduced to ensure confidence in test results.

A range of herbicides specific to the weed species were applied and these are listed in Table 1 and Table 2 below. The herbicide types and rates used were developed with input from a number of sources with an aim to characterise the resistance status of each population to commonly used products (and a number of rates in some instances to examine any rate responsiveness). The selected herbicides are not completely exhaustive as cost would have been prohibitive but do serve to give a significant characterisation of the resistance status of the populations tested.

[2] www.plantscienceconsulting.com/seedtest

Table 1. Herbicides and rates tested on annual ryegrass samples

Herbicide Tested	Group	Common Trade Names	2014 Rate	2013 Rate
Trifluralin 400g/L	D	Triflur X®, Treflan®	2000ml/ha	same
Haloxyfop 520g/L	A (Fop)	Verdict®	100ml/ha	same
Clethodim 240g/L	A (Dim)	Select®, Status®	350ml/ha	same
Clethodim 240g/L	A (Dim)	Select®, Status®	500ml/ha	same
Butroxydim 250g/kg	A (Dim)	Factor®	180g/ha	same
Pinoxaden 100g/L	A (Den)	Axial®	300ml/ha	same
Triasulfuron 750g/kg	B (SU)	Logran 750 WG®	35g/ha	35 g/ha
Iodulfuron-methyl sodium 100g/L	B (SU)	Hussar OD®	100ml/ha	200 g/ha Hussar
Imazamox 13g/L & Imazapyr 15g/L	B (Imi)	Intervix®	750ml/ha	600 ml/ha
Gesaprim 900g/kg	C (Tri)	Atrazine 900 WG, Gesaprim 900 WG®	2000g/ha	same
Glyphosate 540 g/kg	M	Roundup Powermax®	1000ml/ha	same
Glyphosate 540 g/kg	M	Roundup Powermax®	1500ml/ha	same
Glyphosate 540 g/kg	M	Roundup Powermax®	2000ml/ha	same

Table 2. Herbicides and rates tested on wild oats samples

Herbicide Tested	Group	Common Trade Names	2014 Rate	2013 Rate
Clodinofop 240 g/L	A (Fop)	Topik®	100 ml/ha	same
Clodinofop 240 g/L	A (Fop)	Topik®	210 ml/ha	Not tested
Haloxyfop 520 g/L	A (Fop)	Verdict®	100 ml/ha	same
Clethodim 240 g/L	A (Dim)	Select®, Status®	350ml/ha	Same
Clethodim 240 g/L	A (Dim)	Select®, Status®	Not tested	500ml/ha
Pinoxaden 100 g/L	A (Den)	Axial®	200 ml/ha	Same
Mesosulfuron-methyl 30 g/L	B (SU)	Atlantis®	330ml/ha	Same
Flamprop-M-methyl 90 g/L	Z	Mataven 90®	1800ml/ha	Same

Additional details were collected when samples were submitted including herbicide history, suspected resistance status, length of farming history and the number of herbicide applications for each mode of action applied in the last 10 years.

Following testing the individual results of the testing were forwarded by GOA to those growers and/or agronomists that submitted the samples to allow them to make informed decisions as to the management of those populations. The combined results of all tests are the subject of this report.

4 Results

Industry accepted terminology for herbicide resistance is that-

1. *Survival of up to 20% of the treated population is termed to be only "Developing Resistance"*
2. *Survival of 21% or more of the treated population is termed "Resistant"*

To simplify this report a modified definition of resistance will be used for reporting. Any population with 10% or more of the population surviving the treatment will be referred to as resistant.

4.1 Ryegrass

51 samples of annual ryegrass were submitted to the survey. Most of the samples (92%) were collected and logged by advisors and the remainder by growers.

In the 2013 survey it was thought that a reasonable cross section of the region was represented with the exception of the western area beyond Trangie and Warren and the north eastern areas around Coolah. This survey, although with fewer samples, appears to have a more even distribution of sample sites as seen in Figure 1 below.

Close to 75% of the samples submitted came from populations that the farmer or adviser indicated on submission of the samples that they were "Yes-pretty certain" the population was resistant; the remainder were from populations that were suspected "Maybe- but not certain" to be resistant with no samples submitted where no level of resistance was expected at all.

Examining the other answers to the survey questions around past herbicide use, there appeared to be little correlation between the patterns of past herbicide use or the length of farming history and the levels of resistance demonstrated through the testing.

That is, some populations demonstrated resistance to a particular herbicide where there has been no or very little previous use indicated, for example 15 samples were reported to have had less than two Group B herbicide applications yet all demonstrated some level of resistance, 2 of those demonstrating 100% resistance to Hussar OD.

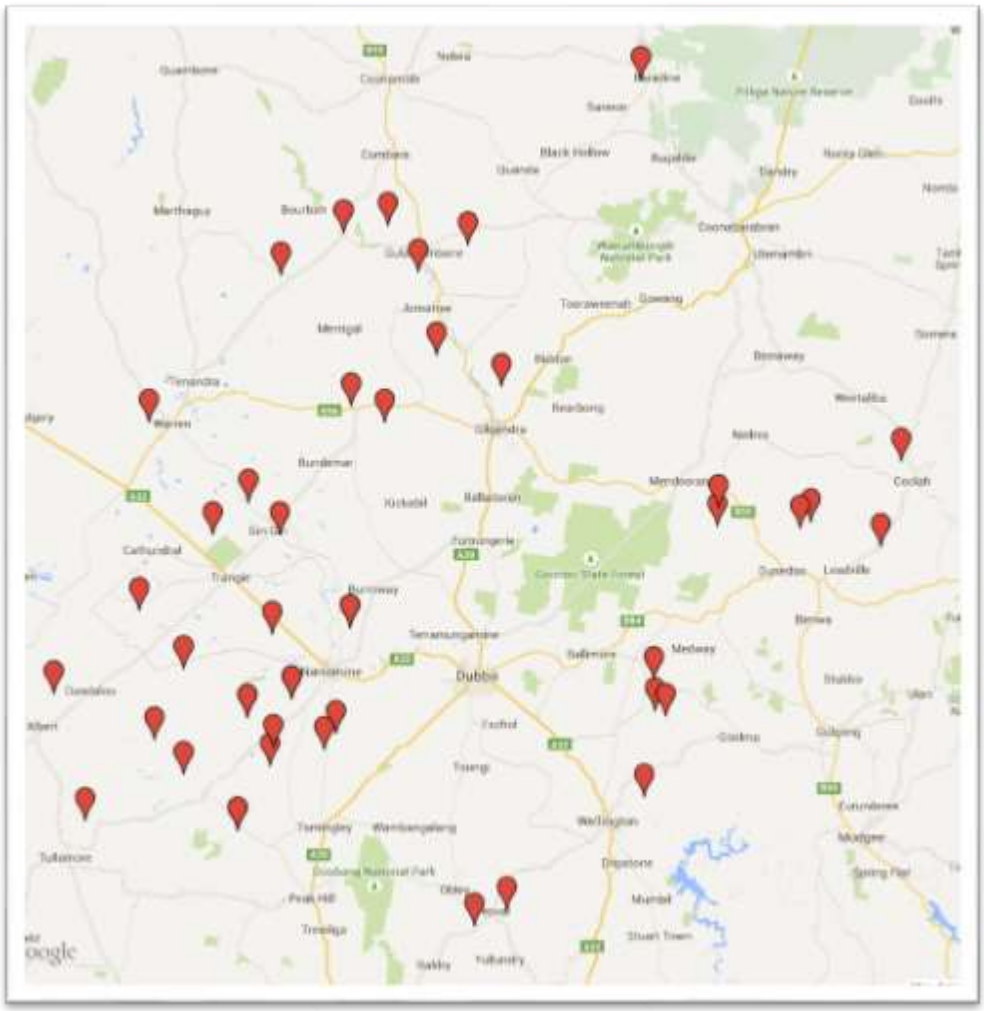

Figure 1. Approximate locations of ryegrass sample collection sites; multiple samples may have been taken from the general locality marked by a single pin.

Similar to the findings from the 2013 survey, none of the sample were completely susceptible to the herbicides tested and multiple resistance, where a sample demonstrates resistance to more than one herbicide type, was common as detailed in Table 3 below.

Table 3. Annual ryegrass sample populations and incidence of multiple resistances to the herbicide groups or subgroups tested in 2014

No. of herbicide groups or sub groups with demonstrated resistance #	No of samples	% of samples submitted
1	3	6
2	5	10
3	3	6
4	8	16
5	14	27
6	12	24
7	6	12
Totals	51	**100**

Herbicides groups and subgroups considered- Fop, Dim (Select® only), Den, SU, Imi, Triazines and Glycines.

For this table Fops, Dims and Dens are considered as subgroups of Group A's because it has been commonly accepted that differential levels of control could be expected when using these herbicides. Similarly, for the Group B's they are in two subgroups being the Sulfonyl urea types and the imidazolinones.

Only three samples, or 6%, demonstrated resistance to only one of the herbicides tested with the vast majority (94%) demonstrating multiple resistance to two or more herbicides tested. The largest group of samples representing 27% of the populations submitted were resistant to five herbicide groups or subgroups. A similar number (24%) were resistant to six herbicide groups while 12% of the samples demonstrated resistance to all seven herbicide groups or sub groups tested.

In comparison to the 2013 survey, the largest group of samples (37%) demonstrated resistance to four herbicide groups tested, 15% to five and only 1% demonstrated resistance to six or seven groups tested.

The number of populations resistant to the individual herbicides and rates tested varied over a wide range as detailed in Table 4 below.

Table 4. Number of annual ryegrass samples demonstrating resistance to the various herbicides and rates tested

Herbicide and Rate	No of samples ≥ 10% Survival	% of samples with ≥ 10% survival
Trifluralin @ 2000ml/ha	1	2
Verdict 100ml/ha	44	86
Select® 350ml/ha	31	61
Select® 500ml/ha	13	26
Factor® 180g/ha	7	14
Axial® 300ml/ha	39	77
Logran 750® 35g/ha	46	90
Hussar OD® 100ml/ha	44	86
Intervix® 750ml/ha	30	59
Atrazine 900 WG 2000g/ha	19	37
Glyphosate 540 1000ml/ha	29	57
Glyphosate 540 1500ml/ha	9	18
Glyphosate 540 2000ml/ha	4	8

Following is some discussion regarding the individual resistances demonstrated in the populations tested but also how it might relate to other resistances but this is limited to those only within the same herbicide groups.

Group A's- Fops, Dims & Dens

- The frequency of resistance to Verdict, a common Fop herbicide, was the second most common resistance, demonstrated in 86% of samples tested
- Resistance to Axial®, a Den herbicide, was the third most common resistance affecting 77% of the populations tested
- Resistance to Select® a Dim herbicide at the lower rate of 350ml/ha was also very common affecting 61% of the samples tested, increasing the rate to 500ml/ha improved control reducing the number of resistant populations to 26%
- Factor®, an alternate Dim herbicide to Select®, had 14% of the samples demonstrating resistance

In terms of the levels of cross resistance between the Group As herbicides;

- No populations that demonstrated resistance to Select® at either rate were not also resistant to Verdict, however in all cases the level of resistance (survival of individuals sprayed) was higher in Verdict than Select®.
- All seven cases where Factor® resistance was demonstrated, populations were also resistant to Verdict, Select® and Axial® but had much lower levels of survival with only 10-20% survival observed.

- All samples demonstrating resistance to Axial® were also resistant to Verdict. 29 of the 39 populations (74%) resistant to Axial® were also resistant to the low rate of Select®, only 13 of the 39 (33%) were resistant to the high rate of Select®.

In summary, Verdict and Axial® are largely ineffective on the majority of these populations. The use of Select® at 350 ml/ha would be effective on only 39% of the populations tested although it was more effective at the higher rate of 500 ml/ha where it remained effective on about 74% of the samples. However even at the higher rate, 1 in 4 of these populations was not effectively controlled.

This is a different story to the 2013 testing, where more than 75% were susceptible to the lower rate of Select® and increasing the rate to improved effectiveness controlling 92%.

The potential value in Factor® as a Dim herbicide to control ARG is higher as it has the lowest frequency of resistance demonstrated out of any of the Group A's. However, resistance was still demonstrated in 14% of the samples tested.

Group B's- SU's and imidazolinones

- Logran was all but ineffective with 90% samples demonstrating resistance,
- 86% of the samples demonstrated resistance to both Hussar and Logran
- 59% of samples tested were resistant to Intervix

In terms of cross resistance between the three Group B herbicide tested-

- All populations that demonstrated resistance to Hussar were also resistant to Logran
- All the cases where resistance to Intervix was demonstrated, they were also resistant to both Logran and Hussar
- No resistance to Intervix was demonstrated on 13 of the 44 (30%) populations that were resistant to both Logran and Hussar

In summary Logran and Hussar were largely ineffective on most of the populations tested. Intervix would still offer some value in controlling those resistant to Logran or Hussar but this data seems to suggest once resistance to Intervix is developed the other Group B would also be ineffective.

Group M

- 57% of samples demonstrated resistance to Glyphosate 540 at 1000 ml/ha. This was reduced to 18% and 8% when the rate was increased to 1500 and 2000 ml/ha respectively
- Samples that were collected in fields where fewer applications of Glyphosate (6-8) were reported tended to have lower resistance (however all samples that were not resistant were reported to have been sprayed with Glyphosate more than 10 times)
- 97% of the populations that demonstrated resistance at the lower rate of glyphosate demonstrated resistance to multiple alternatives. 66% of them demonstrating resistance to five or more alternates herbicide groups or sub groups

The level of resistance to Glyphosate found in the 2014 samples (57%) is much higher than that observed in the 2013 survey at 6% but the majority of those samples also displayed resistance to multiple modes of action. These results clearly show that ARG Glyphosate resistance is present in the

region. Using a higher rate of Glyphosate on these samples is still an alternative (with resistance levels dropping from 57 to 8% when the rate is doubled.

4.2 Wild Oats

43 samples of wild or black oats were submitted to the survey, one sample failed to germinate and was not tested, and two other samples had insufficient plants to complete the herbicide test for Topik® resistance. Most samples were collected and submitted by advisors.

The distribution of the sample locations is detailed in Figure 2 below, this distribution represents a reasonable cross section of the GOA region.

Figure 2. Approximate locations of wild oats sample collection sites; multiple samples may have been taken from the general locality marked by a single pin.

Within these samples there appeared to be little correlation to the length of cropping history and resistance. Only two samples were reported to have been cropped for less than 10 years and these showed lower incidences of resistance. Interestingly there was no resistance found in the one sample for which had been collected on the field with more than 50 years of reported cropping, and amongst the highest reported number of sprays across all groups.

There appears to be little correlation between any particular past herbicides usage indicated in the survey questions and the demonstrated resistance to those herbicides.

All samples were submitted were suspected to either “Yes- pretty certain” of resistance or “Maybe- but not sure” of resistance and no samples were suspected to be susceptible.

Despite these predictions that none of the samples submitted were not thought to be likely resistant to some level, 14% of the samples submitted demonstrated no resistance to the broad range of common herbicide options tested. This was similar to the 2013 survey where 29% of samples, all predicted to resistant or possibly resistant showed no demonstrated resistance to a similarly wide range of herbicides.

Multiple resistances were also common in the BO samples submitted as with the ARG samples. Table **5** below details the levels of multiple resistance in the samples tested. For this table both Topik® and Verdict have been counted as alternate options despite both products being a Fop herbicide. As is shown in Table 6 below and the findings from the 2013 survey, distinctly different levels of control have been demonstrated from the use of the two alternate options. This phenomenon is often observed in other testing as well.

Table 5. Black oat sample populations and incidence of multiple resistances to the herbicide groups or subgroups tested in 2014

No. of herbicide groups or sub groups with demonstrated resistance	No of samples	% of samples submitted
0	6	14
1	2	5
2	12	29
3	9	21
4	7	17
5	6	14
Totals	**42**	**100**

Herbicides groups and subgroups tested- Fop (Topik® & Verdict), Dim, Den, SU, Grp Z.

Only 5% of the samples were resistant to just one herbicide tested, the largest group representing 29% demonstrated resistance to two alternative herbicides. However, a significant number of populations (>50%) demonstrated resistance to three, four and five groups however no population demonstrated resistance to the full six options tested.

The level of resistance to the individual herbicides tested are detailed in Table 6 below. Following is some discussion regarding the individual resistances demonstrated in the populations tested but also how it might relate to other resistances but as for the ARG samples discussion is limited to those only within the same herbicide groups.

- Resistance to Topik® was the most frequent resistance observed affecting 86% of the samples when applied at the lower rate of 100ml/ha
- Topik® when applied at 210ml/ha improved control, but only marginally, reducing the number of resistant populations to 68%
- Verdict, also a Fop herbicide was not effective in 48% of the populations tested and was the third most common in term of the frequency of resistance behind Mataven 90®
- 19% of the samples tested were resistant to Select® at 350ml/ha.

- Axial® a Group A, Den herbicide, was less effective than Select® but more effective than Verdict or Topik® but 33% of populations still demonstrated resistance
- Atlantis® was the most effective of the options tested but resistance was demonstrated in 10% of the populations tested
- Mataven 90® was the second most frequent resistance demonstrated in these populations with 69% of samples demonstrating resistance

Table 6. Number of black oat samples demonstrating resistance to the various herbicides and rates tested

Herbicide and rate	No of samples tested	Number of samples with ≥ 10% resistance	Percentage of samples with ≥ 10% resistance
Topik® 100ml/ha	42	36	86
Topik® 210 ml/ha	40	27	68
Verdict 100ml/ha	42	20	48
Select® 350ml/ha	42	8	19
Axial® 200ml/ha	42	14	33
Atlantis® 330ml/ha	42	4	10
Mataven 90® 1.8L/ha	42	29	69

In term of the observed levels of cross resistance in the populations tested-

- Verdict was still effective on 16 of the 36 (45%) of the populations that demonstrated resistance to Topik® at the lower rate
- Topik® was however not effective on any populations that were resistant to Verdict
- The eight cases that demonstrated resistance to Select® were also resistant to Topik® at both rates, Verdict and Axial® and only one of them was not also resistant to Mataven 90®®. Six however were susceptible to Atlantis®
- Axial® was effective on 61% of populations that were resistant to Topik® at the low rate and 55% at the high rate
- Mataven 90® was only effective on 19% of the population that demonstrated resistance to Topik® at either rate
- Four samples tested low level resistance to Atlantis®, all of which also tested with resistance to Topik® (100 ml/ha.

5 Discussion

Acknowledgement should be first given to the collection method and the potential bias that may have given to the samples submitted to this survey. This was not a random survey of the region and growers and advisors would most likely sampled more suspicious populations than not. This is highlighted in the sample questionnaire noting all samples were either suspected “resistant” or “possibly” resistant. Therefore, it should be considered the outcomes and information presented from this survey may represent a “worst case scenario”. Caution should exercised when comparing

results from this survey and should not be compared to resistance levels reported in other regions that rely on random sampling techniques.

That said, the target populations for this survey are from cropping paddocks, therefore it is likely that the only seed available to sample would be those from plants close to maturity that would have survived in-crop herbicide applications. This scenario would support a theory they are possibly resistant to at least some herbicides. Another way to put it is that susceptible plants would have most likely been controlled by herbicide applications and simply not available to sample. Given that most growers will attempt to control weeds in crop by praying herbicides suggest that herbicide tests conducted on seeds collected from cropping paddocks will always bias towards a greater level of resistance whether the collection method is random or directed.

Given this bias towards sampling populations suspected of resistance the finding of some levels of resistance is no surprise. However, both the ARG and BO samples submitted have overwhelmingly demonstrated a high incidence of resistance with 100% of the ARG and 86% of BO samples showing resistance to at least one of the herbicides tested. But further to this the survey showed an alarmingly high level of multiple resistances with 94% of ARG and 81% of the BO samples with resistance to two or more alternate herbicide options. The survey has also demonstrated the herbicide groups with the most resistance as detailed in the Table 4 and Table 6 above and probably requires little further commentary. Of interest though is some of the broader outcomes in the results discussed below.

An interesting observation from the BO survey is that nearly 14% of the samples showed complete susceptibility to all herbicides tested even though they had been collected from a crop situation and presumably sprayed and suspected to be resistant. This begs the question as to how these “escapes” occurred. There is number of potential explanations however no supporting evidence is available:

- BO is well noted for seed dormancy and possibly the plants sampled simply germinated after the paddock was treated with herbicides
- Poor application of herbicides which has led to escapes
- Impact of plant stresses reducing the herbicide control?
- Use of an alternative herbicides in that years were not tested in this survey

This situation was also evident in the 2013 survey where 29% of the populations submitted were also found susceptible despite predictions of resistance. Does this possibly highlight the potential for improved BO control through greater diligence in control programs but also why BO continue to be a perennial issue in many paddocks?

Multiple resistances

As detailed in Table 3 and Table 5; multiple resistance is common with only 6% of ARG samples and 5% of BO samples demonstrating resistance to only a single herbicide group or subgroup. The clear majority of the samples submitted from both species demonstrated multiple resistances.

Similar to the findings in the 2013 survey, multiple resistances are more common than just single product resistance or put another way- samples with no resistance or single product resistance was a rarity.

The reader may choose to read into the levels and types of cross resistances but as discussed below each population can be unique in its resistance makeup. The reader should exercise caution to make assumptions as what is demonstrated in this data will not necessarily be applicable to all populations. Further to this the complexity of relationships between the large numbers of herbicides tested can be overwhelming.

Knowing your resistance Status®

The results sections above have detailed the frequencies of individual resistances as well as a number of generalisations about levels of cross resistances between some herbicides. However, it should be noted these apply to only this set of samples and may not apply beyond the fields in which they were collected. There is no unique and distinct characterisation of a "resistant" ARG or BO plant- each one can be different.

At a paddock level it is foreseeable that some populations may have some herbicide susceptibilities or resistances that cannot be predicted or expected. To best manage these populations formal identification of the resistance status of weeds will ensure that money and efforts are not wasted in applying a herbicide that will not work and that alternative chemistries (perhaps even from the same group) are not overlooked that are mistakenly thought to have resistance issues.

To highlight this point for example

- 86% of BO samples demonstrated resistance to Topik®, but only 48% demonstrated resistance to Verdict with both herbicides in the same herbicide group
- 90% of ARG samples demonstrated resistance to Logran and 86% demonstrated resistance to Hussar yet only 59% to Intervix- all herbicide are Group B herbicides

This highlights the value in herbicide resistance testing weed populations where it is equally important to confirm that a particular product has not worked because of resistance but to identify which products may still work into the future.

Options are running out!

As discussed the identification of resistance to a number of key products such as the Fop herbicides and Group B herbicides has come as no surprise. Alarmingly though the testing has highlighted some cases of resistance to a few "less used" products thought to be safe and still effective and which were forming a key backstop in controlling ARG and BO now and into the future.

Atrazine and trifluralin have had much less reliance or use in the region compared to many other products for the control of these weeds. Experience from other regions also indicated that resistance to these products can take much longer to develop and is much less common.

However, 19 populations (37%) of ARG samples demonstrated resistance to atrazine. Atrazine in the region is often thought as of underutilised and with little resistance likely but these results should obviously challenge this belief.

Similar to the finding in the 2013 survey trifluralin resistance was found to be low with only one population of ARG that demonstrated resistance in the 2014 survey. Although the incidence of resistance is low the presence of trifluralin resistance in the region cannot be denied.

Similarly, Intervix as a product mainly utilised in Clearfield canola and hence only a small proportion of our annual cropping area, demonstrated resistance in 59% of the ARG samples.

Resistance to Select® in the region is not a total surprise but for many farmers it is the only reliable in-crop selective herbicide available and is therefore a key in the management of ARG, however 61% of ARG samples demonstrated resistance at the lower application rate of 350 ml/ha. It is very concerning that every one of these populations were also resistant to Verdict, Axial®, Logran, and Hussar. Increasing the application rate of Select® to 500ml/ha did decrease the survival to 26% but this still sees ~ 1 in 4 samples with demonstrated resistance.

Mataven 90®has been talked of as an alternate herbicide product for the control of BO however has had very little use in recent times[3]. Despite this 69% of the BO populations demonstrated resistance to it, all of which also demonstrating resistance to Topik®. Again a similar finding was found in the 2013 survey with high levels of resistance identified. There are questions over the future manufacture and supply of Mataven 90®but it usefulness on these populations is certainly questionable.

Finally, herbicides play a pivotal role in our current minimum-till or zero till farming systems. Possibly the most important product in the northern farming region is glyphosate and this survey showed significant levels of resistance, with 57% of populations showing resistance at 1 L/ha, 18% at 1.5 L/la and 8% at 2 L/ha. Generally lower levels of resistance were detected in populations that had received fewer (6-8) applications, while higher levels were recorded where more than 100 applications were reported. This herbicide is invaluable in the control of weeds in our fallow systems which are essential to conserve out of season rainfall to achieve profitable crop yields. It is also important for managing pre-planting flushes of weeds, potentially the largest germination of winter weed. Loss of the effectiveness of this herbicide will seriously challenge the sustainability of this otherwise profitable system.

6 Conclusion

As intended the survey sampled weed seed samples from a healthy cross section of the GOA region of the central West of NSW with 51 ARG samples and 42 BO undergoing testing. This complimented the populations tested in 2013 which brings the totals of 130 ARG and 84 BO populations tested across the GOA region over the two seasons.

Testing revealed that herbicide resistance was common place and that in the vast majority of the samples submitted multiple resistances were almost universal. In a number of cases the incidence of multiple resistances was such that there would be only a few potentially effective herbicide options left that might control those weeds.

Testing also revealed the complexity of multiple resistances, and the lack of clear patterns make it difficult to assume that a weed population is either resistant or susceptible to a particular chemistry based on its resistance to another or herbicide history. In other words, if you are going to test for

[3] Data collected from 2013 herbicide resistance survey

resistance, test for products that may work going forward rather than testing simply confirm the ones that you often suspect do not.

Herbicide resistance is not an issue confined to Western Australia or other regions only- this survey has identified many populations in the Central West of NSW that could make a Western Australian farmer blush. “Herbicide resistance is here and it is bad”. It should no longer be considered as “someone else’s issues” or that “it’s not that bad”.

The survey was also invaluable in identifying what are some of the most challenged herbicide groups are in terms of effectiveness. But the survey also served a warning to growers particularly for what many have thought to be “safe” and “effective” herbicide options such as Select®, Atrazine, Trifluralin and glyphosate with clear signs that resistance is here.

The results of this survey are damming and its strength may be the force that is needed to change attitudes and to acknowledge the issue which of course is the first step to better manage the issue of herbicide resistance.

7 Acknowledgements

GOA would like to thank the support of the GRDC in the undertaking of this work and other work by GOA. GOA would also like to thank the many growers and advisors that have collected and submitted samples to this survey.