

Samples Received

The testing service screened 305 samples in 2013. This was a decrease of 13% compared to the 351 samples screened in 2012 but more than any other year since 2006. However many of the samples were supplied by the Western Australian Department of Agriculture and Food as part of a paddock monitoring project.

As is always the case the majority of these samples were annual ryegrass (236) but large number of wild oat and wild radish samples were also received (Table 1).

Table 1: Total number of samples received since 2009

	2010	2011	2012	2013
Annual ryegrass	89	42	256	236
Wild oats	28	11	73	51
Wild radish	12	8	18	14
Brome grass	0	0	0	1
Others	1	1	4	3
Total	130	62	351	305

Summary of Results

The results obtained from the 2013 resistance screening are similar in the majority of cases to the results from previous years.

Annual ryegrass

This year, 236 annual ryegrass samples were received, of which 226 were tested to five or more herbicides (Table 2). However, only 38 of these were tested to the standard cross-resistance test (Groups A 'fop', A 'dim', B, C and D). Of the remaining 188 samples, 142 had both the addition of a herbicide from another group, usually Roundup, and changes to herbicides within the standard groups.

One hundred and thirty eight samples were also tested to a sixth herbicide, two to seven and 15 samples were tested to eight herbicides. Of the 155 samples, 138 were tested to Roundup with the other herbicides being a variety of Group A or B herbicides.

Ninety percent of all samples tested to a 'fop' herbicide were classed as either resistant or developing resistance to that herbicide (Table 3). This is within the range experienced in previous years.

Table 2: Number of samples tested to each of seven herbicide groups

	2009	2010	2011	2012	2013
A (fops)	63	70	36	75	190
A (dims)	70	79	42	394	255
A (dens)	2	10	1	42	43
B	67	70	35	172	190
C	65	71	39	218	190
D	65	71	39	236	212
M	8	15	23	186	167

Only 12 percent of samples tested to a 'dim' herbicide were classed as resistant or developing resistance (Table 3). This was a large decrease on the last two years but similar to 2009. The lower number of samples screened to 'dim' herbicides other than Select is a major reason for this reduction. In 2012 of the 394 tests to 'dim' herbicides, 151 (38%) were screened to a herbicide other than Select, mostly Achieve (141 tests). This year only 24 (9%) of the 255 'dim' tests were to a herbicide other than Select. The proportion of samples resistant to Select is always much lower than for most of the other 'dim' herbicides, this year 7% of samples were resistant to Select compared to 76% to Achieve (Table 5), last year the levels were 25% and 93% respectively. Of the 43 samples screened to Axial 84% were resistant or developing resistance.

Ninety three percent of samples were resistant to Group B herbicides, a similar level to three of the last four years. No samples were resistant to atrazine (Group C), and 5% were resistant to trifluralin (Group D similar to the last two years (Table 3).

Table 3: Percentage of samples resistant or developing resistance to each herbicide groups

	2009	2010	2011	2012	2013
A (fops)	90	90	83	96	90
A (dims)	16	26	43	50	12
A (dens)	100	70	100	81	84
B	91	93	74	85	93
C	0	1	0	1	0
D	12	13	3	5	3

Cross and Multiple Resistance

Of the 226 samples screened to five or more herbicides, 185 were screened to five different herbicide groups 80% were resistant or developing resistance to two or more herbicides, a similar level to that recorded the last four years. This reflects the

major increase in the level of resistance to the group B herbicides since 2005. One sample was resistant to four of the groups tested while six samples were susceptible to all herbicides (Table 4).

Table 4: Results of cross resistance screening showing percentage of samples resistant or developing resistance to different groups.

No. of groups	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)
5	0	0	0	0	0
4	0	1.4	5.6	1.3	0.5
3	21.5	27.0	19.4	12.8	10.8
2	60.0	56.8	47.2	66.0	68.6
1	16.9	13.5	27.8	18.0	16.8
0	1.6	1.3	0	1.9	3.2
No. of samples	65	74	36	156	185

Herbicide Groups

Among all samples there were major differences between the various groups and in some cases within the different herbicide groups.

Group A herbicides

While Hoegrass and Select were the main herbicides tested, samples were also screened to Verdict, Achieve, Axial, Factor, and Decision (Table 5).

Table 5: Results for ryegrass samples showing percentage resistant (Res) or developing resistance (DR) to individual Group A herbicides.

	Tested	Res	DR	%	Susc
<u>'fops'</u>					
Hoegrass	176	147	11	90	18
Verdict	14	12	0	86	2
<u>'dims'</u>					
Select	231	7	9	7	215
Achieve	17	12	1	76	4
Factor	7	1	0	14	6
<u>'den'</u>					
Axial	43	34	2	84	7
<u>'fop' & 'dim'</u>					
Decision	3	3	0	100	0

Group B herbicides

For only the second year more samples were screened to Logran than to Glean, previously this occurred in 2003 (Table 6). Samples were also screened to Atlantis, Intervix and Hussar.

Table 6: Results for ryegrass samples screened to individual Group B herbicides

	Tested	Res	DR	%	Susc
Glean	57	47	7	95	3
Logran	113	99	5	92	9
Atlantis	1	1	0	100	0
Hussar	8	5	1	75	2
Intervix	11	10	1	100	0

Other herbicides

Annual ryegrass samples were screened to eight other herbicides, simazine, atrazine, trifluralin, Boxer Gold, Avadex, Sakura, Roundup and Gramoxone. The observed incidence of resistance to these herbicides was lower than the resistance to the higher risk Group A and B herbicides (Table 7).

Two samples were found to be resistant or developing resistance to Roundup. This adds to the more than 350 confirmed cases of annual ryegrass resistance to Roundup in Australia and this herbicide needs to be treated carefully due to its importance in Australian agriculture.

Table 7: Results for ryegrass samples screened to other herbicide groups.

	Tested	Res	DR	%	Susc
<u>Group C</u>					
Simazine	64	0	0	0	64
Atrazine	126	0	0	0	126
<u>Group D</u>					
Trifluralin	212	5	3	3	204
<u>Group E,K</u>					
Boxer Gold	3	0	0	0	3
<u>Group J</u>					
Avadex	14	0	0	0	14
<u>Group K</u>					
Sakura	2	0	0	0	2
<u>Group L</u>					
Gramoxone	1	0	0	0	1
<u>Group M</u>					
Roundup	167	2	0	1	165

State by State

The majority of samples came from New South Wales and Western Australia, although 109 of the samples from Western Australia were supplied as part of a state wide paddock monitoring program. Victoria and Tasmania provided 17 samples (Table 8).

Table 8: Number of ryegrass samples received from each state.

	2009	2010	2011	2012	2013
NSW	32	27	25	196	93
Vic	6	10	2	5	7
SA	2	1	0	1	0
WA	27	44	15	50	126
Tas	2	7	0	3	10

With the very low number of samples received from Victoria and Tasmania only the data for New South Wales and Western Australia has been analysed separately (Figure 1).

Similar results were found for samples from New South Wales and Western Australia with approximately 90% of samples from both states resistant to 'fop' herbicides. The proportion of samples resistant to Group A 'dim', Group B and Group D herbicides was also similar for both states (Figure 1).

Similar to the last five years but in comparison to prior to 2005 the level of group B resistance has increased markedly. The reason for this is unknown however the availability and use of the newer group B (On Duty, Hussar and Atlantis) herbicides may be a factor. Another reason could be that the failure of a Group B herbicide is now acting as a critical factor in the decision to supply a sample for resistance testing.

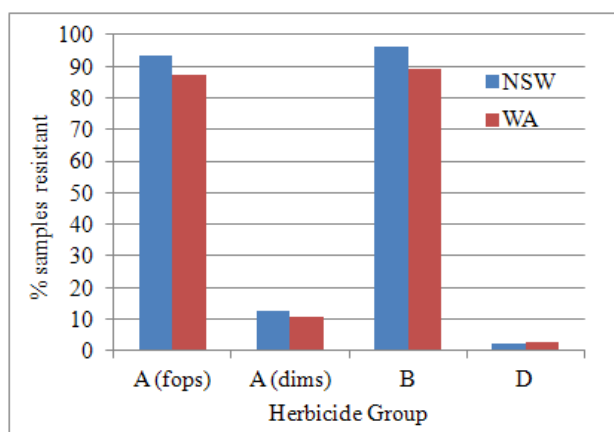


Figure 1: Percentage of ryegrass samples resistant and developing resistance for NSW and WA.

Wild Oats

The number of wild oat samples (51) received was lower than last year but still the most since 2006 when 56 samples were received. On a percentage basis the number of samples was marginally lower than many years (Table 9). All but one of the wild oat samples came from New South Wales, the other sample was supplied from Queensland.

Table 9: Number of wild oat samples received and percentage of total samples

	2009	2010	2011	2012	2013
Total	104	130	62	351	305
Wild oats	23	28	11	73	51
Percentage	22.1	21.5	17.7	20.8	16.7

The level of 'fop' resistance among the samples was 81%, within the range of previous years (Table 10). Twenty five samples were tested to Wildcat (22 resistant), 11 to Topik (9 resistant) and seven to Verdict (4 resistant).

For the 'dim' herbicides, one out of 49 samples tested were resistant to Select and three out of five were resistant to Achieve and the only sample tested to Factor was resistant. Twenty six samples were tested to Axial with 12 of these resistant (Table 10).

Thirty eight samples were tested to Atlantis with three resistant and one of the six samples tested to Hussar was resistant while no samples were resistant to Intervix (5 tested) or Crusader (2 tested). nine samples were tested to Mataven (Group Z), four of which were resistant (Table 10). All of the 34 samples tested to Avadex were susceptible.

Table 10: Percentage of wild oat samples found to be resistant since 2010 (number tested in brackets)

	2010 % (no.)	2011 % (no.)	2012 % (no.)	2013 % (no.)
'fops'	84 (25)	89 (9)	74 (71)	81 (43)
'dims'	0 (25)	0 (8)	7 (75)	9 (55)
'dens'	33 (6)	50 (4)	12 (51)	46 (26)
B	17 (6)	0 (4)	12 (52)	8 (52)
Z	14 (21)	13 (8)	67 (3)	44 (9)

Broadleaf species

Fourteen wild radish samples were provided for resistance screening. Six of the wild radish samples were from Western Australia, five from New South Wales and three from Tasmania.

Fifty six percent of samples were resistant to Group B herbicides with seven samples screened to Glean (three resistant) and two to Logran (both resistant). One sample was found to be developing resistance to Brodal (eleven tested), one to 24D Amine (eleven tested) and one to atrazine (four tested). Two of the Glean resistant samples came from Tasmania and both Logran resistant samples were from NSW. No samples were resistant to MCPA Amine (one tested), Simazine (four tested), Tigrex (two tested), Bromoxynil (one tested) or Roundup (four tested).

Other species

Three silver grass (all from NSW) and one brome grass (Victoria) samples were received this year. The silver grass samples were screened to Select, Simazine, Stomp, Monza and Roundup and all samples were susceptible to all herbicides. The brome grass sample was tested to Verdict, Select, Flame, trifluralin and Roundup and was susceptible to all herbicides.

Final Observations

- The number of samples received was similar to last year, although a large number were provided as part of a DAFWA paddock monitoring project. This increase in numbers from the last few years means care needs to be taken if only using the percentage of samples resistant to specific groups without considering the number tested.
- Samples of annual ryegrass were received from four states with wild oats received from three and wild radish from two states. The brome grass sample came from Victoria while all three silver grass samples were from NSW.
- For ryegrass samples the level of resistance remained constant for all herbicide groups compared to last year except for a marked decrease in resistance to the Group A 'dims'. This was a reflection of the decreased proportion of 'dim' herbicides other than Select tested.
- A larger percentage than normal of the ryegrass samples were resistance to Roundup. However several of the samples were from the high risk areas of irrigation channels and road sides.
- The level of Group B resistance has not changed over the last six years; all years were markedly higher than prior to 2005.
- Wild oat resistance for all groups was within the range experienced in previous years.
- Wild radish samples were resistant to four herbicide groups (B, C, F and I) compared to three in both 2010 and 2012 (B, C and I) and two (B and I) in 2011.

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Testing forms and annual reports are available at:

<http://www.csu.edu.au/research/grahamcentre/people/wwg/strategies/herbicide-resistance.htm>

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