

Samples Received

The testing service screened 655 samples in 2014. This was over a 100% increase compared to the 305 samples screened in 2013 and the third highest since the service started in 1991. The majority of the samples came from four sources, Landmark in WA supplied 387 samples including 111 wild radish samples, the Stirlings to Coast Farmer Group from WA (73 samples), the Cranbury Landcare Group in NSW (37 samples) and a DAFWA paddock monitoring project (18 samples).

As is always the case the majority of these samples were annual ryegrass (462) but the 128 wild radish samples was the most ever received in one year, the previous highest being 30 samples in 2003 large number of wild oat and wild radish samples were also received (Table 1).

Table 1: Total number of samples received since 2011

	2011	2012	2013	2014
Annual ryegrass	42	256	236	462
Wild oats	11	73	51	58
Wild radish	8	18	14	128
Brome grass	0	0	1	5
Others	1	4	3	2
Total	62	351	305	655

Summary of Results

The results obtained from the 2014 resistance screening are similar in the majority of cases to the results from previous years.

Annual ryegrass

This year, 462 annual ryegrass samples were received, of which 456 were tested to five or more herbicides (Table 2). However, only 21 of these were tested to the standard cross-resistance test (Groups A 'fop', A 'dim', B, C and D). Of the remaining 435 samples, 229 had either the addition of a herbicide from another group, usually Roundup, or changes to herbicides within the standard groups while 141 samples had both. Seventy eight samples were also tested to a sixth herbicide, 78 to seven, 21 to eight and 5 to nine herbicides.

Eighty four 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. The samples provided through Landmark WA were not tested to the 'fop' herbicides unless specifically requested by the client.

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

	2010	2011	2012	2013	2014
A (fops)	70	36	75	190	123
A (dims)	79	42	394	255	552
A (dens)	10	1	42	43	33
B	70	35	172	190	127
C	71	39	218	190	452
D	71	39	236	212	729
M	15	23	186	167	403

Only 14 percent of samples tested to a 'dim' herbicide were classed as resistant or developing resistance, a similar result to 2013 (Table 3). The majority of samples screened to 'dim' herbicides were screened to Select and/or Factor. In 2012 when 50% of the samples tested to 'dims' were resistant, of the 394 tests, 151 (38%) were screened to a herbicide other than Select, mostly Achieve (141 tests). This year only 21 (4%) of the 545 'dim' tests were to a herbicide other than Select or Factor. The proportion of samples resistant to Select and Factor is always much lower than for most of the other 'dim' herbicides, this year 13% of samples were resistant to Select and 5% to Factor, compared to 70% to Achieve (Table 5). Of the 36 samples screened to Axial 69% were resistant or developing resistance.

Seventy percent of samples were resistant to Group B herbicides, a similar level to three of the last four years. Two samples were resistant to atrazine (Group C), and 2% were resistant to trifluralin (Group D similar to the last three years (Table 3).

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

	2010	2011	2012	2013	2014
A (fops)	90	83	96	90	84
A (dims)	26	43	50	12	14
A (dens)	70	100	81	84	69
B	93	74	85	93	70
C	1	0	1	0	0.4
D	13	3	5	3	2

Cross and Multiple Resistance

Of the 456 samples screened to five or more herbicides 143 were screened to five or more herbicide groups. Sixty four of these samples were from the Stirlings to Coast Farmer Group and these samples were not screened to a 'fop' of Group B

herbicide and have been excluded from this analysis. Additionally, the majority of the 275 Landmark WA samples were screened to herbicides from only four groups as they were also not screened to ‘fop’ or Group B herbicides but instead to Group M and two Group D herbicides. While the proportion of samples resistant to three herbicide groups (6.3%) was only slightly lower than the last two years a markedly lower proportion of samples were resistant to two herbicide groups. A higher percentage of samples were resistant to either one herbicide group (29.4%) or none (20.3%) (Table 4). This difference from the last two years is mainly due to the lack of samples from Western Australia that were tested to five herbicide groups that included a ‘fop’ and B herbicide.

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

No. of groups	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)
5	0	0	0	0	0
4	1.4	5.6	1.3	0.5	0
3	27.0	19.4	12.8	10.8	6.3
2	56.8	47.2	66.0	68.6	44.0
1	13.5	27.8	18.0	16.8	29.4
0	1.3	0	1.9	3.2	20.3
No. of samples	74	36	156	185	143

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, Targa, Topik, 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	97	79	6	87	12
Verdict	21	13	1	67	7
Targa	2	1	0	50	1
Topik	3	3	0	100	0
<u>‘dims’</u>					
Select	460	32	26	13	402
Achieve	21	14	1	71	6
Factor	71	3	1	5	67
<u>‘den’</u>					
Axial	33	19	4	72	10
<u>‘fop’ & ‘dim’</u>					
Decision	1	0	0	0	1

Group B herbicides

While most of the samples screened to Group B herbicides were screened Glean or Logran samples were also screened to Atlantis, Hussar, Intervix and Crusader (Table 6).

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

	Tested	Res	DR	%	Susc
Glean	62	30	13	69	19
Logran	31	16	7	66	12
Atlantis	2	1	0	50	1
Hussar	7	7	0	100	0
Intervix	19	11	4	79	4
Crusader	2	2	0	100	0

Other herbicides

Annual ryegrass samples were screened to nine other herbicides, simazine, atrazine, trifluralin, Kerb, 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).

Fifteen 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
Group C					
Simazine	77	0	0	0	77
Atrazine	375	0	2	1	373
Group D					
Trifluralin	452	8	6	3	437
Kerb	278	0	0	0	278
Group E,K					
Boxer Gold	75	0	0	0	75
Group J					
Avadex	4	0	0	0	4
Group K					
Sakura	17	0	0	0	17
Group L					
Gramoxone	65	0	0	0	65
Group M					
Roundup	403	8	7	4	388

State by State

The majority of samples came from Western Austral and New South Wales. Most of the Western Australian samples came from either the Landmark WA offer (275) or the Stirlings to Coast Farmers Group (65) while another 16 were supplied as part of a state wide paddock monitoring program which supplied 109 samples in 2013. Twenty eight of the 88 samples from NewSouth Wales came through the Cranbury Landcare Group near Canowindra. Victoria South Australia and Tasmania each provided one sample (Table 8).

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

	2010	2011	2012	2013	2014
NSW	27	25	196	93	88
Vic	10	2	5	7	1
SA	1	0	1	0	1
WA	44	15	50	126	371
Tas	7	0	3	10	1

With only one sample received from each of Victoria, South Australia and Tasmania only the data for New South Wales and Western Australia has been analysed separately (Figure 1). Additionally, the results for the Western Australian samples are skewed as the Landmark WA samples were not screened to Group A 'fop' or B herbicides.

For all but the Group A 'fop' herbicides similar results were found for samples from New South Wales and Western Australia. Ninety five percent of the samples from New South Wales were resistant to a 'fop' herbicide compared to 74% of the Western Australian samples (Figure 1).

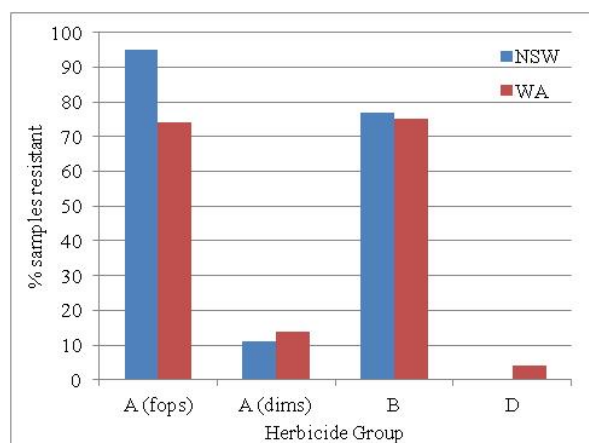


Figure 1: Percentage of ryegrass samples resistant and developing resistance for NSW and WA (Group D trifluralin only).

Wild Oats

The number of wild oat samples (58) received was similar to last year. On a percentage basis the number of samples was the lowest since 2004 and less than half of most of those years (Table 9). All but three of the wild oat samples came from New South Wales, two samples were supplied from Queensland and one from Western Australia.

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

	2010	2011	2012	2013	2014
Total	130	62	351	305	655
Wild oats	28	11	73	51	58
Percentage	21.5	17.7	20.8	16.7	8.8

The level of 'fop' resistance among the samples was 78%, within the range of previous years (Table 10). Thirty samples were tested to Wildcat (23 resistant), six to Verdict (4 resistant) and seventeen to Topik (14 resistant).

For the 'dim' herbicides, none of 47 samples tested were resistant to Select and six out of eleven were resistant to Achieve. Thirty samples were tested to Axial with fourteen of these resistant (Table 10).

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

	2011 % (no.)	2012 % (no.)	2013 % (no.)	2014 % (no.)
'fops'	89 (9)	74 (71)	81 (43)	78 (53)
'dims'	0 (8)	7 (75)	9 (55)	10 (61)
'dens'	50 (4)	12 (51)	46 (26)	47 (30)
B	0 (4)	12 (52)	8 (52)	20 (54)
Z	13 (8)	67 (3)	44 (9)	11 (9)

Forty nine samples were tested to Atlantis with eleven resistant while no samples were resistant to

Intervix (2 tested) or Crusader (3 tested). Nine samples were tested to Mataven (Group Z), with one of these resistant (Table 10). All samples tested to Avadex (35), Roundup (9) or atrazine (2) were susceptible.

Broadleaf species

One hundred and twenty eight wild radish samples were provided for resistance screening with 125 coming from Western Australia of which 111 were provided as part of the Landmark WA deal and eight from the Stirlings to Coast Farmers Group. The other three came from New South Wales.

Eighty eight percent of samples were resistant to Group B herbicides with 114 samples screened to Logran (101 resistant), four to Glean (3 resistant) and eleven to Intervix (10 resistant). Significant levels of resistance were found to atrazine (11/125), Brodal (59/128) and Ester 680 (20/114). Resistant samples were found to simazine (1/4) bromoxynil (4/20) and Sencor (1/9), while no samples were found to be resistant to Velocity, Jaguar, Tigrex, Precept or Gramoxone.

One sample was classed as developing resistance to Roundup however survivors were only found in one replicate and none at the half or two times rate so this population needs further testing to confirm its status.

Table 11: Percentage of wild radish samples found to be resistant since 2010 (number tested in brackets)

	2011 % (no.)	2012 % (no.)	2013 % (no.)	2014 % (no.)
B	44 (9)	75 (20)	55 (9)	88 (130)
C	0 (5)	0 (15)	13 (8)	11 (158)
F	0 (7)	6 (17)	9 (11)	46 (128)
I	50 (6)	0 (22)	9 (11)	16 (129)
M	(0)	0 (12)	0 (2)	1 (122)

Other species

Five brome grass, four from NSW and one from WA, and one barley grass sample from Tasmania were received this year. The brome grass samples were screened to Verdict, Targa, Select, Atlantis, Crusader, atrazine, trifluralin or Roundup. One of the samples was resistant to both Atlantis and Crusader, all other samples were susceptible to the tested herbicides. The barley grass sample was tested to Verdict, Select, Raptor and Gramoxone and was susceptible to all herbicides.

Final Observations

- The number of samples received was higher than all but two other years since the service commenced. The majority of the samples came from four sources, a Landmark WA deal, the Stirlings to Coast Farmers Group, the Cranbury Landcare Group and a DAFWA paddock monitoring project.
- The majority of annual ryegrass was received from two states (NSW and WA), with wild oats mainly received from NSW and wild radish from WA.
- For ryegrass samples the level of resistance remained similar to last year for all herbicide groups
- A larger percentage than normal of the ryegrass samples were resistance to Roundup.
- 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, an indication of the larger number of Western Australian samples.

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Testing forms and annual reports are available at:

<http://www.csu.edu.au/research/grahamcentre/>

and click on Herbicide Resistance in the Quicklinks box

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