2016 Herbicide Resistance Testing Service Report

Samples Received

The testing service screened 235 samples in 2016. This was less than half received in 2014 and 2015 but still more than received in 15 of the previous 25 years the service has operated. Approximately 45% of the samples came from two farmer groups in Western Australia, the Stirlings to Coast Farmer Group 47 samples and the Nyabing Farm Improvement Group supplied 47.

As is always the case the majority of these samples were annual ryegrass (152) but the 41 wild radish samples was the third most received in one year, behind only 2014 and 2015 and higher than wild oats for only the fourth time. A large number of wild oat samples were also received (Table 1).

Table 1: Total number of samples received since 2013

	2013	2014	2015	2016
Annual ryegrass	236	462	408	152
Wild oats	51	58	58	37
Wild radish	14	128	89	41
Brome grass	1	5	2	1
Others	3	2	1	4
Total	305	655	558	235

Summary of Results

The results obtained from the 2016 resistance screening are similar in the majority of cases to the results from previous years.

Annual ryegrass

This year, 152 annual ryegrass samples were received, of which 142 were tested to five or more herbicides (Table 2). However, only two of these were tested to the standard cross-resistance test (Groups A 'fop', A 'dim', B, C and D). Of the remaining 140 samples, 111 had both the substitution of one herbicide from another group, usually Roundup, and changes to herbicides within the standard groups. Forty three samples were also tested to a sixth herbicide, 42 to seven, 30 to eight, 12 to nine, 2 to 10 herbicides and one sample was tested to 11 herbicides.

Eighty seven 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. As in the previous two years many samples were not tested to the 'fop' or Group B herbicides unless specifically requested by the client.

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

	2012	2013	2014	2015	2016
A (fops)	75	190	123	61	46
A (dims)	394	255	552	480	201
A (dens)	42	43	33	45	30
B	172	190	127	99	93
C	218	190	452	394	143
D	236	212	729	396	181
L	1	1	65	312	91
M	186	167	403	393	140

Fifteen percent of samples tested to a 'dim' herbicide were classed as resistant or developing resistance, lower than 2015 but similar to both 2013 and 2014 (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 11 (6%) of the 199 '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 9% of samples were resistant to Select and 11% to Factor, compared to 100% to Achieve (Table 5). Of the 30 samples screened to Axial 55% were resistant or developing resistance lower than all previous years.

Ninety two percent of samples were resistant to Group B herbicides, a similar level to the previous four years. Five samples (4%) were developing resistance to atrazine or simazine (Group C), and 6% were resistant to trifluralin (Group D similar to the last few years (Table 3).

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

	2012	2013	2014	2015	2016
A (fops)	96	90	84	97	87
A (dims)	50	12	14	24	15
A (dens)	81	84	69	84	55
B	85	93	70	84	92
C	1	0	0.4	0	4
D	5	3	2	5	6

Cross and Multiple Resistance

Of the 142 samples screened to five or more herbicides 135 were screened to five or more herbicide groups. Many samples, especially those from WA, were screened to herbicides from five

groups but they were not screened to 'fop' or Group B herbicides but instead to two 'dim' herbicides, Group J/K, L and/or M herbicides.

Forty four of the samples were tested to one or more herbicides from the following selective herbicide groups; A 'fop', A 'dim' B, C and D. The proportion of samples resistant to three herbicide groups (15.9%) was much lower than last year, the highest to date, but similar to many of the previous years. The proportion of samples resistant to zero, one or two herbicide groups was within the range experienced in previous years (Table 4).

As stated previously many samples were not tested to a 'fop' or B herbicide due to the high probability that the samples would be resistant to these herbicides. One hundred and five samples were tested to between one and four of the selective herbicide groups (1 group – 4; 2 groups – 2; 3 groups 52; 4 groups – 47), of these 45 (42.9%) were susceptible to all groups and 47 (44.8%) were resistant to one group. Nine samples were resistant to two groups, three to three groups and one sample was resistant to all four selective groups to which it was tested (A 'fop', A 'dim' B and D).

With 54 of these 105 samples not tested to both 'fop' and B herbicides, and only six tested to both these groups, ('dim, C and/or D excluded) it is probable that some of these samples would be resistant to an additional one or two herbicide groups

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

No. of groups	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2016 (%)
5	0	0	0	0	0
4	1.3	0.5	0	0	0
3	12.8	10.8	11.1	37.7	15.9
2	66.0	68.6	50.0	52.8	54.5
1	18.0	16.8	28.6	7.5	25.0
0	1.9	3.2	10.3	1.9	4.5
No. of samples	156	185	126	53	44

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, Topik Achieve, Axial and Factor (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
'fops'					
Hoegrass	37	30	2	**86**	5
Verdict	7	6	0	**86**	1
Topik	2	2	0	**100**	0
'dims'					
Select	150	8	6	**9**	136
Achieve	11	11	0	**100**	0
Factor	39	3	1	**11**	35
'den'					
Axial	29	15	1	**55**	13

Group B herbicides

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

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

	Tested	Res	DR	%	Susc
Sulfonylureas					
Glean	31	28	3	**100**	0
Logran	3	2	1	**100**	0
Atlantis	2	2	0	**100**	0
Hussar	2	2	0	**100**	0
Imidazolinones					
Intervix	47	36	4	**85**	7
Sulfonamides					
Crusader	7	6	1	**100**	0

Other herbicides

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

Seven of the 139 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	41	0	1	**2**	40
Atrazine	99	0	4	**4**	95
Group D					
Trifluralin	142	5	6	**8**	131
Kerb	39	0	0	**0**	39
Group J					
Avadex Xtra	1	0	0	**0**	1
Group J/K					
Boxer Gold	88	0	0	**0**	88
Group K					
Sakura	4	0	0	**0**	4
Group L					
Gramoxone	91	0	0	**0**	91
Group M					
Roundup	140	2	5	**5**	133

State by State

The majority of samples came from Western Australia and New South Wales. Most of the Western Australian samples came from the Nyabing Farm Improvement Group (59) or the Stirlings to Coast Farmers Group (47). Thirty samples came from New South Wales while two samples came from Victoria and five from Tasmania (Table 8).

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

	2012	2013	2014	2015	2016
NSW	196	93	88	83	30
Vic	5	7	1	1	2
SA	1	0	1	1	0
WA	50	126	371	323	115
Tas	3	10	1	0	5

With only limited samples received from each of Victoria 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 most of these samples were not screened to Group A 'fop' or B herbicides.

For all but the Group A herbicides similar results were found for samples from New South Wales and Western Australia. Eighty eight percent of samples from New South Wales were resistant to a 'fop' herbicide compared with 60% from Western Australia. Similarly, resistance to the 'dim' herbicides was higher for the samples from NSW (37%) than for samples from WA (10%) (Figure 1).

The lower resistance levels for Western Australia in the Group A herbicides is most likely caused by two reasons. Firstly, many of the WA samples were not tested to 'fop' herbicides as resistance was already confirmed or assumed to this group leaving only samples from lower risk paddocks or areas tested to this group; and secondly, the level of resistance to the 'dim' herbicides for the area many of the WA samples were provided from is lower than that reported from surveys of other parts of WA and much of southern NSW.

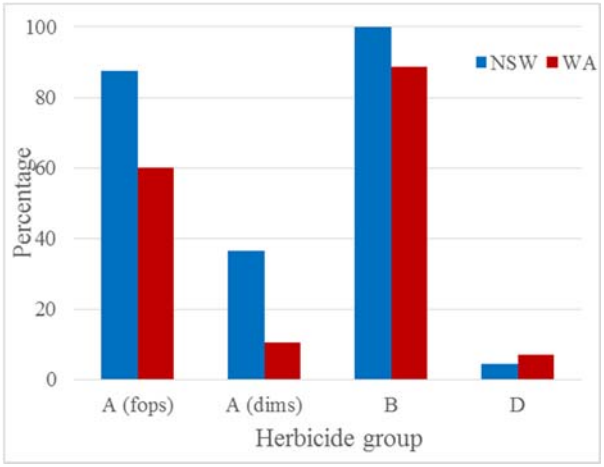

Figure 1: Percentage of ryegrass samples resistant and developing resistance for NSW and WA

Wild Oats

The number of wild oat samples (37) received was slightly lower than last year. On a percentage basis the number of samples was higher than the last two years and similar to most previous years (Table 9). All but six of the wild oat samples came from New South Wales, five samples were supplied from Queensland and one each from Victoria.

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

	2012	2013	2014	2015	2016
Total	351	305	655	558	235
Wild oats	73	51	58	58	37
Percentage	20.8	16.7	8.8	10.4	15.7

The level of 'fop' resistance among the samples was 78%, higher than last year but similar to previous years (Table 10). Twenty six samples were tested to Topik (23 resistant) and 11 to Verdict (6 resistant).

For the 'dim' herbicides, none of 30 samples tested were resistant to Select and two out of five were resistant to Achieve. Twenty five samples were tested to Axial with four of these resistant (Table 10).

Twenty one samples were tested to Atlantis with four resistant and eight tested to Crusader with three resistant while no samples were resistant to Intervix (4 tested). Seven samples were tested to Mataven

(Group Z), with three of these resistant (Table 10). All samples tested to Avadex (11), Roundup (4) or atrazine (1) were susceptible.

Table 10: Percentage of wild oat samples found to be resistant since 2012 (number tested in brackets)

	2013 % (no.)	2014 % (no.)	2015 % (no.)	2016 % (no.)
'fops'	81 (43)	78 (53)	69 (55)	78 (37)
'dims'	9 (55)	10 (61)	2 (56)	6 (35)
'dens'	46 (26)	47 (30)	27 (29)	16 (25)
B	8 (52)	20 (54)	8 (51)	21 (33)
Z	44 (9)	11 (9)	47 (15)	43 (7)

Broadleaf species

Forty one wild radish samples were provided for resistance screening with 38 coming from Western Australia with 22 from the Nyabing Farm improvement Group and nine from the Stirlings to Coast Farmers Group. Two of other three came from New South Wales and one from Queensland.

Forty seven percent of samples were resistant to Group B herbicides with 25 screened to Logran (11 resistant), nine to Intervix (2 resistant), four to Glean (all resistant) and one to Flame (resistant) and Spinnaker (resistant) (Table 11). A significant level of resistance was also found to Brodal (24/40). Resistant samples were also found to atrazine (1/38), MCPA Amine (2/22) and 24D Amine (1/15), while no samples were found to be resistant to Velocity (1), Ester 680 (2), MCPA LVE 570 (1) or Roundup (38) (Table 11).

A number of the thirty three samples screened to bromoxynil were classed as resistant or developing resistance, upon retesting under colder weather conditions many of these samples were controlled by the herbicide (Table 11).

Table 11: Percentage of wild radish samples found to be resistant since 2013 (number tested in brackets)

	2013 % (no.)	2014 % (no.)	2015 % (no.)	2016 % (no.)
B	55 (9)	88 (130)	67 (15)	47 (41)
C	13 (8)	11 (158)	0 (27)	7 (72)
F	9 (11)	46 (128)	20 (84)	60 (40)
I	9 (11)	16 (129)	5 (91)	8 (40)
M	0 (2)	0 (122)	0 (86)	0 (38)

Other species

One brome grass sample (from WA) and four barley grass samples (all from NSW), were received this year. The brome grass sample was screened to Select, atrazine, trifluralin, Gramoxone and Roundup all of which were susceptible. The four barley grass samples were tested to Verdict (4), Shogun (4), Select (4) and Gramoxone (3). One sample was resistant to Verdict, Shogun and Select, two were resistant to Verdict and Shogun with the fourth susceptible to all screened herbicides.

Final Observations

- 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
- Wild oat resistance for all groups was within the range experienced in previous years.
- Wild radish samples were resistant to three herbicide groups (B, C, F and I) compared to three last year, and four in 2014. In Group C samples were resistant to both atrazine and bromoxynil.

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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

Note: