

Samples Received

The testing service screened 232 samples in 2022. This was 30 below the average annual receipts since the service started in 1991. Samples were supplied by 61 different agronomists representing 48 different stores or companies. Twenty-seven samples came direct from farmers although 23 of these were supplied by the Stirlings to Coast farmer group.

Again, a high proportion of wild oat samples were received this year due to Corteva sponsoring again wild oat tests from NSW and Queensland (Table 1). This was. Nineteen samples of wild radish were received as were samples of brome grass and Indian hedge mustard (Table 1)

Table 1: Total number of samples received since 2019

	2019	2020	2021	2022
Annual ryegrass	97	52	141	111
Wild oats	23	19	139	99
Wild radish	21	6	10	19
Brome grass	0	0	0	1
Barley grass	0	1	3	0
Phalaris	0	0	4	0
Sow thistle	1	0	2	0
Indian hedge mustard	0	0	0	1
Charlock	0	1	1	0
Paterson's curse	0	0	1	0
Total	142	79	301	231

Summary of Results

The results obtained from the 2022 resistance screening are similar in the majority of cases to the results from previous years.

Annual ryegrass

This year, 112 annual ryegrass samples were received, of which 109 requested testing to five or more herbicides resulting in a total of 684 individual herbicide tests (Table 2). However, none of these were tested to the standard cross-resistance test (Hoegrass, Select, Glean, simazine and trifluralin) with no additions or changes, same as 2019. The most commonly requested herbicides for testing were Roundup and Select, requested for all but one and two samples respectively, followed by trifluralin (99 samples) and atrazine (82 samples). No other herbicide was tested to more than 48 samples showing the customisation of testing by growers or

agronomists. One sample was tested to only one herbicide (Select), one to three herbicides and a third to four. Nineteen samples were tested to the standard cross resistance test number of five herbicides with 50 (tested to six herbicides). Twenty-nine samples were tested to seven, six to eight and five to nine herbicides.

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

Group	2019	2020	2021	2022
1 (fops)	16	13	54	19
1 (dims)	137	71	166	151
1 (dens)	7	6	38	13
2 (SU)	13	17	61	10
2 (Imi)	12	14	22	25
3	104	47	122	97
5	46	28	88	96
9	96	51	137	110
15	94	42	103	106
22	53	13	13	47

Only 19 samples were to a 'fop' herbicide with all but one classed as resistant to that herbicide a similar level (95%) to most of the previous years (Table 3). As in usually the case in recent years, many samples were not tested to the 'fop', or Group 2 herbicides unless specifically requested by the client (Table 2). This may be the result of those clients from areas with a higher incidence of resistance requesting changes to the standard test to look for susceptible options and dropping the 'fop' and Group 2 test whereas clients from areas with lower resistance incidence are still confirming if the herbicides are still effective.

Ten percent of samples tested to a 'dim' herbicide were resistant, lower than the last three years (Table 3). The samples screened to 'dim' herbicides were screened to Select, Achieve and/or Factor. As is usually the case the proportion of samples resistant to Select and Factor was lower than for the other 'dim' herbicides tested. This year no samples were resistant to Select or Factor and 5% were developing resistance to Select (none to Factor) compared to 69% to Achieve (54% resistant: 15% developing resistance) (Table 5). Five samples were tested to the mix of Select and Factor, all were susceptible. Of the 13 samples screened to Axial 12 were resistant or developing resistance.

Ninety percent of samples were resistant to a sulfonylurea herbicide and 88% to an imidazolinone, a similar level to the majority of previous years

(Table 3). As mentioned previously the proportion of samples being tested to the sulfonylureas is decreasing.

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

	2019	2020	2021	2022
1 (fops)	94	92	96	95
1 (dims)	26	45	19	10
1 (dens)	100	100	71	92
2 (SU)	46	77	77	90
2 (Imi)	92	86	73	88
3	5	11	6	19
5	2	1	0	0
9	20	24	41	31
15	3	0	0	0
22	0	0	8	2

No samples were resistant to Group 5 or 15 herbicides this year. In previous years samples resistant to Groups C or developing resistance to Group 15 have been received. One sample was resistant to Gramoxone (Group 22) Six percent of samples were resistant to trifluralin (Group 3), slightly higher than the last three years but lower than some years prior to then (Table 3).

Probably the most concerning finding is the continued significant proportion of samples resistant to Roundup (Table 3; 7). For the third consecutive year over 20% of samples were resistant or developing resistance to this herbicide, one of the, if not the, most important herbicides available. Some of these samples have been provided from non-agricultural settings (eg. roadsides, firebreaks) which will increase the risk profile for resistance

Cross and Multiple Resistance

108 samples were screened to five or more herbicides with 103 of these screened to five or more herbicide groups. However, only 10 samples were sprayed to the five standard selective herbicide groups ('fop', 'dim', B, C and D). Of these, none were susceptible to all groups, one was resistant to one group, seven to two and two to three groups.

Of the eight samples tested to less than five herbicide four were susceptible to the tested groups, one to two of three groups tested and three to one of four tested groups (Table 4).

The remaining 103 samples were tested to five or more groups, of these 32 were susceptible to all herbicide groups, 30 resistant to only one group while 29 were resistant to two, ten to three groups, and one to five groups (Table 4).

The level of cross and/or multiple resistance is much lower in these samples as in most cases the herbicide groups not tested are the 1 'fops' and/or 2 which have the highest level of resistance (Table 3) suggesting that the farmers or their agronomists are acknowledging these populations are resistant to these groups and are investigating the susceptibility of alternative herbicide groups. As only 16 of the 103 samples that were screened to five herbicide groups were tested to both 'fop' and B herbicides, it is probable that most of the other 87 samples would be resistant to an additional one or two herbicide groups.

Table 4: Number of groups samples were tested to in 2020 and the number of resistant groups

Resistant groups	Herbicide groups tested							
	1	2	3	4	5	6	7	8
0	1	1	0	2	14	18	0	0
1	0	0	0	3	16	13	0	1
2	0	0	1	0	19	7	3	2
3	0	0	0	0	0	1	6	2
4	0	0	0	0	0	1	0	0
5	0	0	0	0	0	0	0	0
Total	1	1	1	5	49	40	9	5

Herbicide Groups

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

Group 1 herbicides

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

Table 5: Results for ryegrass samples showing percentage resistant (Res) or developing resistance (DR) to individual Group 1 herbicides.

	Tested	Res	DR	%	Susc
<i>'fops'</i>					
Hoegrass	6	6	0	100	0
Topik	7	7	0	100	0
Verdict	6	5	0	83	1
<i>'dims'</i>					
Select	108	0	5	5	103
Achieve	13	7	2	69	4
Factor	30	0	0	0	30
<i>'den'</i>					
Axial	13	10	2	92	1

Group 2 herbicides

While most of the samples screened to Group 2 herbicides were screened to Intervix, samples were also screened to Glean, Logran and Hussar (Table 6).

Table 6: Results for ryegrass samples screened to individual Group 2 herbicides

	Tested	Res	DR	%	Susc
<i>Sulfonylureas</i>					
Glean	7	6	1	100	0
Logran	2	1	0	50	1
Hussar	1	1	0	100	0
<i>Imidazolinones</i>					
Intervix	25	18	4	88	3

Other herbicides

Annual ryegrass samples were screened to 16 other herbicides, trifluralin, Kerb, simazine, atrazine, Avadex Xtra, Arcade, Boxer Gold, Sakura, Gramoxone and Roundup. The observed incidence of resistance to these herbicides was lower than the resistance to the higher risk Group 1 and 2 herbicides (Table 7).

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

	Tested	Res	DR	%	Susc
<i>Group 3</i>					
Trifluralin	97	9	10	19	78
Kerb	3	0	0	0	3
<i>Group 5</i>					
Simazine	17	0	0	0	17
Atrazine	79	0	0	0	79
<i>Group 9</i>					
Roundup	110	20	14	31	76
<i>Group 15</i>					
Avadex Xtra	1	0	0	0	1
Arcade	31	0	0	0	31
Boxer Gold	35	0	0	0	35
Sakura	39	0	0	0	39
<i>Group L (22)</i>					
Gramoxone	47	1	0	2	46

Thirty-four of the 110 samples tested to Roundup were found to be resistant or developing resistance. This herbicide needs to be treated carefully due to its importance in Australian agriculture. One sample was found to be resistant to Gramoxone this year (Table 7). No samples were resistant to any of the Group 15 herbicides or to Kerb. With significant levels of resistance to other herbicides these herbicides are very important, and need to be managed well, through crop and herbicide rotations in conjunction with non-chemical weed control to maintain their effectiveness for as long as possible.

State by State

New South Wales and Western Australia supplied the most samples with samples also received from Tasmania, Victoria and South Australia (Table 8).

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

	2018	2019	2020	2021	2022
NSW	52	21	14	101	48
Vic	3	2	3	2	5
SA	1	5	8	6	2
WA	56	69	22	29	1
Tas	3	0	5	2	56

With limited samples received from Victoria, South Australia and Tasmania only the data for New South Wales and Western Australia has been analysed separately (Figure 1) and then only for the herbicide groups where more than 10 samples were tested for each state (1 'dime', 3, 9 and 22). There are minimal differences in all but the Group 3 resistance with 35% of NSW samples resistant compared with 7% of WA samples (Figure 1).

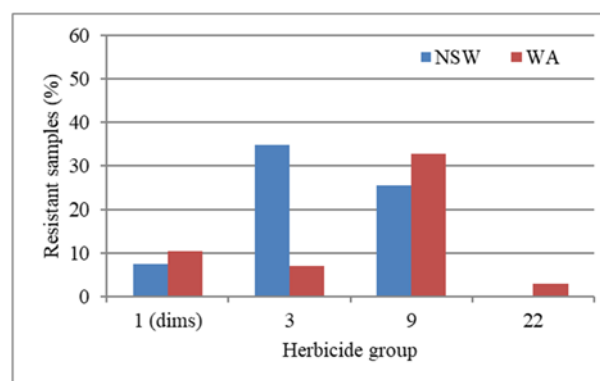


Figure 1: Percentage of ryegrass samples from NSW and WA resistant and developing resistance to selected herbicide groups

Wild Oats

The number of wild oat samples (99) received was the third most ever received, behind last year and 2002. On a percentage basis the number of samples was the second highest (42.9%) behind only last year and the second time wild oat samples were over 30% of samples received (Table 9). All wild oat samples (75) were received from New South Wales and Queensland (24).

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

	2018	2019	2020	2021	2022
Total	170	142	78	301	232
Wild oats	37	23	19	139	99
Percentage	21.8	16.2	24.4	46.2	42.9

The level of 'fop' resistance among the samples was 56%, slightly lower than previous years (Table 10). Eighty-seven samples were tested to Topik (53 resistant) and 16 to Verdict (5 resistant). For the 'dim' herbicides, none of the 112 samples tested to Select were resistant while one of nine were resistant to Achieve. Eighty-seven samples were tested to Axial with 11 of these resistant (Table 10).

Twelve samples tested to Atlantis (76) were resistant, while all samples tested to Intervix (7), Rexade (9), trifluralin (2), Avadex (7), Mataven (3) or Roundup (9) were susceptible.

Table 10: Percentage of wild oat samples found to be resistant since 2019 (number tested in brackets)

	2019 % (no.)	2020 % (no.)	2021 % (no.)	2022 % (no.)
1 'fops'	78 (18)	68 (19)	71 (142)	56 (95)
1 'dims'	18 (23)	13 (16)	4 (137)	1 (95)
1 'dens'	36 (14)	50 (8)	23 (112)	13 (87)
2	4 (27)	0 (21)	1 (125)	16 (76)

There were minimal differences in the incidence of resistance between NSW and Queensland with possible exception of Group 2 but more samples would be required to confirm this (Figure 2).

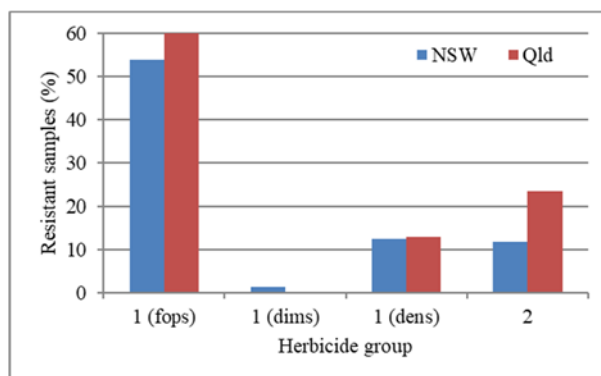


Figure 1: Percentage of wild oat samples from NSW and Qld resistant and developing resistance to selected herbicide groups

Broadleaf species

Nineteen wild radish samples were provided for resistance screening with 14 from Western Australia and five from NSW.

Table 11: Percentage of wild radish samples found to be resistant since 2019 (no. of tests in brackets)

	2019 % (no.)	2020 % (no.)	2021 % (no.)	2022 % (no.)
2	21 (19)	33 (3)	67 (6)	5 (19)
4	26 (23)	0 (7)	33 (12)	0 (22)
5	11 (19)	0 (4)	0 (5)	12 (16)
6	0 (16)	0 (1)	0 (4)	0 (10)
9	0 (19)	0 (4)	0 (2)	0 (15)
12	90 (20)	0 (6)	100 (9)	50 (18)

Resistance was detected to Logran (1/9), atrazine (2/16) and Brodal (9/18). No samples were resistant to Glean (1 tested), Hussar (1), Intervix (8), 2,4-D Amine (10), MCPA Amine (2), MCPA LVE 570 (10), bromoxynil (10), Precept (1), Roundup (15 and Gramoxone (2) (Table 11).

Other species

One brome grass was received, resistant to Verdict and Select but not Intervix, Crusader or Roundup. The Indian hedge mustard sample was susceptible to Brodal and Roundup.

Final Observations

- As normal NSW and WA supplied the most annual ryegrass samples and wild oats all received from NSW and Qld.
- For ryegrass samples the level of resistance remained similar to previous years for the major herbicide groups.
- For the fourth consecutive year over 20% of ryegrass samples were resistant or developing resistance to Roundup. This is a major concern.
- Wild oat resistance for all groups was within the range experienced in previous years.
- Resistance incidence of the wild radish samples decreased this year, but this is likely a result of sample source not indicative of the species as a whole.

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Testing forms and annual reports are available at:

<https://science-health.csu.edu.au/eal/herbicide-resistance-testing>

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