

### Samples Received

The testing service screened 136 samples in 2024, 67% more than the 81 received last year but well below the average of 254 sample per year since the service started in 1991. This was a similar number supplied in 2019 and several other years during the time of this service. Samples were supplied by 35 different stores or companies with an additional five samples supplied directly from farmers.

As usually occurs the majority of samples were ryegrass, however this year a significant number of wild oat samples were also received. Wild oats comprised 38% of samples, a higher proportion than all other years except 2021 and 2022. The other species sent in were wild radish (3 samples) and phalaris (2 samples) (Table 1)

Table 1: Total number of samples received since 2020

|                 | 2021       | 2022       | 2023      | 2024       |
|-----------------|------------|------------|-----------|------------|
| Annual ryegrass | 141        | 111        | 59        | 79         |
| Wild oats       | 139        | 99         | 15        | 52         |
| Wild radish     | 10         | 9          | 6         | 0          |
| Phalaris        | 4          | 0          | 1         | 2          |
| Other grass     | 3          | 1          | 0         | 0          |
| Other broadleaf | 4          | 1          | 0         | 0          |
| <b>Total</b>    | <b>301</b> | <b>231</b> | <b>81</b> | <b>136</b> |

### **Summary of Results**

The results obtained from the 2024 resistance screening are similar in the majority of cases to the results from previous years.

#### Annual ryegrass

This year, 79 annual ryegrass samples were received of which all but eight were tested to five or more herbicides resulting in a total of 466 individual herbicide tests (Table 2). Of 71 samples tested to five or more herbicides only one was tested to the standard cross-resistance test (Hoegrass, Select, Glean, simazine and trifluralin), four requested additional herbicide groups to be tested along with the standard herbicides, eight changed both herbicides within a group and herbicide groups while still only testing five herbicides. The remaining 58 samples changed both herbicides within a group and herbicide groups plus added up to 6 additional herbicides. The most commonly requested herbicides for testing were Select (all samples) and Roundup (all but one), followed by

trifluralin (56 samples), Sakura (46) and Gramoxone (45). In total 22 different herbicides were screened, along with five after market mixtures showing the customisation of testing by growers or agronomists. The most commonly tested mixture was Roundup and Select with 26 samples. Six samples were tested to only two herbicides, one to each of three and four herbicides with seven tested to five herbicides and 23 to six herbicides. Thirty three samples were tested to seven, three to nine, two to 10 and three samples were tested to 11 herbicides.

Table 2: Number of samples tested to each of seven herbicide groups since 2020

| Group    | 2021 | 2022 | 2023 | 2024 |
|----------|------|------|------|------|
| 1 (fops) | 54   | 19   | 20   | 28   |
| 1 (dims) | 166  | 151  | 73   | 84   |
| 1 (dens) | 38   | 13   | 12   | 15   |
| 2 (SU)   | 61   | 10   | 23   | 24   |
| 2 (Imi)  | 22   | 25   | 28   | 28   |
| 2 (SA)   | 18   | 0    | 3    | 2    |
| 3        | 122  | 97   | 45   | 58   |
| 5        | 88   | 96   | 36   | 24   |
| 9        | 137  | 110  | 52   | 78   |
| 15       | 103  | 106  | 38   | 79   |
| 22       | 13   | 47   | 13   | 45   |

As with most previous years over 90% of samples were classed as resistant or developing resistance to a 'fop' herbicide (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. This has extended to the GRDC funded resistance surveys in which ryegrass samples are no longer screened for resistance to a Group 1 fop or chlorsulfuron.

Nine percent of samples tested to a 'dim' herbicide were resistant, lower than the last three years (Table 3). All samples screened to 'dim' herbicides were screened to Select and/or Factor. No samples were screened to Achieve this year, normally a few are screened to this herbicide every years and the higher proportion of resistant samples usually recorded for this herbicide compared with both Select and Factor increases the level of 'dim' resistance. Of the 15 samples screened to Axial only one was not resistant or developing resistance.

Sixty five percent of samples were resistant to a sulfonylurea herbicide and 54% to an imidazolinone, a lower level to many of the previous years (Table 3). As mentioned previously the proportion of samples being tested to the sulfonylureas is decreasing and these could be considered to be more likely to be resistant.

Table 3: Percentage of samples resistant or developing resistance to each herbicide groups since 2020

|          | 2021 | 2022 | 2023 | 2024 |
|----------|------|------|------|------|
| 1 (fops) | 96   | 95   | 100  | 93   |
| 1 (dims) | 19   | 10   | 13   | 9    |
| 1 (dens) | 71   | 92   | 100  | 94   |
| 2 (SU)   | 77   | 90   | 78   | 65   |
| 2 (Imi)  | 73   | 88   | 68   | 54   |
| 3        | 6    | 19   | 4    | 0    |
| 5        | 0    | 0    | 0    | 0    |
| 9        | 41   | 31   | 21   | 49   |
| 15       | 0    | 0    | 0    | 0    |
| 22       | 8    | 2    | 0    | 2    |

No samples were resistant to Group 3, 5 or 15 herbicides this year. In previous years samples resistant or developing resistance to these groups have been received. One sample was resistant to Gramoxone (Group 22), this has occurred in a number of years previously (Table 3).

Probably the most concerning finding is that nearly half of the samples tested to Roundup were resistant or developing resistance, the highest level yet (Table 3; 7). For the seventh consecutive year over 20% of samples were resistant or developing resistance to this herbicide, one of, 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

Seventy three samples were screened to five or more herbicide groups. However, only eight samples were sprayed to the five standard selective herbicide groups ('fop', 'dim', 2, 3 and 5). Of these, none were susceptible to all groups, one was resistant to one group, six to two and one to three groups. Sixteen samples were tested to less than five herbicide groups, six of which were tested to more than five herbicides (5 – herbicides; 1 – 3; 3 – 4; 2 – 5; 3 - 6 and 1 – 9 herbicides and one sample had zero germination) of the 15 that could be tested four were susceptible to all tested groups, six were resistant to one group, four to two groups and one to three groups (Table 4).

Of the 63 samples tested to five or more groups 15 were susceptible to all herbicide groups, 23 resistant to only one group while seven were resistant to two and two to both three and four groups (Table 4).

The limited testing of the Group 1 'fops' and/or 2 which have the highest level of resistance (Table 3) suggests that the farmers or their agronomists are acknowledging populations are resistant to these groups and are investigating the susceptibility of alternative herbicide groups. With all 78 samples tested (one sample had no germination) to two or more groups only 13 were tested to both 'fop' and Group 2 herbicides and 34 to neither, it is probable that many of the 65 samples not tested to both would be resistant to an additional one or two herbicide groups.

Table 4: Number of herbicide groups tested and the number of resistant groups for ryegrass samples

| Resistant groups | 0 | 2 | 3 | 4 | 5  | 6  | 7 | 8 | 9 |
|------------------|---|---|---|---|----|----|---|---|---|
| 0                | 1 | 2 | 0 | 2 | 10 | 4  | 1 | 0 | 0 |
| 1                | 0 | 3 | 0 | 3 | 19 | 4  | 0 | 0 | 0 |
| 2                | 0 | 0 | 1 | 3 | 11 | 3  | 2 | 2 | 0 |
| 3                | 0 | 0 | 0 | 1 | 0  | 1  | 0 | 0 | 2 |
| 4                | 0 | 0 | 0 | 0 | 2  | 0  | 1 | 1 | 0 |
| 5                | 0 | 0 | 0 | 0 | 1  | 0  | 0 | 0 | 0 |
| Total            | 1 | 5 | 1 | 9 | 43 | 12 | 4 | 2 | 2 |

### 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

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

### Group 2 herbicides

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

### Other herbicides

Annual ryegrass samples were screened to 14 other herbicides; trifluralin, Kerb, simazine, atrazine, Arcade, Boxer Gold, Sakura, Overwatch, Luximax, Ultro, Mateno Complete, Gramoxone and Roundup. Except for, as previously mentioned for 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 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      | 9      | 8   | 1  | <b>89</b>  | 1    |
| Verdict       | 13     | 12  | 0  | <b>92</b>  | 1    |
| Topik         | 5      | 5   | 0  | <b>100</b> | 0    |
| Shogun        | 1      | 1   | 0  | <b>100</b> | 0    |
| <i>'dims'</i> |        |     |    |            |      |
| Select        | 78     | 2   | 6  | <b>10</b>  | 70   |
| Factor        | 5      | 0   | 0  | <b>0</b>   | 5    |
| <i>'den'</i>  |        |     |    |            |      |
| Axial         | 15     | 13  | 1  | <b>93</b>  | 1    |

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

|                       | Tested | Res | DR | %          | Susc |
|-----------------------|--------|-----|----|------------|------|
| <i>Sulfonylureas</i>  |        |     |    |            |      |
| Glean                 | 12     | 5   | 1  | <b>50</b>  | 6    |
| Logran                | 2      | 0   | 1  | <b>50</b>  | 1    |
| Atlantis              | 6      | 4   | 1  | <b>83</b>  | 1    |
| Hussar                | 3      | 2   | 1  | <b>100</b> | 0    |
| <i>Imidazolinones</i> |        |     |    |            |      |
| Intervix              | 28     | 9   | 6  | <b>54</b>  | 13   |
| <i>Sulfonamides</i>   |        |     |    |            |      |
| Crusader              | 2      | 0   | 0  | <b>0</b>   | 2    |

Thirty eight of the 77 samples tested to Roundup were found to be resistant or developing resistance. One of these was also resistant to Gramoxone and another resistant to Roundup+Select mixture. Two more of the 26 samples tested to the Roundup+Select mixture were developing resistance. No samples were resistant to Kerb or any of the Group 5 or 15 herbicides. 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 two samples received from both South Australia and Victoria and one sample from Tasmania. For the first time ryegrass samples were received from Queensland showing the spread of this species northward (Table 8).

Due to low numbers received from other states only the only the data for NSW and WA has been analysed separately (Figure 1) and then only for the herbicide groups where more than 10 samples were tested for each state and resistance was detected (1 'dim' Select, 9 and 22). No WA samples were resistant to Select or Gramoxone compared with seven and one respectively from NSW (Figure 1).

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

|                 | Tested | Res | DR | %         | Susc |
|-----------------|--------|-----|----|-----------|------|
| <i>Group 3</i>  |        |     |    |           |      |
| Trifluralin     | 56     | 0   | 0  | <b>0</b>  | 56   |
| Kerb            | 2      | 0   | 0  | <b>0</b>  | 2    |
| <i>Group 5</i>  |        |     |    |           |      |
| Simazine        | 11     | 0   | 0  | <b>0</b>  | 11   |
| Atrazine        | 11     | 0   | 0  | <b>0</b>  | 11   |
| <i>Group 9</i>  |        |     |    |           |      |
| Roundup         | 77     | 25  | 13 | <b>49</b> | 39   |
| <i>Group 15</i> |        |     |    |           |      |
| Arcade          | 25     | 0   | 0  | <b>0</b>  | 25   |
| Boxer Gold      | 8      | 0   | 0  | <b>0</b>  | 8    |
| Sakura          | 46     | 0   | 0  | <b>0</b>  | 46   |
| <i>Group 22</i> |        |     |    |           |      |
| Gramoxone       | 45     | 1   | 0  | <b>2</b>  | 44   |

Table 8: Number of ryegrass samples received from each state since 2020.

|     | 2020 | 2021 | 2022 | 2023 | 2024 |
|-----|------|------|------|------|------|
| NSW | 14   | 101  | 48   | 38   | 44   |
| Vic | 3    | 2    | 5    | 0    | 2    |
| SA  | 8    | 6    | 2    | 1    | 2    |
| WA  | 22   | 29   | 56   | 19   | 25   |
| Tas | 5    | 2    | 1    | 1    | 1    |
| Qld | 0    | 0    | 0    | 0    | 5    |

Due to low numbers received from other states only the only the data for NSW and WA has been analysed separately (Figure 1) and then only for the herbicide groups where more than 10 samples were tested for each state and resistance was detected (1 'dim' Select, 9 and 22). No WA samples were resistant to Select or Gramoxone compared with seven and one respectively from NSW (Figure 1).

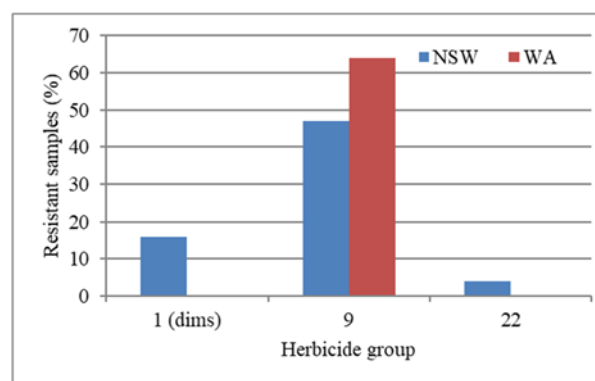


Figure 1: Percentage of ryegrass samples from NSW and WA resistant and developing resistance to selected herbicide groups

#### Wild Oats

The number of wild oat samples (52) received was as a percentage (38%) than all but two years when wild oats resistance screening had been sponsored by

Corteva and higher than all other years (max - 29%) (Table 9). All wild oat samples were received from NSW (31) and Qld (21).

The level of ‘fop’ resistance was 72%, higher than the last two years (Table 10). Thirty nine samples were tested to Topik (35 resistant) and 28 to Verdict (13 resistant). For the ‘dim’ herbicides, none of the 48 samples tested to Select were resistant, while resistance was recorded in one of the three samples tested to Achieve. Forty one samples were tested to Axial with 11 resistant (Table 10).

Table 9: Number of wild oat samples received and percentage of total samples since 2020

|            | 2020 | 2021 | 2022 | 2023 | 2024 |
|------------|------|------|------|------|------|
| Total      | 78   | 301  | 232  | 81   | 136  |
| Wild oats  | 19   | 139  | 99   | 15   | 52   |
| Percentage | 24.4 | 46.2 | 42.9 | 18.5 | 38.2 |

One sample was resistant to Mataven (5) and another developing resistance to Intervix (19). No samples tested to Atlantis (23), Flame (1), Rexade (20), Avadex (13), Atrazine (2), trifluralin (1), Roundup (7) or Gramoxone (2) were resistant.

Table 10: Percentage of wild oat samples found to be resistant since 2020 (number tested in brackets)

|          | 2021<br>% (no.) | 2022<br>% (no.) | 2023<br>% (no.) | 2024<br>% (no.) |
|----------|-----------------|-----------------|-----------------|-----------------|
| 1 ‘fops’ | 71 (142)        | 56 (95)         | 45 (11)         | 72 (67)         |
| 1 ‘dims’ | 4 (137)         | 1 (95)          | 0 (14)          | 2 (51)          |
| 1 ‘dens’ | 23 (112)        | 13 (87)         | 18 (11)         | 27 (41)         |
| 2        | 1 (125)         | 16 (76)         | 0 (14)          | 5 (20)          |

For the first time for wild oats two states met the same criteria used for comparison resistance levels as for ryegrass. Resistance was higher in NSW samples for all groups except for the ‘fops’, however all but two of the Qld samples tested to this group were tested to two ‘fop’s but only three of the NSW samples were, the effect of this is unknown and requires further investigation (Figure 2).

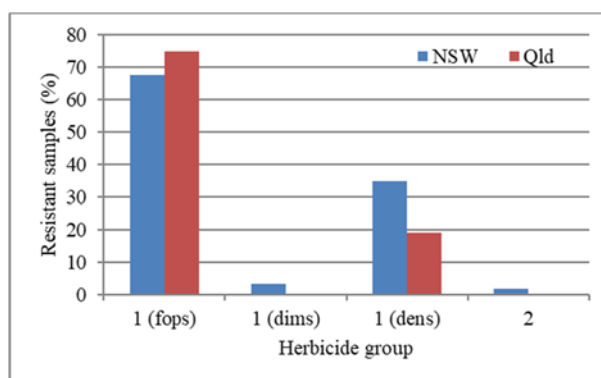


Figure 2: Percentage of wild oat samples from NSW and Qld resistant and developing resistance to selected herbicide groups

### Broadleaf species

Three wild radish samples, all from Western Australia, were provided for resistance screening. Resistance was detected to Glean (1/1), bromoxynil (1/2) and Brodal (2/2). No samples were resistant to Intervix (1), 2,4-D Amine (1), MCPA Amine (1), MCPA LVE 570 (1), Ester 80 (1), Velocity (1), Jaguar (1), Tigrex (1), or Roundup (3).

### Other species

Two phalaris samples were received, one was resistant to Verdict and Axial but not Select or Atlantis while the other was susceptible to Topik, Verdict, Select and Axial.

### **Final Observations**

- As normal NSW and WA supplied the most annual ryegrass samples and all wild oats samples were received from either NSW or Qld.
- For ryegrass samples the level of resistance remained similar to previous years for the major herbicide groups.
- Nearly 50% of ryegrass samples were resistant or developing resistance to Roundup. This is a major concern.
- Wild oat resistance for many groups was higher than experienced in recent years.

### **For further information contact:**

Charles Sturt University  
Locked Bag 588  
Wagga Wagga NSW 2678

John Broster 02 6933 4001  
0457 272 075  
[jbroster@csu.edu.au](mailto:jbroster@csu.edu.au)

Testing forms and annual reports are available at:

<https://www.csu.edu.au/research/gulbali/research/agricultural-innovation/herbicide-resistance>

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