

The 'R' system for interpreting results from herbicide-resistance screening assays in the UK

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Most centres testing for resistant black-grass (*Alopecurus myosuroides*), and other grass-weeds, rely on standard pot tests in which seeds are sown in pots and plants sprayed at the 3 leaf stage with herbicides. Most centres use a visual assessment of reduction in growth or a more objective assessment of foliage weights three to four weeks after spraying. For some herbicides, Petri-dish tests are used as a means of diagnosing resistance. Between 2000 and 2004, 11 organisation/companies conducted 55 screening assays aimed at detecting resistance in black-grass in the UK (22 pot; 28 Petri-dish; five DuPont agar test). (See: Moss, S. R. *et al.* (2005). The current status of herbicide-resistant grass and broad-leaved weeds of arable crops in Great Britain. *In* Proceedings BCPC Congress – Crop Science & Technology 2005, Glasgow, UK. Hampshire, UK: BCPC, 139-144.

In the past different organisations/companies interpreted results in different ways in terms of designating degree of resistance. Some used the * rating system while others used a simpler categorisation either derived from the * rating system or based on visual scores. In order to achieve greater consistency, the UK Weed Resistance Action Group (WRAG) promoted the use of a standard 'R' system, and this has been adopted by all resistance testing centres in the UK.

How the new 'R' system relates to the older * rating system

The original * rating system required the use of three standard black-grass populations (Rothamsted, Faringdon, Peldon) which were used in every test. This system was only really applicable for chlorotoluron. The revised system required the use of only two standards (Rothamsted, Peldon) and this was suitable for chlorotoluron and fenoxaprop. Faringdon had to be dropped as seed supplies could not be maintained and it was relatively more resistant to fenoxaprop than chlorotoluron. It was recognised that a system was required which:

- was applicable to other species (e.g. wild-oats, rye-grass) as well as black-grass
- was applicable to a wider range of herbicides
- was less dependent on the provision of resistant standards which might only be applicable to a narrow range of herbicides and which might be difficult to maintain long term.

Consequently the following system was developed by the UK Weed Resistance Action Group and is now used by most centres undertaking resistance screening in the UK. The system is summarised overleaf and is also appropriate for wild-oats and Italian rye-grass. This system is applicable to single dose screening assays conducted in pots or Petri-dishes. A vital prerequisite is that control of the susceptible standard is reasonably high, preferably over 80%.

The later version of the * rating system required the inclusion of just a single standard reference populations in every test – a susceptible standard. The newer 'R' system retains the advantages of the previous system in terms of accommodating a continuum of responses, allows for a slight reduction in number of resistance categories and utilises the same susceptible standard for all herbicides. The * rating and 'R' rating systems are summarised overleaf.

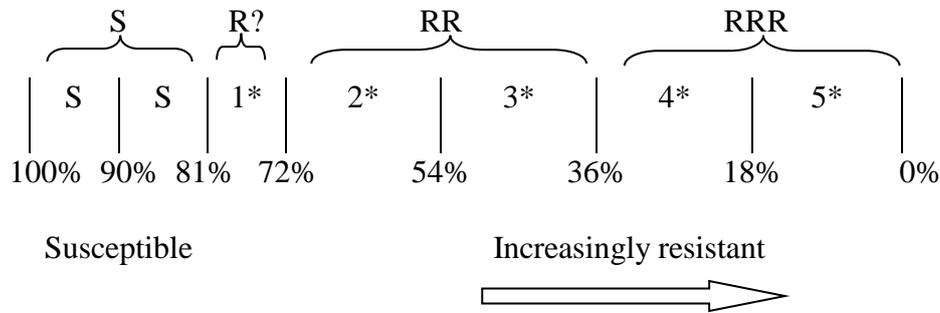


Figure 1. The older ‘*’ rating and newer ‘R’ rating systems used in the United Kingdom for designating different degrees of resistance based on responses to single doses of herbicides in resistance screening assays (Moss et al. 1999). The percent reduction values between the susceptible standard and zero are separated into five equal categories. One of these categories, at the susceptible end of the range, is subdivided about its mid-point into two smaller categories, S and 1*. In this example the percent reduction value for the susceptible standard is 90%, so each category would be 18% (i.e. $90\% \div 5 = 18\%$). Thus $< 18\% = 5^*$; 18% to 36% = 4*; 36% to 54% = 3*; 54% to 72% = 2*; 72% to 81% = 1*; 81% to 90% (and over) = S (susceptible). Each test population is assigned a * or ‘R’ rating according to the % reduction value obtained. It is important to stress that the determination of the different categories is made using the % reduction value obtained for the standard susceptible population in each individual test. The actual values delineating the categories will differ between tests and the results only relate to the specific herbicide tested.

The six * categories calculated above are more than are needed for screening purposes, so the following four category ‘R’ system has been adopted, with appropriate descriptions.

- 5*/4* = **RRR** **Resistance confirmed, highly likely to reduce herbicide performance**
- 3*/2* = **RR** **Resistance confirmed, probably reducing herbicide performance**
- 1* = **R?** **Early indications that resistance may be developing, possibly reducing herbicide performance**
- S = **S** **Susceptible**

This system incorporates a risk element in that the higher the degree of resistance the greater the risk of herbicide failure.

The ‘R’ system has been published in:
Moss, S.R., Clarke, J.H., Blair, A.M., Culley, T.N., Read, M.A., Ryan, P.J. & Turner, M. (1999). The occurrence of herbicide-resistant grass-weeds in the United Kingdom and a new system for designating resistance in screening assays. In: *Proceedings 1999 Brighton Conference - Weeds*, 179-184.
Moss, S.R. (2007). Managing herbicide-resistant black-grass (*Alopecurus myosuroides*): theory and practice. *Weed Technology*, 21, 300-309.