Managing and preventing herbicide-resistant grass weeds

To understand the extent of herbicide-resistant weeds in Ireland, TEAGASC researchers examined black-grass populations taken from tillage farms.

Conservation agriculture (CA) systems, including zero tillage and reduced tillage, may improve soil quality and reduce production costs. Irish growers are slow to adopt CA systems because of grass weed control problems in a wetter climate, which also impact on plough-established crops. Herbicide resistance and a declining armoury of herbicides are challenging our ability to control problem grass weeds like wild oats, bromes, Italian ryegrass and black-grass. The European Innovation Partnership (EIP)-funded Enable Conservation Tillage (ECT) knowledge transfer and research project focuses on co-designing cultural/non-chemical integrated weed management (IWM) strategies to mitigate grass weed problems. Mapping of herbicide-resistant grass weeds is a key research component of the ECT project.

Black-grass

Black-grass (*Alopecurus myosuroides* Huds.) is the most important herbicide-resistant weed in the UK and across Europe (Moss, 2017). It is particularly challenging in early-sown winter cereals established after reduced tillage. In Ireland, the possibility that herbicide-resistant UK black-grass has been introduced in recent years poses a significant challenge to the industry. Anecdotal evidence suggests that these populations have entered Ireland from the UK via seed, straw and machinery, and are now dispersed across tillage fields. However, it is possible that native populations were in existence, which may now carry a degree of resistance if they were regularly treated with herbicides that are active against black-grass.

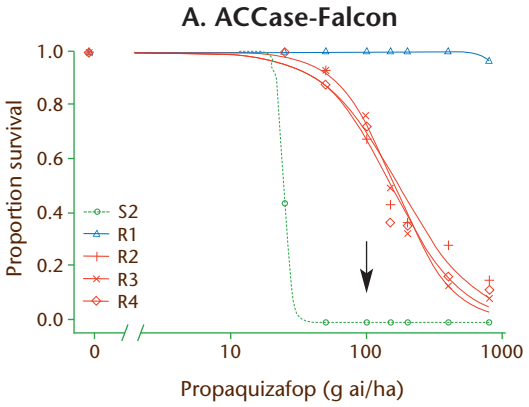
Multiple herbicide-resistant black-grass

In a survey of grass weeds on tillage farms, 12 black-grass populations were collected prior to the 2020 harvest and screened for resistance with ACCase- and ALS-inhibiting herbicides. Four of these populations (R1 to R4), collected in Cork, Meath and Waterford, appeared to exhibit resistance and were subjected to detailed dose-response studies where they were compared with a known susceptible population (S2) collected in Dublin.

Plants were sprayed at the two- to three-leaf stage, with rates ranging from 0.25 to eight times the recommended label rates of ACCase-propaquizafop (Falcon) and ALS-mesosulfuron/iodosulfuron (Pacifica Plus). Herbicide effectiveness was measured by estimating the effective dose rates causing 50 % mortality of the treated plants (ED_{50}). For non-resistant weeds, the ED_{50} values should be much lower than the label rate.

For the ACCase herbicide, the ED_{50} values of populations R2 to R4 were between 1.5 and 1.8 times the label rate of 100 g active ingredient (ai)/ha (**Figure 1A**), indicating that effective control is not possible on these populations (**Figure 2A**). The R1 population was much more resistant, resulting in ED_{50} values more than eight times the label rate.

For the ALS herbicide, the ED_{50} of population R1 was well below the label rate of 500 g product/ha (**Figure 1B**), indicating that this ACCase-resistant population was highly sensitive to the ALS herbicide (**Figure 2B**). But all other ACCase-resistant populations were also ALS resistant, with ED_{50} values >2.4 times the label rate for R3 and R4, and ED_{50} values >8 times the label rate for R2, respectively. For these multiple-resistant populations, no chemical control options are available in any tillage crop and extreme IWM strategies, including grass leys/fallows for a minimum of five years, would be needed to help eliminate the seedbank. This study highlights the importance of testing different herbicide types, where resistance is found in the populations.



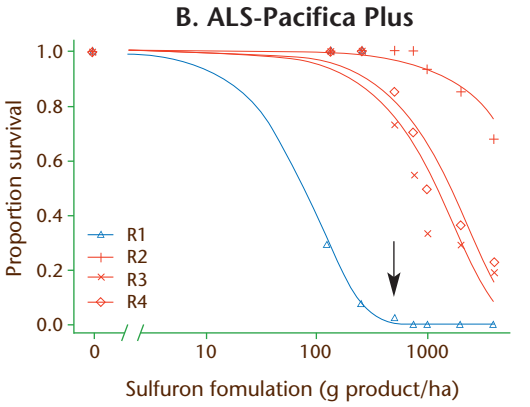
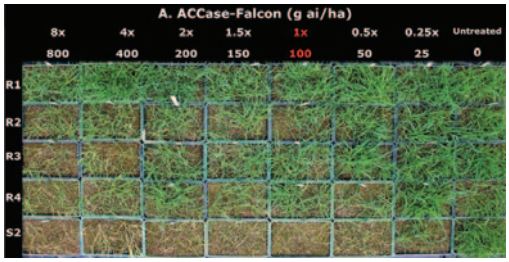


FIGURE 1: Dose-response curves for survival of susceptible (S2) and resistant (R1 to R4) populations of black-grass treated with dose rates ranging from 0.25 to eight times the recommended label rates of ACCase-Falcon (A) and ALS-Pacifica Plus (B). Arrows indicate the label rates of Falcon (100 g ai/ha) and Pacifica Plus (500 g product/ha) for black-grass control. Note: S2 was fully controlled at 0.25 times the label rate (see Figure 2B); therefore, model (B) could not be fitted with S2.



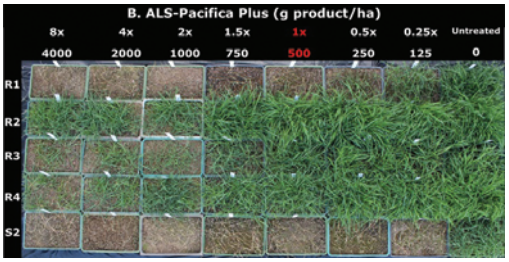


FIGURE 2: Symptoms of susceptible (S2) and resistant (R1 to R4) populations of black-grass following application of ACCase-Falcon (A) and ALS-Pacifica Plus (B) at dose rates ranging from 0.25 to eight times the recommended label rates (highlighted in red).

Benefits to industry

This is the first study to confirm herbicide-resistant black-grass in Ireland. Knowledge of resistance levels and cross-resistance among the main herbicide types, coupled with weed pressure and previous herbicide use on an individual field, will inform the actions needed to eliminate or control the resistant populations. More importantly, this knowledge should help to prevent resistance evolution. This information is being disseminated among growers and industry, but to build more robust IWM, there is a need for more comprehensive knowledge on the evolution of herbicide resistance and the genetic mechanisms that are involved. If we allow resistance to develop and fail to control challenging grass weeds, the sustainability of the tillage industry will be threatened.

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References

Moss, S.R. (2017). 'Black-grass (*Alopecurus myosuroides*): Why has this weed become such a problem in Western Europe and what are the solutions?' *Outlooks on Pest Management*, 10: 207-212.

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