Herbicide resistance in Irish grass weeds

TEAGASC is looking into herbicide resistance and devising strategies to counteract this serious threat.

Weeds compete with crops for light, water and nutrients, causing reductions in yield, difficulties in harvesting, and in the case of seed crops, rejection of the crop. Grass weeds in particular may be challenging for growers to control due to the fact that cereals are also grasses, limiting options for herbicidal control. Herbicide resistance poses further problems for weed management, increasing costs and eroding profit margin for the grower. Herbicide resistance can be defined as the evolved ability of a plant to survive a dose of herbicide that would normally be lethal. Our research focuses on identifying herbicide resistance in grass weeds on Irish farms and understanding the nature of this resistance.

Approach

Grass weed samples were obtained in 2016 from fields where weed control had been an issue. A library of populations of wild oats (*Avena fatua*), black grass (*Alopecurus myosuroides*), lesser canary grass (*Phalaris minor*) and various species of brome (*Bromus sterilis*, *Bromus diandrus*, *Bromus secalinus*, *Bromus hordeaceus*, *Bromus commutatus*) was constructed. In all, 77 populations were tested for their susceptibility to four different commonly used herbicide active ingredients. The trial cohort comprised 31 populations of wild oats, 22 populations of brome, 16 populations of black grass and eight populations of lesser canary grass (**Figure 1**). Weeds were treated with pinoxaden, cycloxydim, propaquizafop and meso/iodosulfuron, representing the ACCase- and ALS-inhibiting herbicides (**Table 1**). To determine the levels of resistance present, the biomass of plants sprayed with the various herbicides was compared to that of unsprayed controls (**Figure 2**). Dividing the weight of the biomass of the sprayed plant by the weight of the unsprayed control for a given population allows for a resistance score to be assigned to each population for each active ingredient tested.

Findings

Before making absolute statements about the levels/presence of resistance in Irish grass weeds, more analysis is certainly required. This survey is being carried on in 2017 and 2018. That said, initial findings

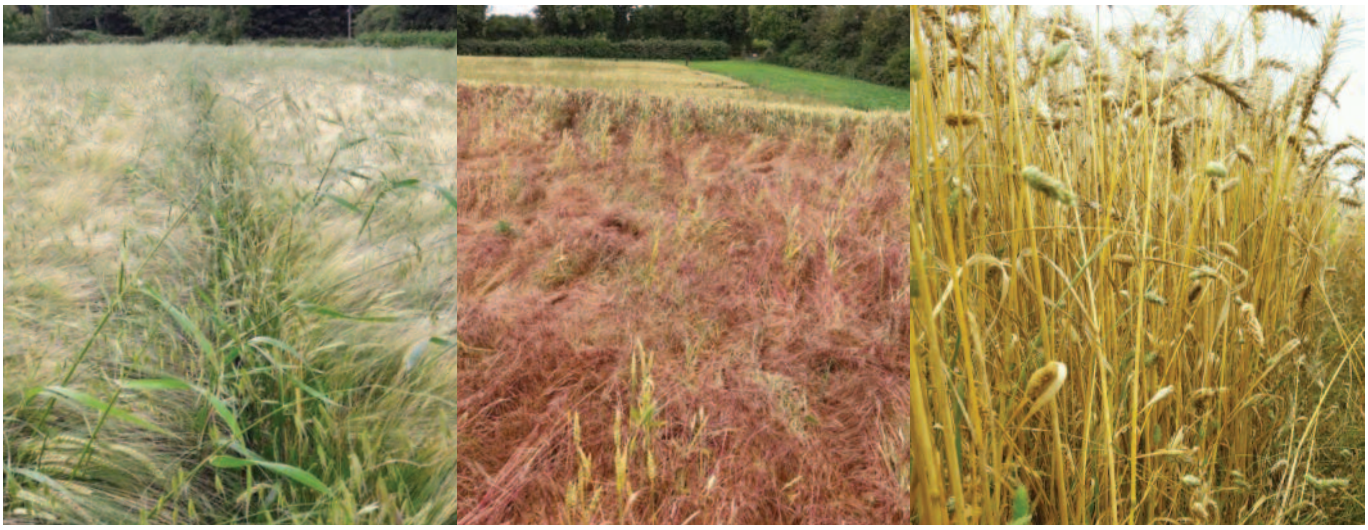

FIGURE 1: From left: infestation of wild oats (Avena fatua) *in spring barley; sterile brome* (Bromus sterilis) *in winter wheat; and, lesser canary grass* (Phalaris minor) *in spring wheat.*

Table 1: Overview of weed grass species targeted with this project and identified resistances to available herbicide groups.

Weed species	Resistance found to cycloxydim?	Resistance found to propaquizafop?	Resistance found to pinoxaden?	Resistance found to meso/iodosulfuron?
Wild oats	Yes	Yes	Yes	Suspected
Black grass	Yes	Yes	Yes	Yes
Brome	No	No	N/A; doesn't claim control	Suspected
Lesser canary grass	No	No	No	No

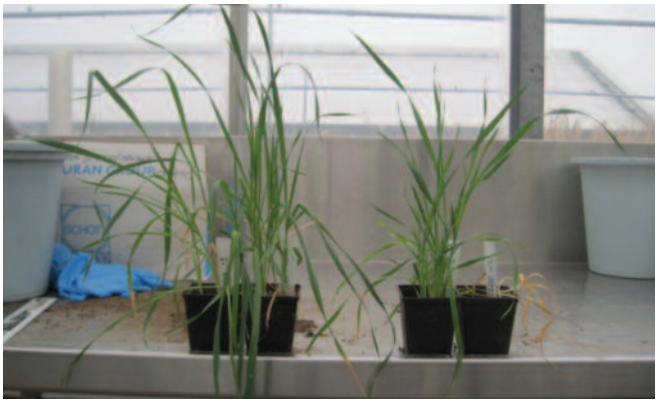

FIGURE 2: Side by side comparison of two pots of unsprayed wild oats (left) and two of sprayed wild oats (right). Note the disparity in size/vigour between the resistant (left) and susceptible (right) plants in the examples on the right. Picture taken three weeks post spraying with cycloxydim.

indicate that 'dim', 'den', 'fop' and sulfonylurea resistance seem to be present in wild oats, with these findings mirrored in tests carried out on black grass. Trials carried out on the various species of brome returned no signs of resistance to ACCase inhibitors, but resistance is suspected to ALS inhibitors (sulfonylureas).

Implications

The implications of these results are profound and add another layer of complexity to a tillage sector that is already under pressure. Studies carried out in Canada and across continental Europe suggest that the spread of herbicide resistance is caused more by the spread of resistant seed, as opposed to independent resistance-endowing mutations. In small geographical areas, such as the Irish grain-producing region, the potential for the spread of resistant genes is significant. Controlling this spread, and furthermore, managing resistant weeds at farm and regional level, may cause input costs to rise and reduce profit margins for growers.

Follow-up studies

The first step following these initial tests is to determine the response of the resistant populations to varying doses of herbicides. This gives a more accurate idea of the levels of resistance at play in these populations, while providing further replication of the experiments to add statistical significance to the data being acquired.

Black grass is a relatively new weed in Ireland. While it has been present in extremely low background numbers over the years, the past few seasons have seen an increase in the presence of this pernicious weed. This in itself is significant, as black grass is one of the most widespread weeds in the UK, with up to 98% of populations showing resistance to at least one herbicide active ingredient. The working hypothesis is that Irish populations of resistant black grass are, in fact, British populations that have migrated to Ireland via imported machinery, seed, bales, etc. Teagasc is carrying out population genetics experiments to uncover the genetic relationship between Irish and British black grass populations.

Further experiments, in conjunction with Rothamsted Research in the UK, aim to investigate the genetic basis for herbicide resistance in Irish grass weeds. This will look at the herbicide target enzymes of the plants, as well as identifying markers for mutations to the cell machinery responsible for detoxifying xenobiotics such as herbicides.

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