Glyphosate resistance update

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Glyphosate resistance risks?

• No known cases of glyphosate resistance in UK
• Essential component of many weed control strategies; need to keep it!
• Glyphosate resistance globally
• Lack of other actives
• Multiple resistance increases risk
• Over-reliance/use of glyphosate
• Post-em use increasingly considered an option
Guidelines published 2015

4 key principles:
- Prevent survivors
- Maximise efficacy
- Use alternatives
- Monitor success
Minimising the risk of glyphosate resistance  
(2015-2020)

Aim
Practical management guidelines for farmers & agronomists reducing the risk of glyphosate resistance developing in grass-weeds in arable cropping in the UK

Key objectives
1. Risk of repeat glyphosate applications in stubbles
2. The use of glyphosate post-em - between crop rows
3. Determining resistance status (seed + plant testing)
4. Agree & communicate practical management guidelines

Outcomes and Impact
• Improved management guidelines & resistance tests for seed & plants
To reduce the risk of glyphosate resistance:

**Prevent survivors**
- Repeat application to surviving plants presents the highest risk

**Monitor success**
- Consult your agronomist or supplier
- Remove survivors to prevent spread
- Test seed samples of survivors

**Maximise efficacy**
- Use the right dose rate for the target weed on actively growing plants
- Reduced rates increase risk of reduced efficacy

**Use alternatives**
- Use cultivation or other non-chemical control when practical
- Use other herbicides in sequence (or mixture only if recommended)

- Black-grass & Italian ryegrass
- Glasshouse Pots
- Containers
- Field
Basic UK data review summary-comparing existing glyphosate use data

• Data very variable and not all autumn applications
• Optimum glyphosate dose 1080 g a.i.
  • Rate generally split into two application timings
• No increase in control with > 3 glyphosate applications
• No increase in control above 1080g a.i.
• Lack of robust data on pre-drilling use
  • Majority of trials in fallow
How are risks are mitigated?

Container experiments (Years 1-2):
• 216 containers/experiment
• 3 populations of each species

Effect of glyphosate dose against weed growth stage
• Four doses and three weed growth stages

Effect of glyphosate dose, weed size and cultivation
• Two doses and two growth stages
• Two ‘simulated’ cultivation depths
Glyphosate @ 540g/ha+ at GS 12-13 most effective
Dose rate and timing are critical for control

Effect of dose

**Black-grass**
- 2-3 leaves
  - Untreated
  - 360 g/ha
  - 540 g/ha
  - Tillering

**Italian ryegrass**
- 2-3 leaves
  - Untreated
  - 360 g/ha
  - 540 g/ha
  - Tillering

Effect of timing (540 g/ha)

**Black-grass**
- Untreated
- 1 leaf
- 2-3 leaves
- Tillering

**Italian ryegrass**
- Untreated
- 1 leaf
- 2-3 leaves
- Tillering
Quantifying the need for repeat glyphosate

- Three sites 2016-18
- Plots (12m x 3m)
- 3 reps
- Post-harvest cultivation
- Plots split drilled
- Plant & head counts

Risk of repeat glyphosate applications in stubbles
# Field trial treatments pre-drilling 2016-18

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
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<tbody>
<tr>
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<td>540g/ha</td>
<td>540g/ha x2</td>
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<tr>
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<td>Early</td>
<td>Early</td>
<td>Mid</td>
<td>Mid</td>
<td>Late</td>
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<td>Minimum cultivation</td>
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<td>540g/ha</td>
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<tr>
<td></td>
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<td>Early</td>
<td>Early</td>
<td>Mid</td>
<td>Mid</td>
<td>Late</td>
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</table>

*Risk of repeat glyphosate applications in stubbles*
Later glyphosate timings = better black-grass control

Mean number black-grass heads/m$^2$ 2016-17

Reducing resistance risk: cultivations and timing

Risk of repeat glyphosate applications in stubbles
Treatment 4 (Both years)

Evidence of reduced efficacy due to large growth stage and shading?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Application Timing</th>
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<tbody>
<tr>
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<td>2</td>
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<td>5</td>
<td>x</td>
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<td>6</td>
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Risk of repeat glyphosate applications in stubbles
Spring barley trials 2018-19

<table>
<thead>
<tr>
<th></th>
<th>No cultivation</th>
<th>Autumn cultivation</th>
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<tbody>
<tr>
<td><strong>No glyphosate</strong></td>
<td><strong>720g/ha glyphosate autumn</strong></td>
<td><strong>720g/ha glyphosate spring</strong></td>
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<tr>
<td><strong>No glyphosate</strong></td>
<td><strong>720g/ha glyphosate autumn</strong></td>
<td><strong>720g/ha glyphosate spring</strong></td>
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<thead>
<tr>
<th></th>
<th>Boxworth</th>
<th>Cambs H</th>
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<tbody>
<tr>
<td>Autumn glyphosate</td>
<td>19 October</td>
<td>17 October</td>
</tr>
<tr>
<td>Autumn cultivation</td>
<td>9 November</td>
<td>25 November</td>
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<td>Spring glyphosate</td>
<td>22 February</td>
<td>14 February</td>
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<td>Drilling</td>
<td>2 March</td>
<td>22 February</td>
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Risk of repeat glyphosate applications in stubbles
Spring barley
Boxworth: post-drilling plant counts

Risk of repeat glyphosate applications in stubbles
Conclusions from field trials

• Cultivations are essential to reduce plant numbers
• Split dose (540g) most effective & less resistance risk
• Confirmation of delayed drilling = less black-grass!
• Spring crops- consider timing of cultivations and glyphosate applications to suit the season
• Consider weather conditions (moisture/temp)
• Dose and weed size important
WP2.1 Containers: Large growth stages

*Started year 3 repeated year 4*

- Re-sown saved seed autumn 2018
- Two black-grass populations
- Three weed growth stages
  - GS23
  - GS25-28
  - GS32
- Two glyphosate doses 180g + 360g + UTC
- Three replicates
- Seed collected tested 2019/20
WP 2.1 Survival of large growth stage treatments at two glyphosate doses: Year 1
WP 2.1 Survival of large growth stage treatments at two glyphosate doses: Year 2

![Bar Chart]

- **Untreated**
- **Glyphosate 360g/ha**
  - GS 23
- **Glyphosate 180g/ha**
  - GS 25-28
- **Glyphosate 360g/ha**
  - GS 32
- **Glyphosate 180g/ha**

**Mean heads/container**

**Colors:**
- **Blue** for Susceptible
- **Orange** for Peldon

**Dates:**
- 20/02/19
- 06/03/19
- 02/04/19
Selection containers

- Black-grass only
  - Resistant (other MoA) x2
  - Susceptible
- Pushing selection
- Glyphosate rates low
  - 90g a.i.
  - 180g a.i.
  - 360g a.i.
- Applied GS 14-21
- Seed collected
- Repeated over 4 years

WP 3.4 Selection containers
Selection containers: Black-grass heads 2018

![Bar chart showing mean number of black-grass heads per container for susceptible, moderately resistant, and resistant populations under UTC, Glyphosate @ 180g/ha, and Glyphosate @ 90g/ha treatments.](image-url)

- ** UTC
- ** Glyphosate @ 180g/ha
- ** Glyphosate @ 90g/ha

**Black-grass populations:**
- Susceptible
- Mod Res
- Resistant
Selection containers: BG heads 2019

The graph shows the mean number of heads per container for different black-grass populations treated with different glyphosate applications. The treatments are:
- Untreated
- Glyphosate @ 180g/ha
- Glyphosate @ 90g/ha

The populations are categorized as:
- Susceptible
- Mod Res (Moderate Resistance)
- Resistant

The untreated population shows a significantly higher number of heads compared to the treated populations, especially in the susceptible category.
Temperatures at application 2019

Mid-January

3.5 °C

Mid-February

17 °C !!
Improving resistance testing in the UK Syngenta RISQ test

• Pot and Petri dish methods currently
• Resistance In Season Quick (RISQ) test
• Comparable results to whole plant tests
• Suitable for all weeds and herbicide MOA
• Seedlings from field tested
• Quicker and space saving

Adapting the method with glyphosate

- Designed for GS12-14
- Most likely larger plants will be sent
- Tillered plants can be sectioned
- Black-grass and Italian rye-grass

Determining the discriminating dose for black-grass

<table>
<thead>
<tr>
<th>UTC</th>
<th>35 mM</th>
<th>50 mM</th>
<th>75 mM</th>
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Italian rye-grass results 2018

UTC  
50µM  
75µM

Susceptible

ALS resistant
To reduce the risk of glyphosate resistance:

- Prevent survivors
- Monitor success
- Maximise efficacy
- Use alternatives
Key messages: Overall project

- Glyphosate ideal **timing** GS12-13
- Glyphosate **dose** >540g critical
- Dose should be 720g on tillered plants
- **Temperature** at application important
- **Cultivation** in stale seedbed essential
- Two applications timings for stale seedbed

- **Optimise efficacy**
Other species of concern for glyphosate resistance???

Thank you!