Glyphosate resistance update

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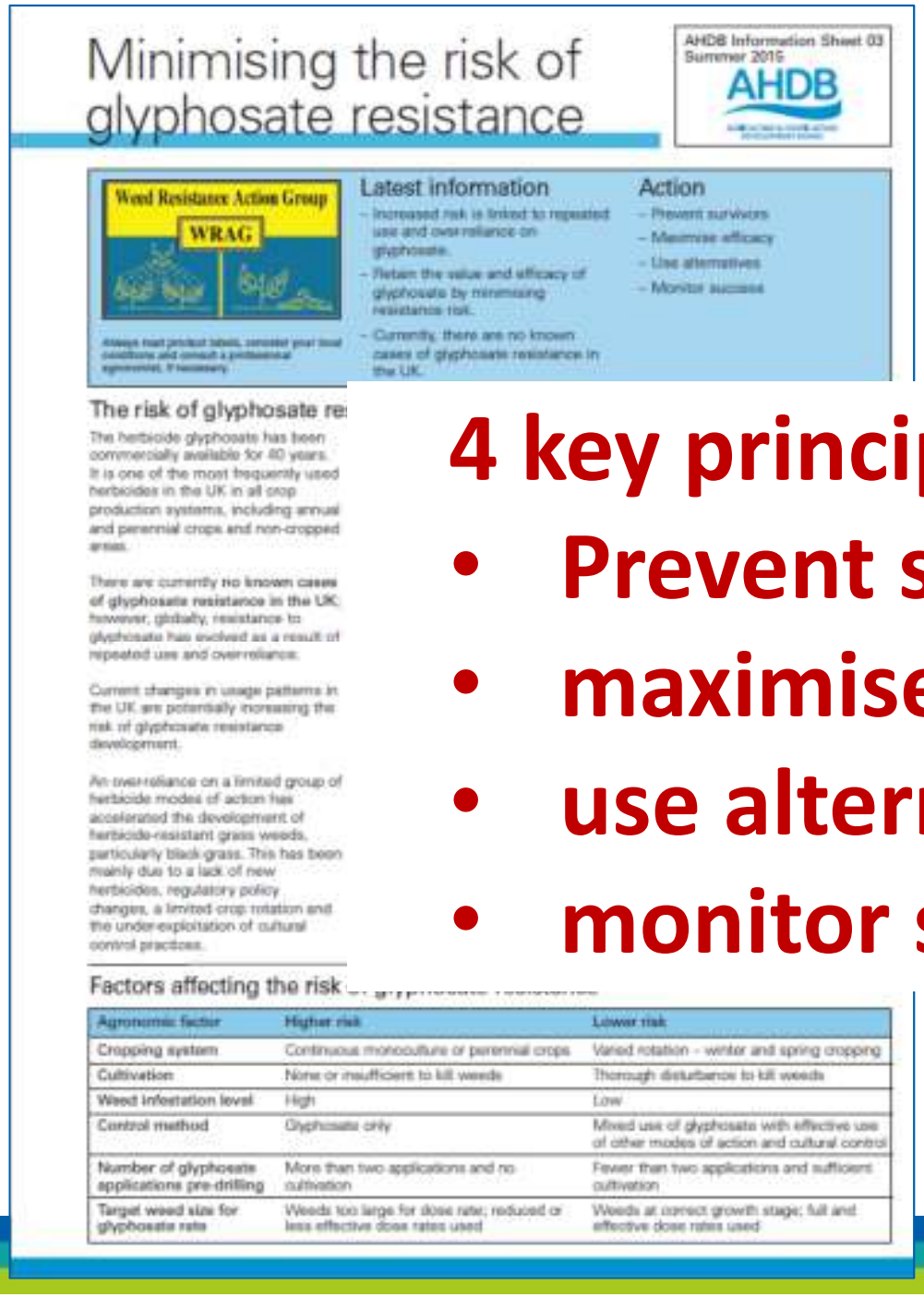
Glyphosate resistance risks?

- 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


Minimising the risk of glyphosate resistance

AHDB Information Sheet 03 Summer 2015

AHDB

Weed Resistance Action Group

WRAG

Latest information

- Increased risk is linked to repeated use and over-reliance on glyphosate.
- Retain the value and efficacy of glyphosate by minimising resistance risk.
- Currently, there are no known cases of glyphosate resistance in the UK.

Action

- Prevent survivors
- Maximise efficacy
- Use alternatives
- Monitor success

The risk of glyphosate re

The herbicide glyphosate has been commercially available for 40 years. It is one of the most frequently used herbicides in the UK in all crop production systems, including annual and perennial crops and non-cropped areas.

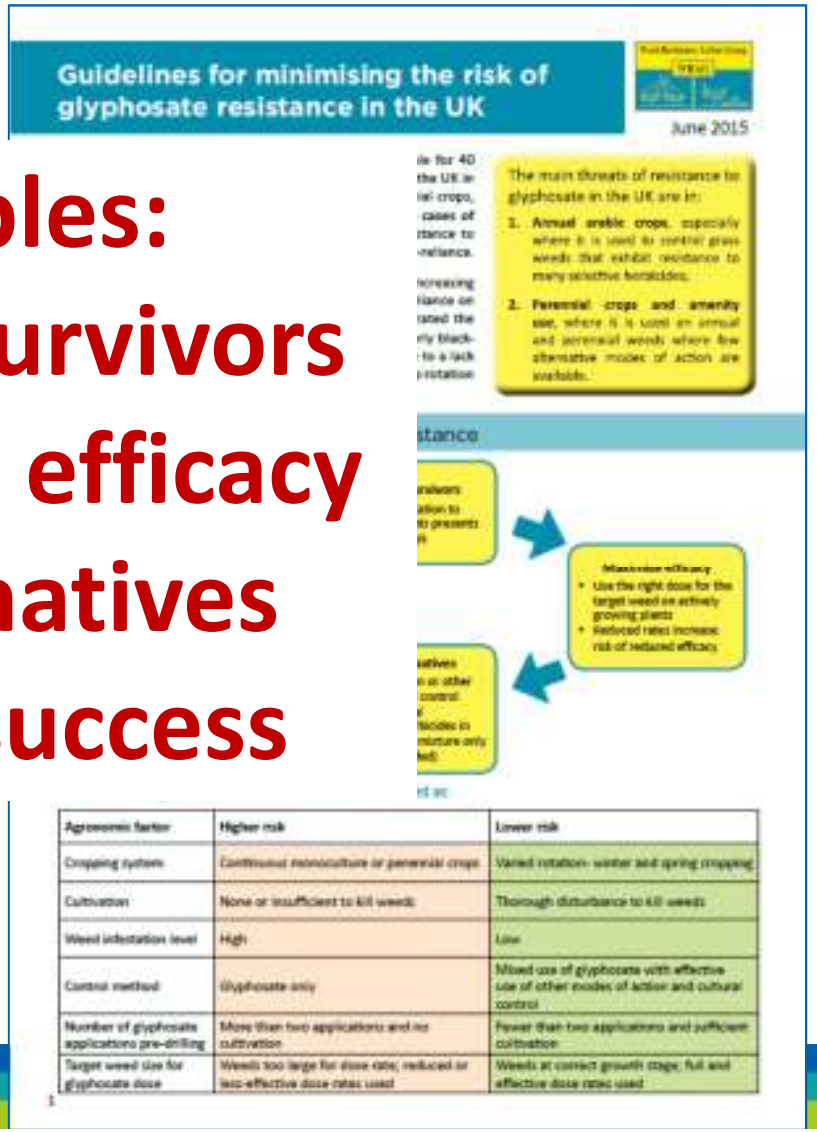
There are currently no known cases of glyphosate resistance in the UK; however, globally, resistance to glyphosate has evolved as a result of repeated use and over-reliance.

Current changes in usage patterns in the UK are potentially increasing the risk of glyphosate resistance development.

An over-reliance on a limited group of herbicide modes of action has accelerated the development of herbicide-resistant grass weeds, particularly black-grass. This has been mainly due to a lack of new herbicides, regulatory policy changes, a limited crop rotation and the under-exploitation of cultural control practices.

Factors affecting the risk

Agronomic factor	Higher risk	Lower risk
Cropping system	Continuous monoculture or perennial crops	Varied rotation - winter and spring cropping
Cultivation	None or insufficient to kill weeds	Thorough disturbance to kill weeds
Weed infestation level	High	Low
Control method	Glyphosate only	Mixed use of glyphosate with effective use of other modes of action and cultural control
Number of glyphosate applications pre-drilling	More than two applications and no cultivation	Fewer than two applications and sufficient cultivation
Target weed size for glyphosate rate	Weeds too large for dose rate; reduced or less effective dose rates used	Weeds at correct growth stage; full and effective dose rates used


Guidelines for minimising the risk of glyphosate resistance in the UK

June 2015

The main threats of resistance to glyphosate in the UK are in:

1. Annual arable crops, especially where it is used to control grass weeds that exhibit resistance to many selective herbicides;
2. Perennial crops and amenity use, where it is used on annual and perennial weeds where few alternative modes of action are available.

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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

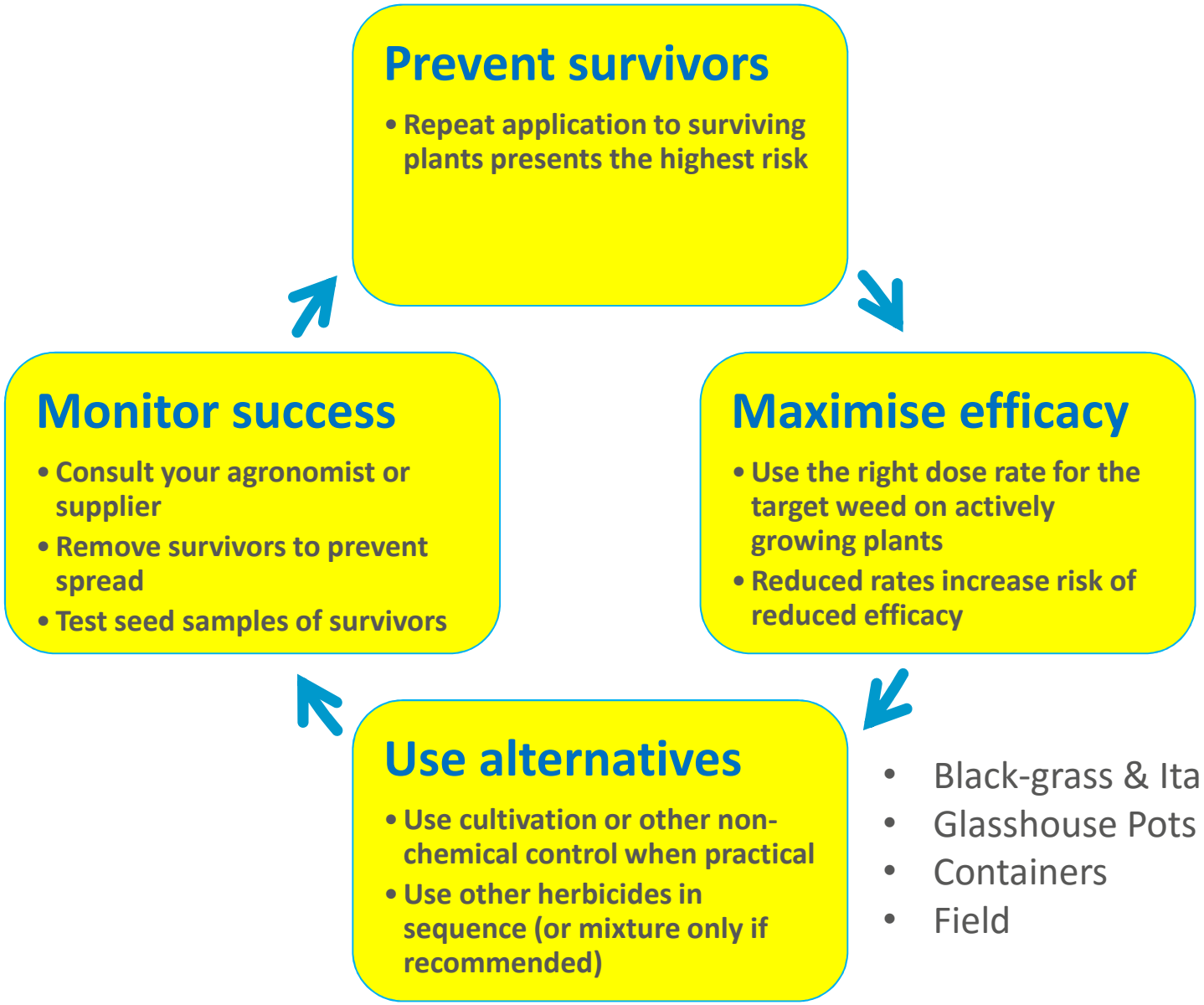
Key objectives

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:



- Black-grass & Italian ryegrass
- Glasshouse Pots
- Containers
- Field

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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

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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

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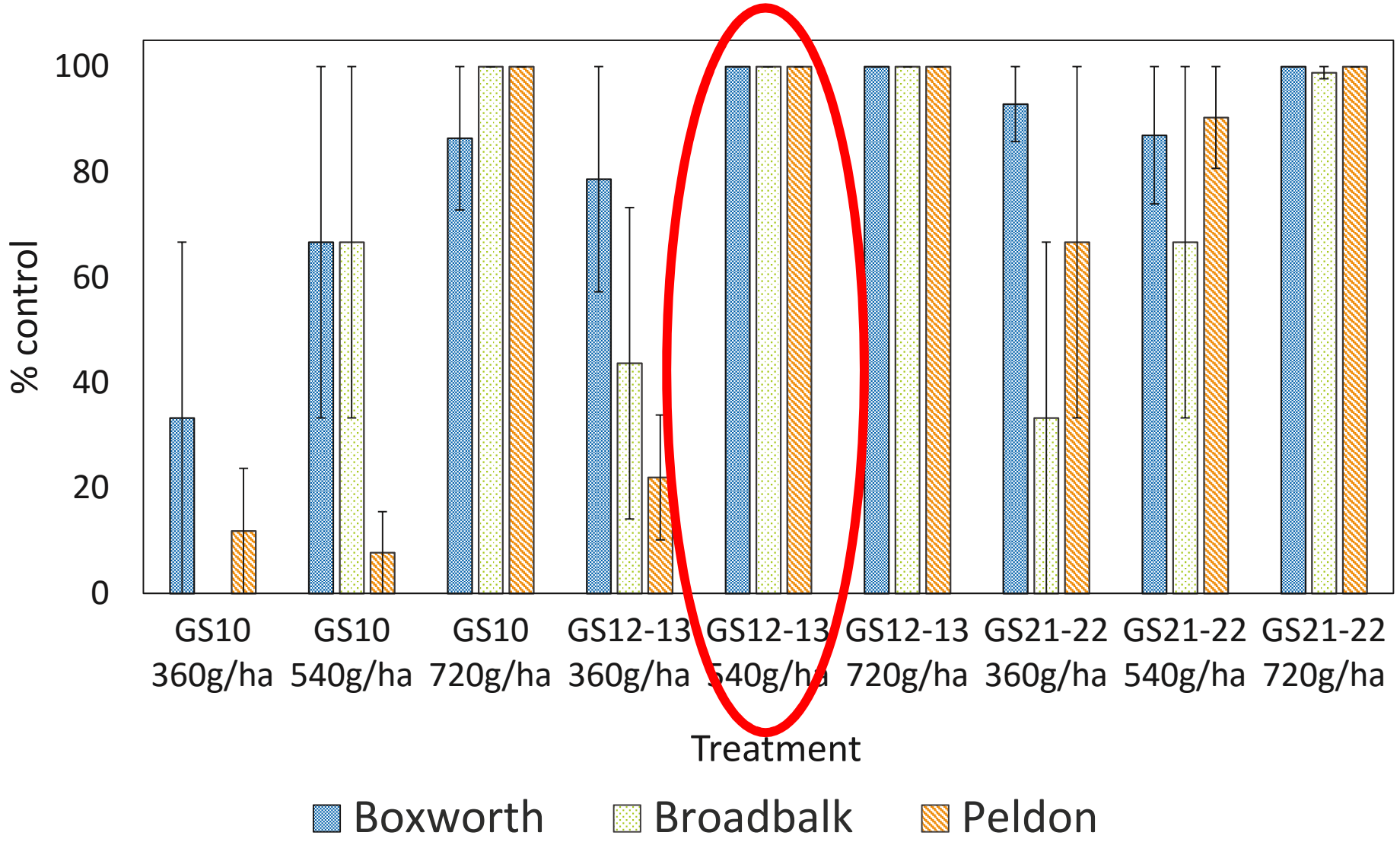
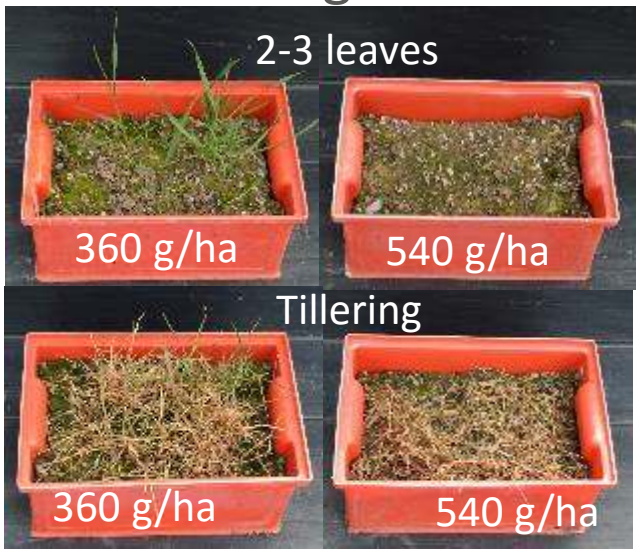
Glyphosate @ 540g/ha+ at GS 12-13 most effective



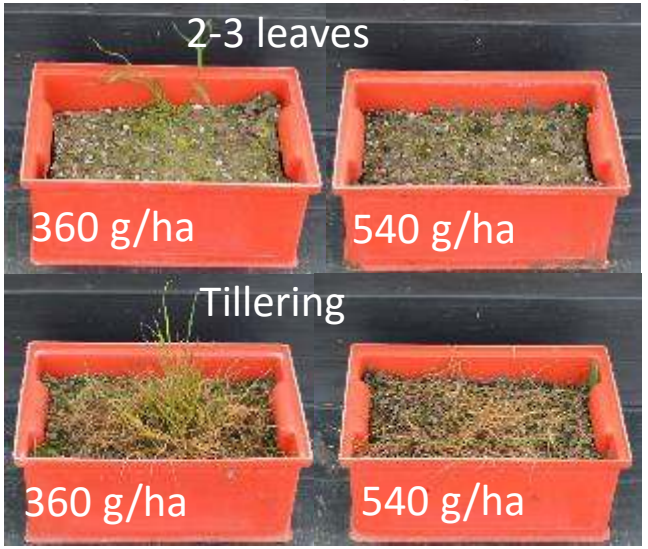
Dose rate and timing are critical for control

Effect of dose

Black-grass



Italian ryegrass



Effect of timing (540 g/ha)

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

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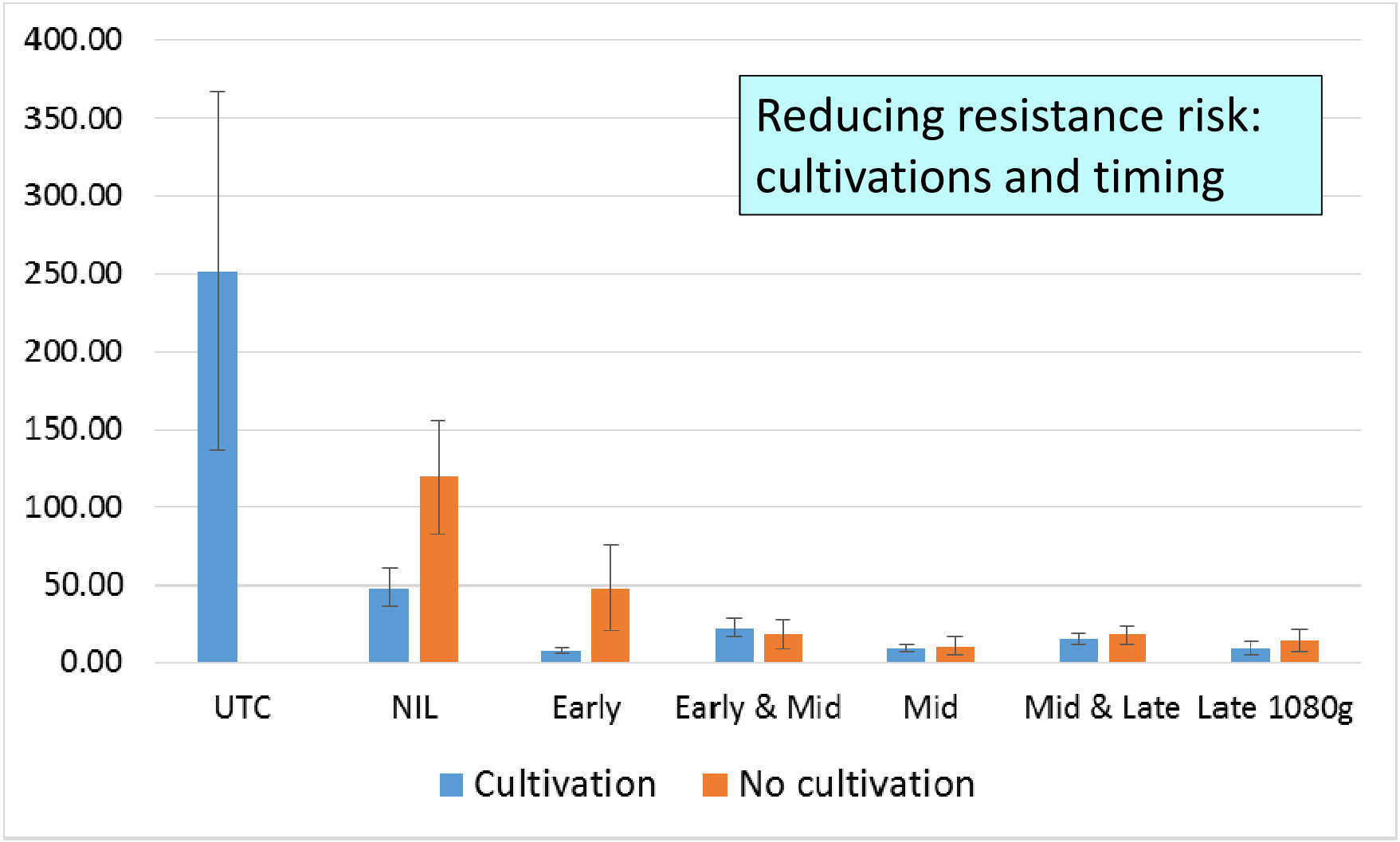
Field trial treatments pre-drilling 2016-18

	T1	T2	T3	T4	T5	T6
No cultivation	UTC	540g/ha Early	540g/ha **x2** Early Mid	540g/ha Mid	540g/ha **x2** Mid Late	1080g/ha Late
Minimum cultivation	UTC	540g/ha Early	540g/ha **x2** Early Mid	540g/ha Mid	540g/ha **x2** Mid Late	1080g/ha Late

Risk of repeat glyphosate applications in stubbles

Later glyphosate timings = better black-grass control

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



Risk of repeat glyphosate applications <u>in stubbles</u>

Treatment 4 (Both years)

Treatment	Application Timing		
	Early	Mid	Late
1	-	-	-
2	x		
3	x	x	
4		x	
5		x	x
6			x

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

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Risk of repeat glyphosate applications <u>in stubbles</u>

Spring barley trials 2018-19

No cultivation	**No** glyphosate	720g/ha glyphosate **autumn**	720g/ha glyphosate **spring**
Autumn cultivation	**No** glyphosate	720g/ha glyphosate **autumn**	720g/ha glyphosate **spring**

	Boxworth	Cambs H
Autumn glyphosate	19 October	17 October
Autumn cultivation	9 November	25 November
Spring glyphosate	22 February	14 February
Drilling	2 March	22 February

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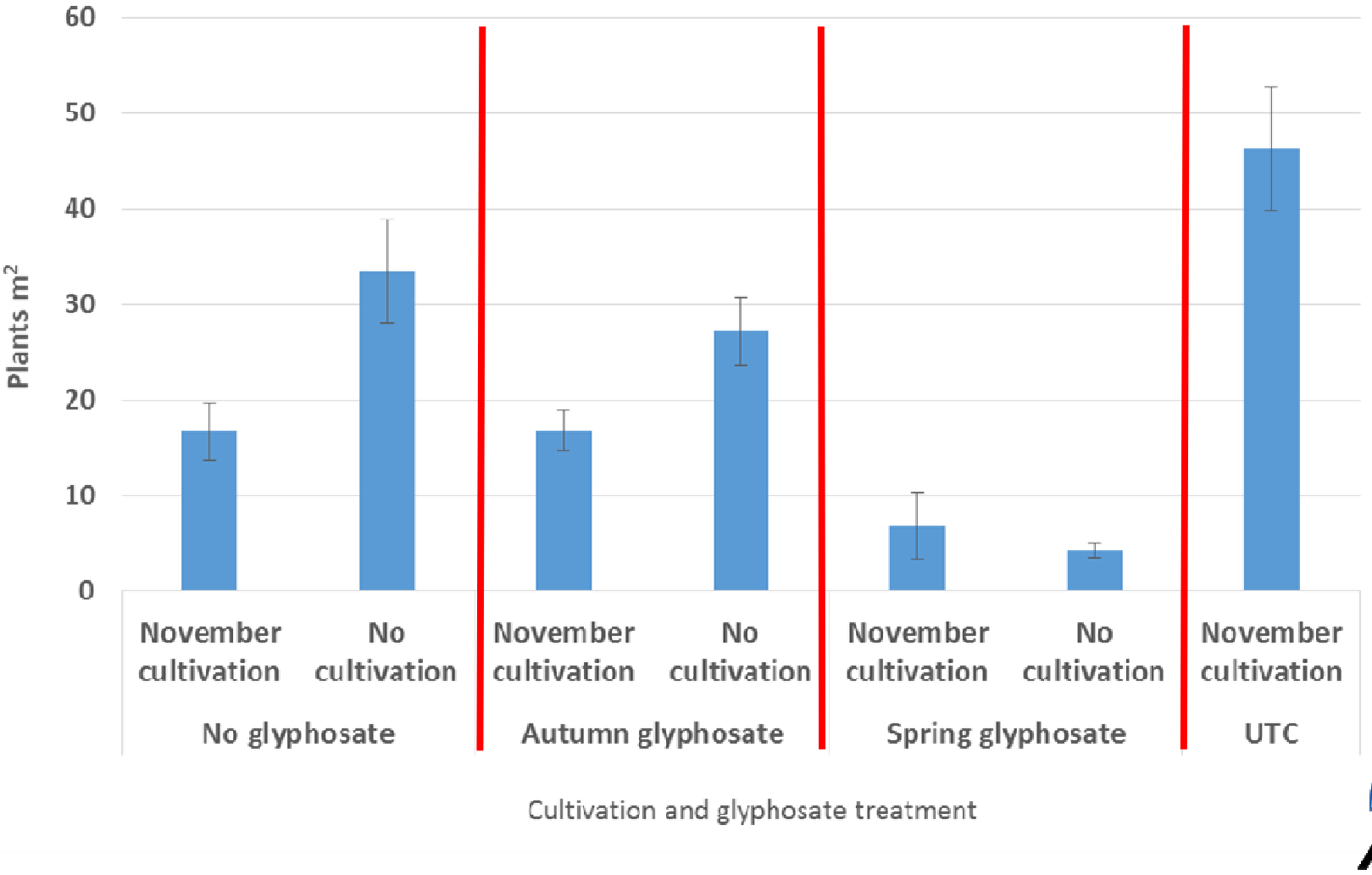
Risk of repeat glyphosate applications in stubbles

Spring barley
Boxworth: post-drilling plant counts



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Risk of repeat glyphosate applications <u>in stubbles</u>

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

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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

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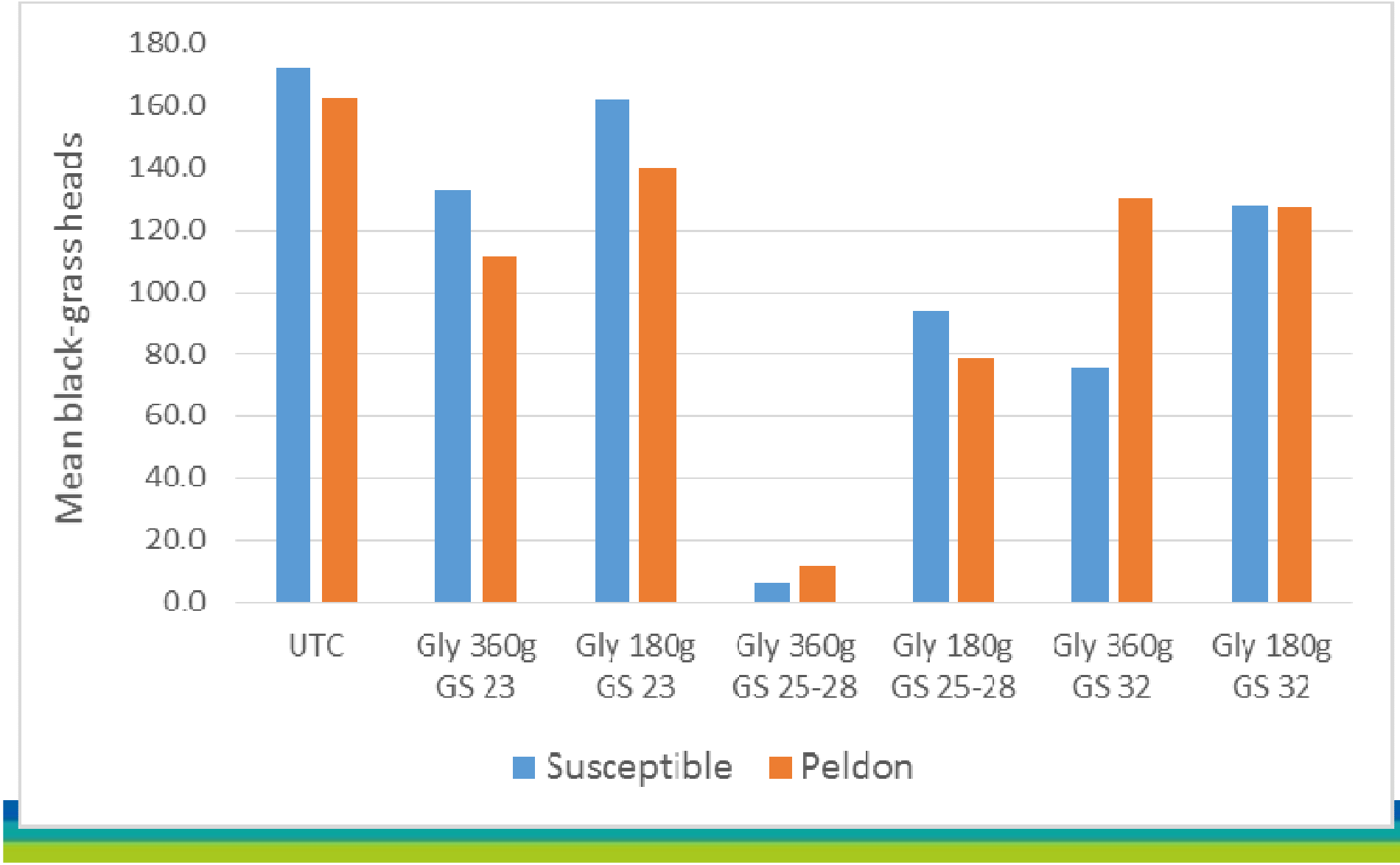
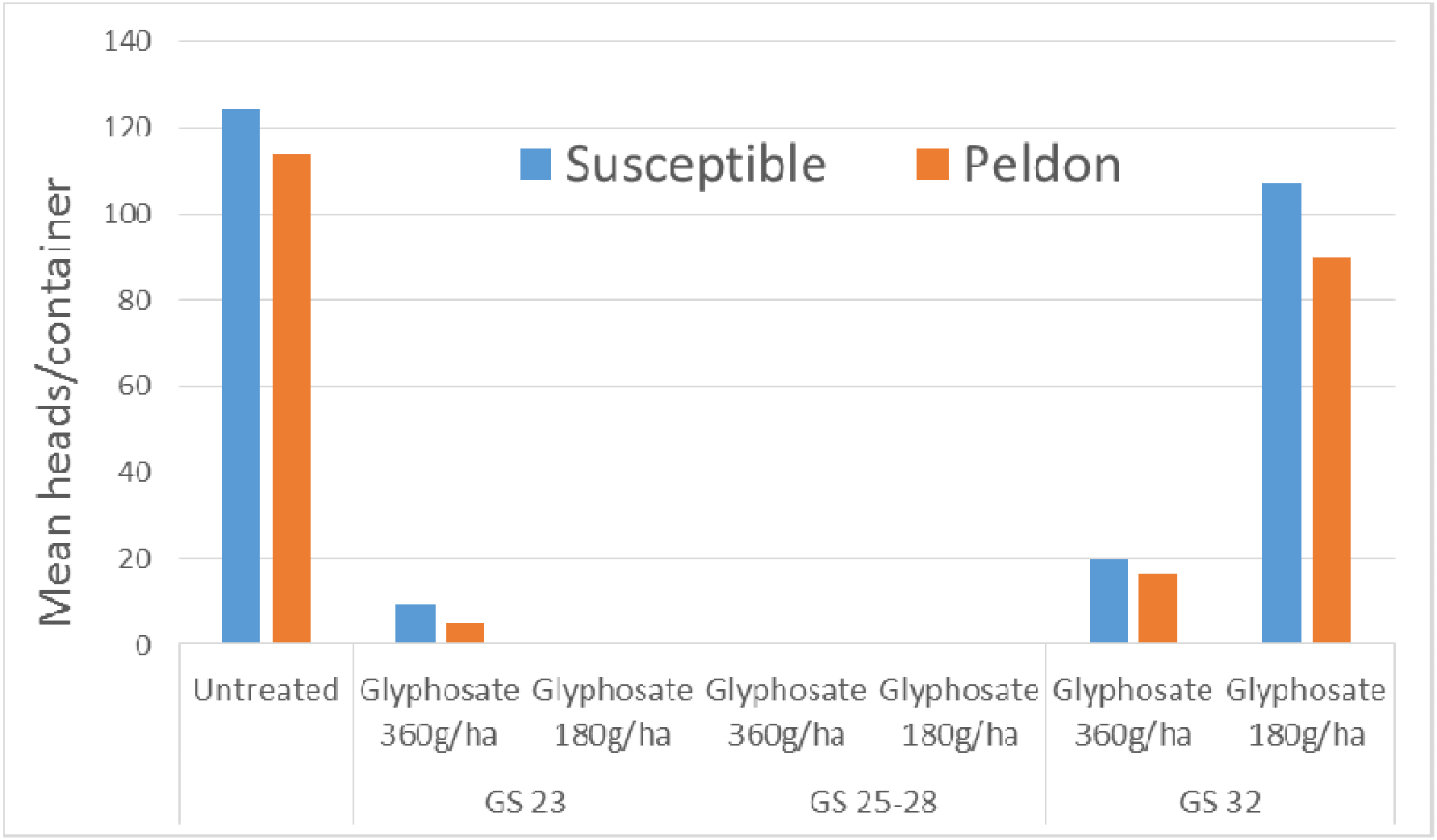
WP 2.1 Survival of large growth stage treatments at two glyphosate doses: Year 1



WP 2.1 Survival of large growth stage treatments at two glyphosate doses: Year 2



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

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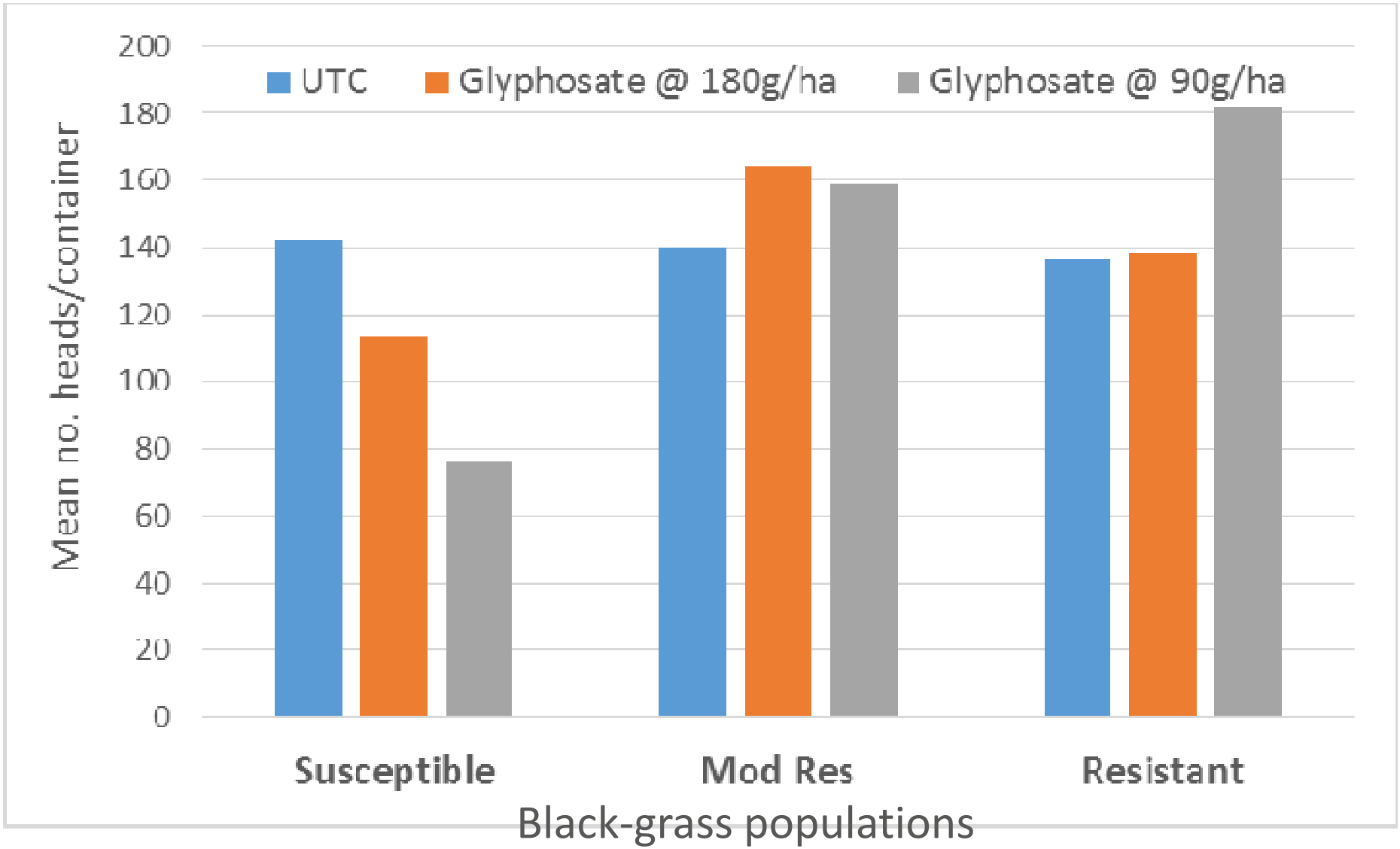
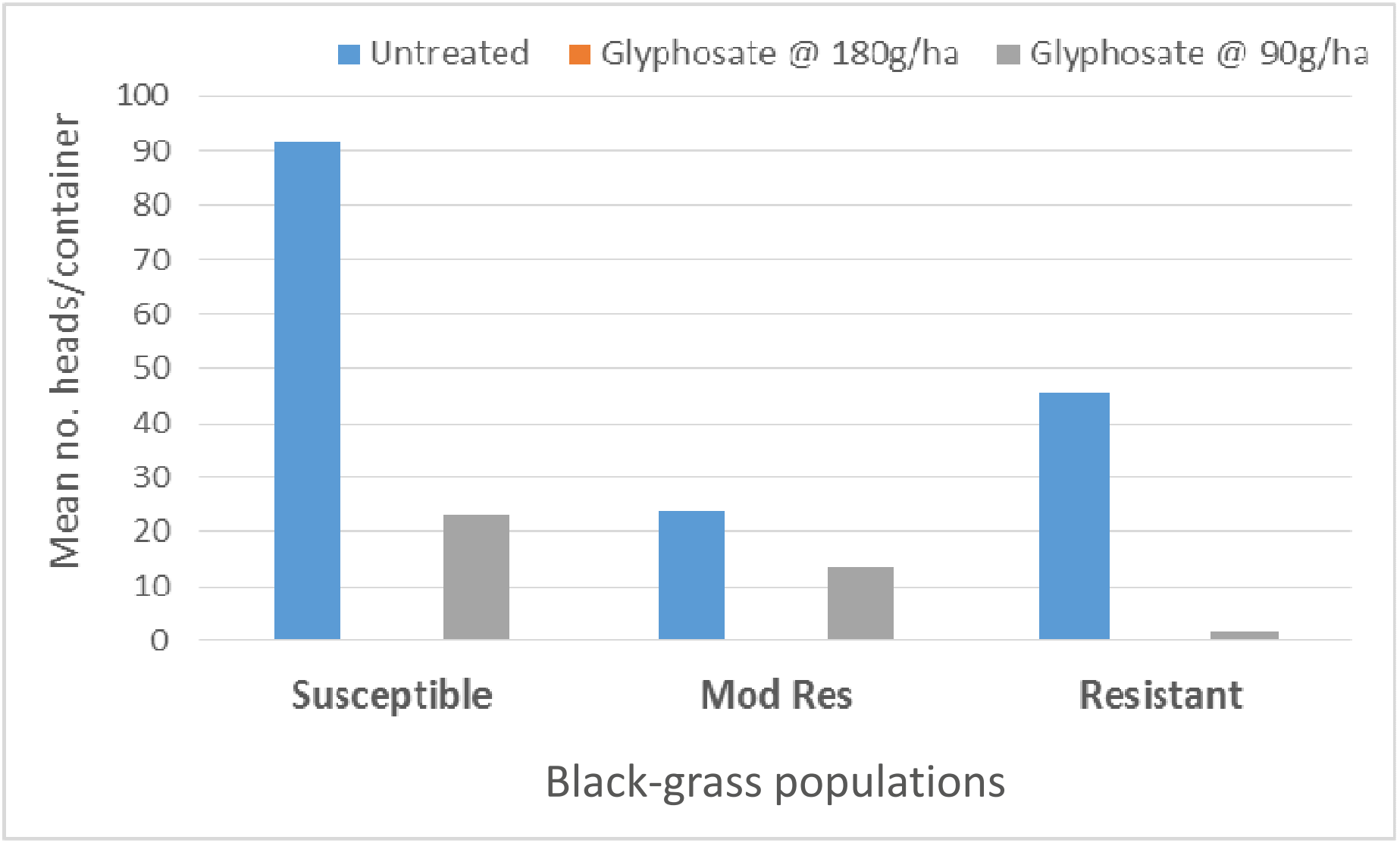
Selection containers: Black-grass heads 2018



Selection containers: BG heads 2019



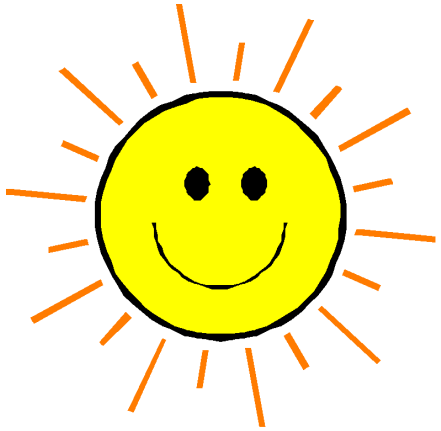
Temperatures at application 2019

Mid-January

3.5 ºC

Mid-February

17 ºC !!



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

Kaundun S.S. et al,. (2011) Weed Research. 51 284-293

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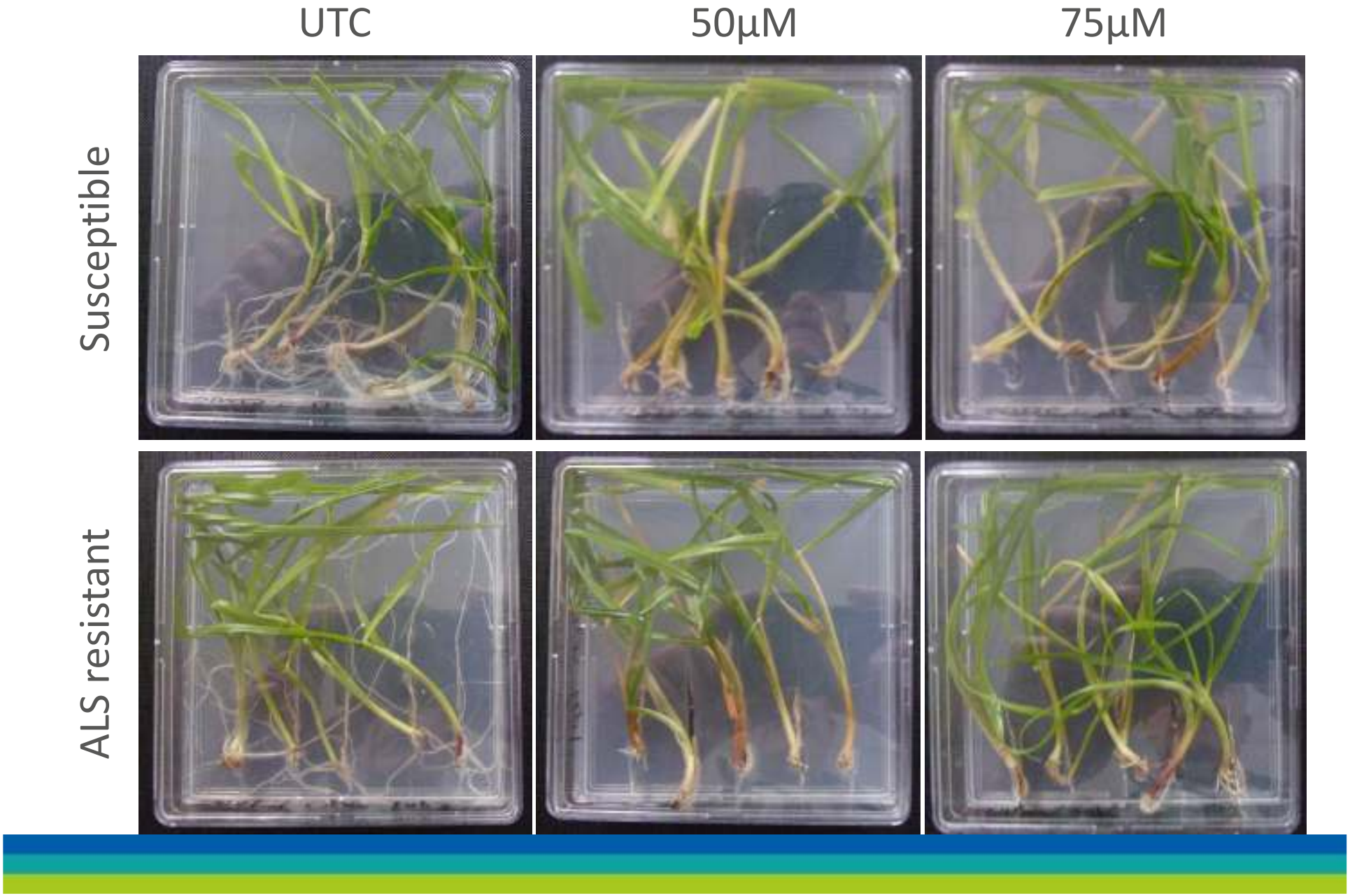
Adapting the method with glyphosate

- 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

UTC 35 mM 50 mM 75 mM

Italian rye-grass results 2018



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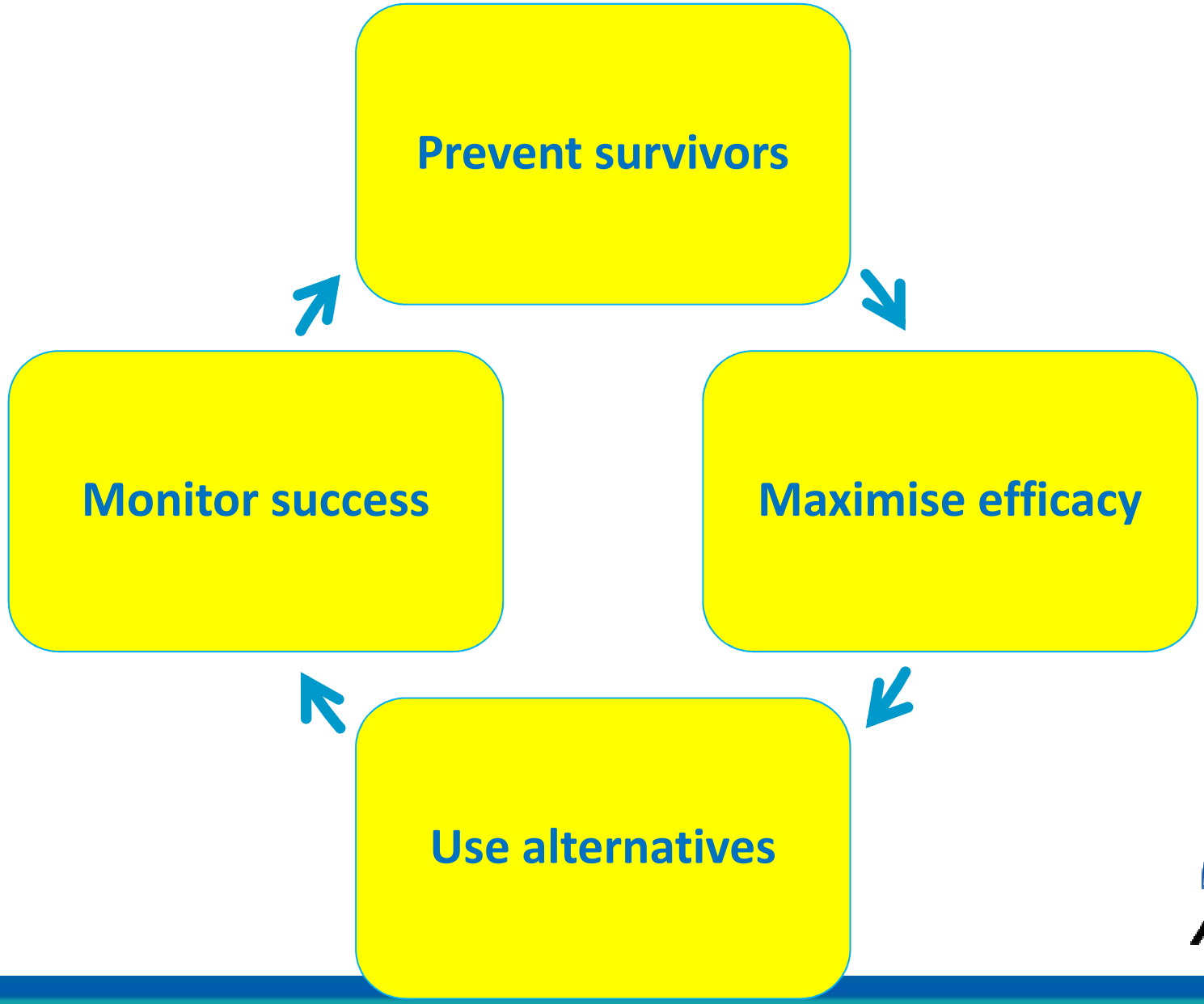

Key messages: Overall project

- 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**

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Other species of concern for glyphosate resistance????