28 May 2020

SB19-9143 – The potential for shallow cultivations to replace glyphosate ahead of spring cropping

Centre: Cambridge **Variety:** RGT Planet

Objectives

- Explore the potential for shallow cultivations may have in reducing the reliance on glyphosate for the establishment of spring crops within the confines of conservation agriculture (CA).
- Understand if repeated shallow cultivations are capable of encouraging enough black-grass emergence to have a tangible effect in future seasons

The most successful technique for improving the control of black-grass is to alter the drilling date of the crop to avoid the key germination periods of the weeds. For black-grass management in the UK this is achieved by drilling later in autumn, typically after the second week in October, or in the spring. Whilst effective, this technique relies upon successfully controlling any weed, or crop volunteers, that emerge prior to drilling. Currently, this is achieved solely with the application of glyphosate. The discussion on glyphosate is extremely divisive, however what is clear is that modern agriculture is very reliant on this single chemical – not only for black-grass management directly, but also for the protection of soil health with the wider uptake of the principles of conservation agriculture (CA), in particular no-till. At some point, this reliance may be tested by regulation or resistance, so finding ways in which its use can be reduced should be considered a priority.

The main viable alternative to glyphosate is cultivation, most often the use of the plough for full inversion of the soil profile, and this has its own detractors in respect to degrading soil health. A compromise may be the use of cultivations of sufficient depth to cause fatality to weeds that have emerged, whilst limiting further weed emergence. For black-grass, this optimal depth is between 30-50mm, as this species finds it difficult to emerge from a depth greater than this.

Summary

- The use of pre-drilling glyphosate enabled the establishment of a crop with almost no black-grass pressure.
- Increasing the number of cultivations correlated with better control, however in even the best case scenario the population of black-grass was at 143 heads/m2.
- The success, or otherwise, of the cultivation at destroying the black-grass was strongly influenced by soil conditions, with high soil moisture, but low chance of future rainfall seen as ideal.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement nº 727321.

Treatments

Trt	Timing of Operation			Notes
	Autumn	Late February	Prior to Drilling	
1	Ploughed		Glyphosate	Best practice
2			Glyphosate	Single glyphosate
3		Cultivation	Glyphosate	Cultivation timing prior to glyphosate
4	Cultivation		Glyphosate	
5			Cultivation	Single cultivation
6		Cultivation	Cultivation	Double cultivation
7	Cultivation		Cultivation	Split cultivation
8		Glyphosate	Glyphosate	Double glyphosate
9	Cultivation	Cultivation	Glyphosate	Final "kill"
10	Cultivation	Cultivation	Cultivation	

Table 1. List of treatments. Glyphosate was applied at a rate of 1440g a.i./ha by commercial sprayer. The cultivation was achieved with a set of discs and packer, targeting a depth of 40-50mm.

Operation	Date	Relative to drilling date (days after)
Destruction A	09/11/2018	-126
Destruction B	12/02/2019	-31
Destruction C	15/03/2019	-7
Drilling	22/03/2019	0
Harvest	19/08/2019	150

Table 2. Dates of key events from the trial

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Results

Trt	Black-grass seedlings (per m^2)		Black-grass Heads (per m^2)	
1	0.27	c	0.00	d
2	0.53	c	2.40	d
3	5.87	c	4.80	d
4	0.53	c	1.33	d
5	57.60	a	512.67	a
6	32.80	b	309.33	b
7	54.67	a	175.60	c
8	1.33	c	5.60	d
9	3.47	c	2.40	d
10	42.13	b	143.07	c
LSD	11.41		89.86	

Table 3. A summary of treatment averages for black-grass seedlings and black-grass heads. Where letters differ, the treatments were significantly different ($p < 0.05$)

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Trt	Crop Populations (per m^2)		Crop Ears (per m^2)		Yield (t/ha)	
1	240.80	a	504.00	a	5.90	a
2	123.20	e	215.33	e	2.84	f
3	138.00	de	336.67	de	4.28	cde
4	148.00	de	300.67	de	3.76	e
5	144.40	de	209.33	de	2.66	f
6	165.60	bcd	276.67	bcd	4.12	de
7	171.60	bcd	326.67	bcd	4.11	de
8	153.20	cde	382.00	cde	4.64	bcd
9	183.60	bc	425.33	bc	5.00	bc
10	190.00	b	410.00	b	5.19	ab
LSD	33.63		55.38		0.79	

Table 4. A summary of treatment average for crop density and crop yield. Where letters differ, the treatments were significantly different ($p< 0.05$)

Discussion

This trial studied whether repeated shallow cultivations could be effective enough at destroying black-grass prior to establishing a crop of spring barley, and how this may reduce the reliance upon glyphosate at producing sterile seedbeds.

The performance of glyphosate against black-grass

Glyphosate was successful in controlling pre-drilling black-grass flushes, so that any black-grass observed in these plots had emerged after crop establishment. In this year's trial there was no additional benefit to using two applications of glyphosate for black-grass control, provided that the rate used is at least 1440 g a.i./ha (4 l/ha) and there is no soil movement between application and drilling.

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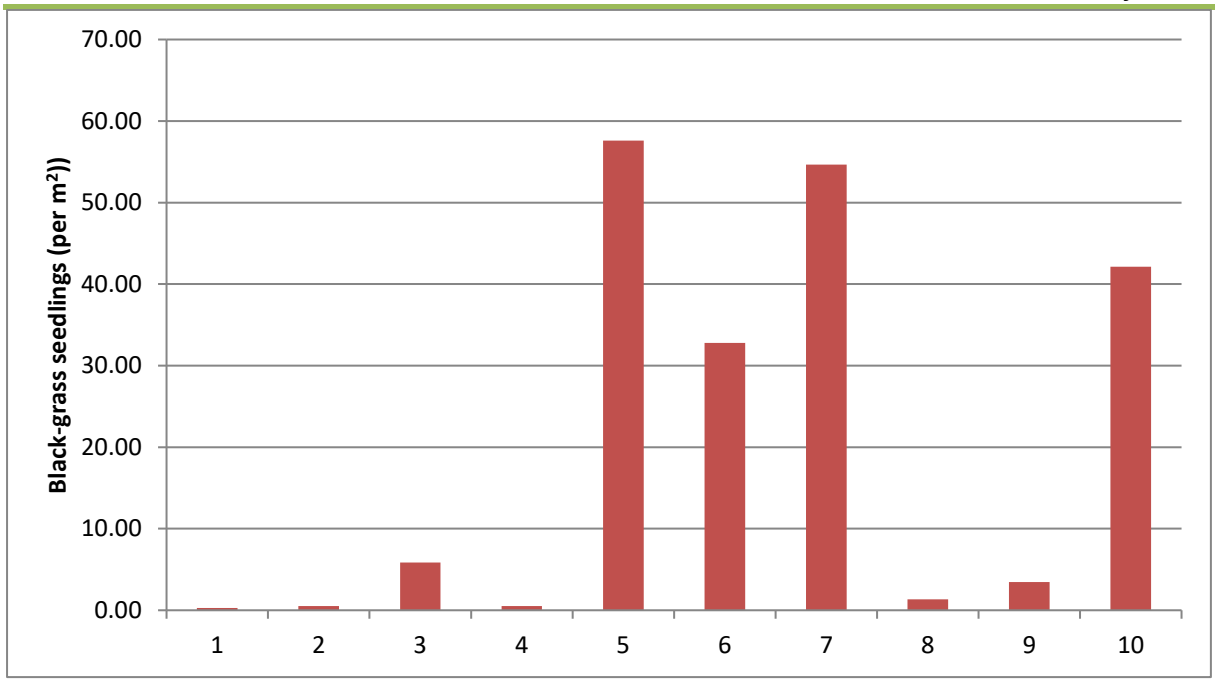

Figure 1. The number of black-grass seedlings observed (per m^2)

The performance of shallow cultivations against black-grass

Shallow cultivations were unable to successfully control either black-grass or crop volunteers that had emerged prior to drilling, regardless of intensity or regularity of passes. Although not assessed after each cultivation due to practical difficulties, it appears that when cultivations were made in either the autumn, or early spring, that effectiveness was improved. It is suggested that at these timings the conditions for mortality were closer to optimal. There was sufficient soil moisture for the discs to dislodge the plants, and sufficient warmth to dry out these plants before they could re-root. In later spring, the soil conditions were too dry, and the discs rode over the mat of material, not effectively removing any plants from the soil.

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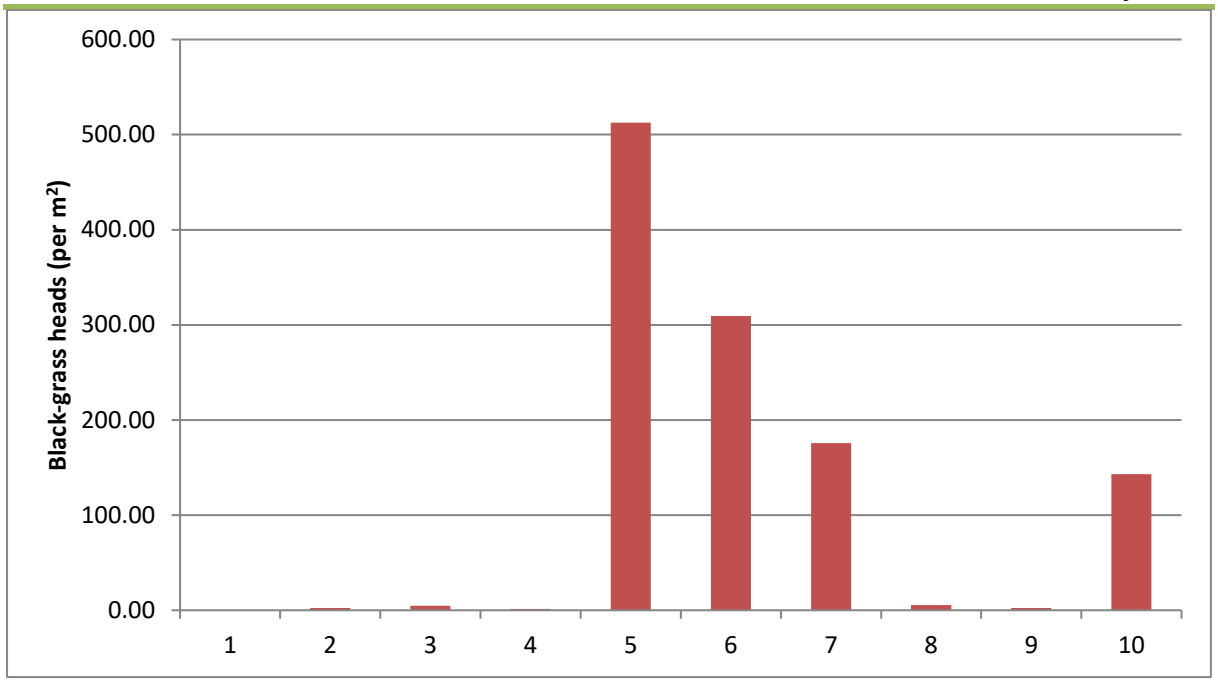

Figure 2. The number of black-grass heads observed (per m^2)

Crop performance

The trial has thrown up some interesting observations regarding the determinant factors for spring barley crops. The importance of initial crop establishment is far greater than the competition with black-grass within the crop canopy. Even when there was little control of pre-drilling black-grass, there was no detrimental effect on crop yield. Treatment 5 could be seen as an exception here, however, it yielded similarly to treatment 2, which had total control of the weed pre-drilling. The common factor was very poor, patchy establishment. Observations post-drilling, showed that the drill had forced trash material into the slot, which inhibited seed to soil contact, and germination. It is apparent that in this year, two methods of destruction, ideally a cultivation, which can be shallow, followed by a single dose of glyphosate, is required for successful weed management.

The observation that drilling into green material, with no yield penalty, is interesting, although leaving such high levels of black-grass seed to populate the seedbank is not a sustainable weed management message. However, it does open the opportunity to test other over-winter cover crop mixes, whether temporary or permanent, which may be able to compete with the weed, whilst adding other benefits to soil health.

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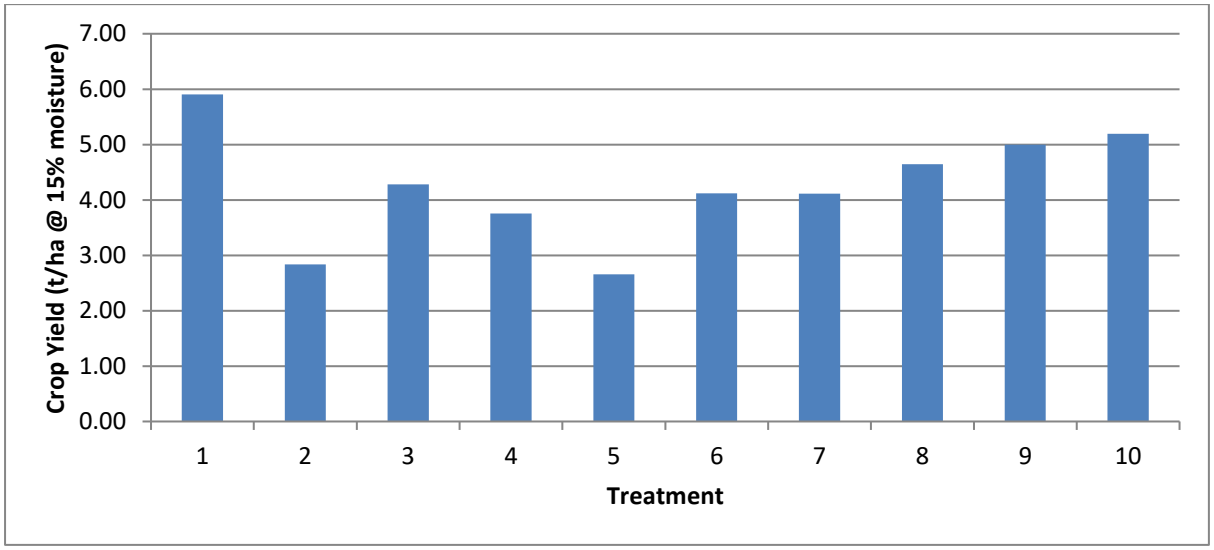

Figure 3. Crop yield (t/ha @ 15% moisture)

The future of the soil seedbank

The emergence of weed seedlings in the following crop will be monitored to observe any differences associated with these treatments. It is hypothesised that where shallow cultivations were used additional black-grass was encouraged to germinate, denuding the seedbank, and resulting in lower populations in the following crop. Additionally, understanding the effect of spring germinating black-grass on the soil seedbank is a vital knowledge gap, which will help to aid prediction on seed return in the future.

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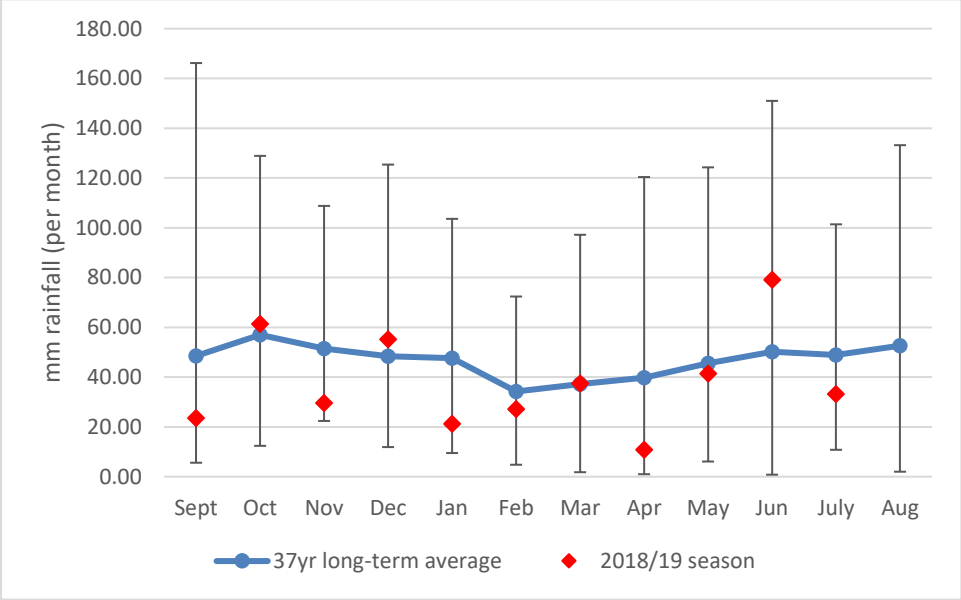
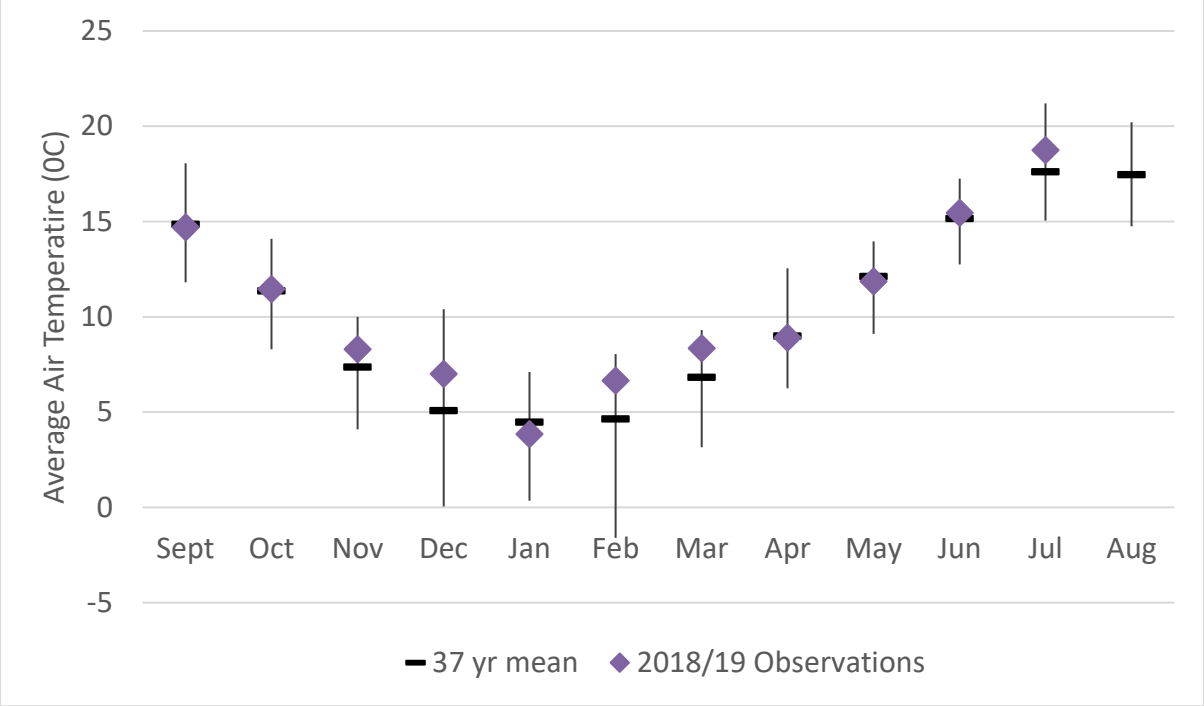
Weather data.

Figure 1. Summary monthly weather observations compared to long-term averages (from Cambridge NIAB weather station). Vertical bars represent the minimum and maximum values observed over the 37 year period.

a. Rainfall (Monthly total mm)



b. Average daily air temperature (ºC)



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