NIAB TAG NETWORK

IWMPRAISE
28 May 2020

SB19-9155 – The effect of drilling date of spring cereals on black-grass control.

Centre: Cambridge **Trial Code:** SB19-9155

Variety: RGT Planet & WPB Elyann

Objectives

- Evaluate the role that drilling date has in spring cereals for black-grass management.
- Demonstrate and quantify the trade-offs between crop productivity, black-grass seed return and herbicide efficiency
- Evaluate the requirement for pre-em herbicides in spring barley crops

Drilling date for autumn sown crops has been shown to be a major factor in determining the abundance of black-grass in crops. Specifically later sown crops in the autumn have the potential to significantly reduce black-grass plants and black-grass seed return. In addition shifting cropping to spring as opposed to autumn sown crops has been sown to have a significant impact of black-grass levels. There has been relatively little focus on the role of sowing date for the spring crops themselves.

For autumn sown crops, one major element of the success of later drilling has proven to be the increase in herbicide efficacy associated with later drilling. In the autumn conditions tend to change from warm and dry to cold and wet increasing the efficacy of soil applied herbicides. At the same time in the autumn later drilling is associated with lower abundance of black-grass seedlings in the established crop.

For spring sown crops the dynamics are quite different although one would expect that later drilling is still associated with lower abundance of black-grass seedlings in the established crop the effect is smaller and seems to be as much driven by environmental conditions as calendar date. The trend in herbicide efficacy (with respect to soil applied herbicides) will tend to be reversed with conditions transforming from cold and wet to warmer and drier and thus later drilling will tend to result in lower herbicide efficacy. In addition the role of the crop is effectively supressing weed growth and potential seed return has been observed as a key element of successful weed management in a wide range of contexts and the optimum drilling window for spring cereals is smaller and more variable in the spring than in the autumn.

Summary

- The time of drilling in spring barley can have an enormous effect on the levels of black-grass in the crop, with earlier sown crops more infested than later sown crops.
- However, there are yield penalties associated with later drilling. These are relatively small between February and March but very significant for later, April drilled, crop.
- Spring oats are more competitive than spring barley against black-grass, but are more susceptible to yield penalties associated with drilling date and/or herbicide application.
- Optimum herbicide inputs to spring sown cereals are relatively low at all drilling dates; for spring barley a single application of Liberator (0.3 l/ha) was effective, for spring

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oats it's questionable if any grass weed herbicide can be justified on the basis of these data.

- The 2018/19 field season was relatively unusual in that the conditions for drilling spring crops were good from early in the season as a result of low January rainfall. Conditions for crop growth were also good for early drilled spring crops with very high air temperature in January and February. These unusual conditions need to be considered when reviewing these results.
- Even in this season when January drilled spring crops established very well and grew unusually vigorously in term of grass weed management optimum drilling date balancing potential crop productivity with grass weed abundance and potential seed return was later around the March drilling date. By April although black-grass seed return was at its lowest the potential crop yield had dropped very significantly.

Treatments

Table 1. List of treatments.

Treatment	Drilling Date	Crop	Herbicide
1	February	Spring Oats	Untreated
2			Hurricane (0.25 l/ha)
3		Spring Barley	Untreated
4			Hurricane (0.25 l/ha)
5			Liberator (0.3 l/ha)
6			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)
7			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)
8	March	Spring Oats	Untreated
9			Hurricane (0.25 l/ha)
10		Spring Barley	Untreated
11			Hurricane (0.25 l/ha)
12			Liberator (0.3 l/ha)
13			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)
14			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)
15	April	Spring Oats	Untreated
16			Hurricane (0.25 l/ha)
17		Spring Barley	Untreated
18			Hurricane (0.25 l/ha)
19			Liberator (0.3 l/ha)
20			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)
21			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)

Results

Table 2. Key dates

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Drilling Date	Operation	Date	Relative to drilling date (days after)
February	Drilling	22/02/2019	0
	Pre-em	22/02/2019	0
	Post-em	26/03/2019	32
March	Drilling	19/03/2019	0
	Pre-em	19/03/2019	0
	Post-em	13/04/2019	25
April	Drilling	12/04/2019	0
	Pre-em	13/04/2019	1
	Post-em	24/04/2019	9
All	Harvest	19/08/2019	178/153/129

Table 3. Weed Population in untreated plots (per m^2)

Drilling Date	Crop species	Black-grass density		Estimated black-grass heads per plant
		Seedlings	Heads	
February	Spring Oats	97.6	8.8	0.10
	Spring Barley	79.8	16.8	0.21
March	Spring Oats	30.4	6.4	0.21
	Spring Barley	46.7	12.0	0.26
April	Spring Oats	10.4	1.3	0.13
	Spring Barley	6.4	0.3	0.05

Table 4. Weed seedling density (per m2)

Trt	Drilling Date	Crop	Herbicide	Treatment Mean	Drilling date Average	Crop Average	Herbicide Average
1	February	Spring Oats	Untreated	97.60	82.3	37.7	46.1
2			Hurricane (0.25 l/ha)	54.13			29.2
3		Spring Barley	Untreated	79.84		40.1	44.30
4			Hurricane (0.25 l/ha)	79.20			36.36
5			Liberator (0.3 l/ha)	72.53			36.32
6			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	86.00			38.71
7			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	106.93			44.67

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8	March	Spring Oats	Untreated	30.40	31.1		
9			Hurricane (0.25 l/ha)	32.27			
10		Spring Barley	Untreated	46.67			
11			Hurricane (0.25 l/ha)	25.60			
12			Liberator (0.3 l/ha)	33.87			
13			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	24.53			
14			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	24.27			
15	April	Spring Oats	Untreated	10.40	4.75		
16			Hurricane (0.25 l/ha)	1.20			
17		Spring Barley	Untreated	6.40			
18			Hurricane (0.25 l/ha)	4.27			
19			Liberator (0.3 l/ha)	2.57			
20			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	5.60			
21			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	2.80			

Drilling date was a significant factor (p<0.001)

Table 5. Black-grass head population (per m2)

Trt	Drilling Date	Crop	Herbicide	Treatment Mean	Drilling date Average	Crop Average	Herbicide Average
1	February	Spring Oats	Untreated	8.8	12.1	4.9	5.5
2			Hurricane (0.25 l/ha)	6.7			4.3
3		Spring Barley	Untreated	16.8		7.9	9.7
4			Hurricane (0.25 l/ha)	16.8			8.6

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5			Liberator (0.3 l/ha)	6.9			6.4
6			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	6.8			4.8
7			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	21.6			10.1
8	March	Spring Oats	Untreated	6.4	8.9		
9			Hurricane (0.25 l/ha)	6.1			
10		Spring Barley	Untreated	12.0			
11			Hurricane (0.25 l/ha)	8.8			
12			Liberator (0.3 l/ha)	12.3			
13			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	7.7			
14			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	8.8			
15	April	Spring Oats	Untreated	1.3	0.3		
16			Hurricane (0.25 l/ha)	0.0			
17		Spring Barley	Untreated	0.3			
18			Hurricane (0.25 l/ha)	0.3			
19			Liberator (0.3 l/ha)	0.0			
20			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	0.0			
21			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	0.0			

Drilling date and crop were both significant factors ($p<0.001$ and $p<0.05$ respectively)

Table 6. Crop yields (t/ha @ 15% moisture)

Trt	**Drilling Date**	**Crop**	**Herbicide**	**Treatment Mean**	**Drilling date Average**	**Crop Average**	**Herbicide Average**
1	February	Spring Oats	Untreated	6.59	6.91	4.87	4.97
2			Hurricane (0.25 l/ha)	6.46			4.77
3			Untreated	7.10		5.86	5.86

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4		Spring Barley	Hurricane (0.25 l/ha)	7.49			5.90
5			Liberator (0.3 l/ha)	6.96			5.76
6			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	7.30			6.00
7			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	6.50			5.75
8	March	Spring Oats	Untreated	5.94	6.23		
9			Hurricane (0.25 l/ha)	5.30			
10		Spring Barley	Untreated	6.44			
11			Hurricane (0.25 l/ha)	6.69			
12			Liberator (0.3 l/ha)	6.37			
13			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	6.24			
14			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	6.58			
15	April	Spring Oats	Untreated	2.40	3.59		
16			Hurricane (0.25 l/ha)	2.55			
17		Spring Barley	Untreated	4.04			
18			Hurricane (0.25 l/ha)	3.52			
19			Liberator (0.3 l/ha)	3.94			
20			Liberator (0.3 l/ha) + Crystal (2.0 l/ha)	4.48			
21			Liberator (0.3 l/ha) f/b Crystal (2.0 l/ha)	4.17			
			LSD				
			S.E.D				
			%CV				

Drilling date and crop were both significant factors (p<0.001 and p<0.001 respectively)

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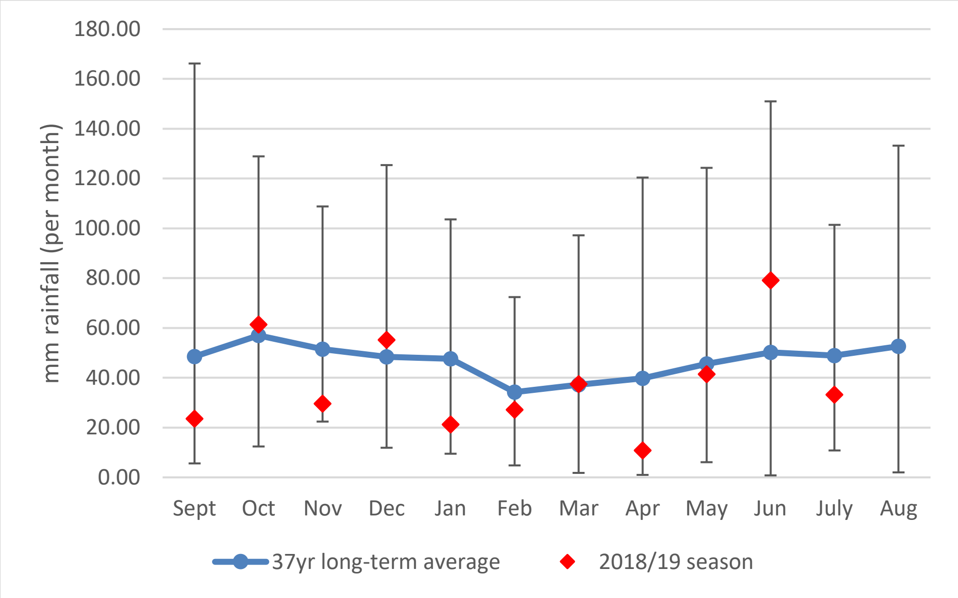
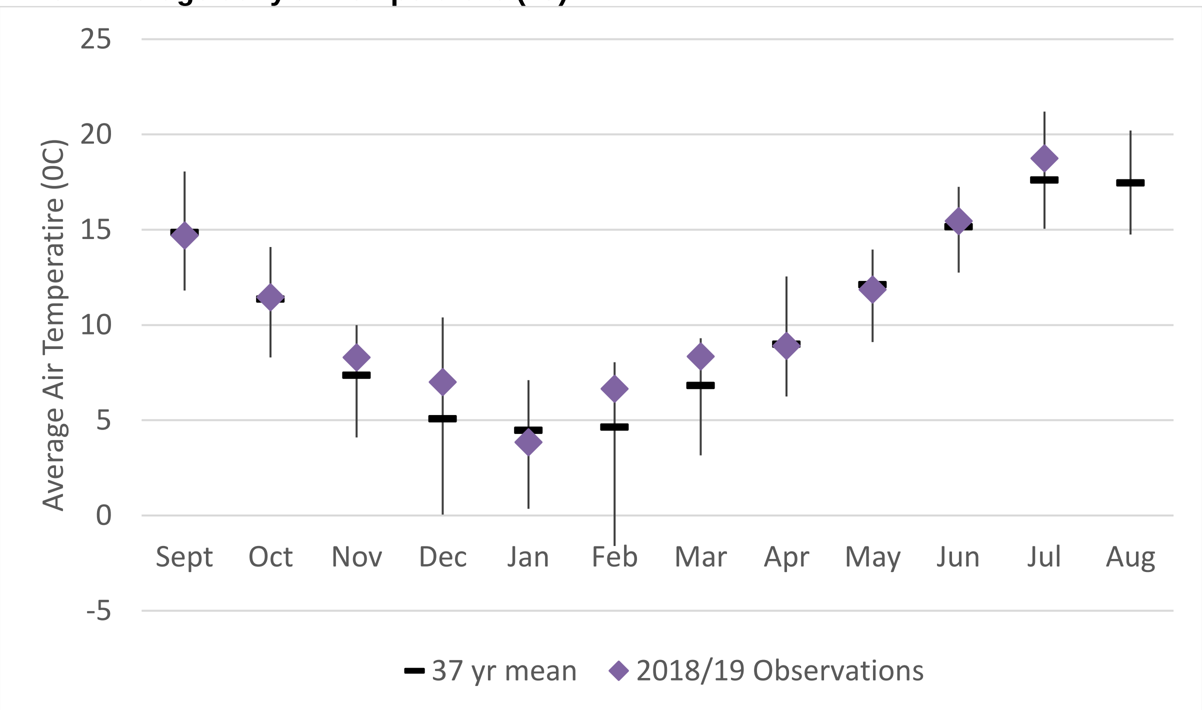
Weather data.

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 (°C)



Analysis

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It's important to put these observations into a wider context in terms of weed management; the effectiveness of spring drilling for reducing black-grass is significant and robust. Using the observations here a nearby winter barley trial in the same block 293.0 heads/m2 were recorded in untreated plots, where as in this trials the overall whole trial average was just 6.4 heads per m^2. This amounts to a potential 98% reduction is seed return before any effect of reduced seed number per head is taken into account.
In that context comparing the potential seed return from seed return in an autumn sown crop the highest black-grass head density (recorded in a February drilled crop with the highest herbicide input level) the reduction was ~93% whereas the lowest black-grass head density (recorded in April drilled treated plots) equates to a 100% reduction.

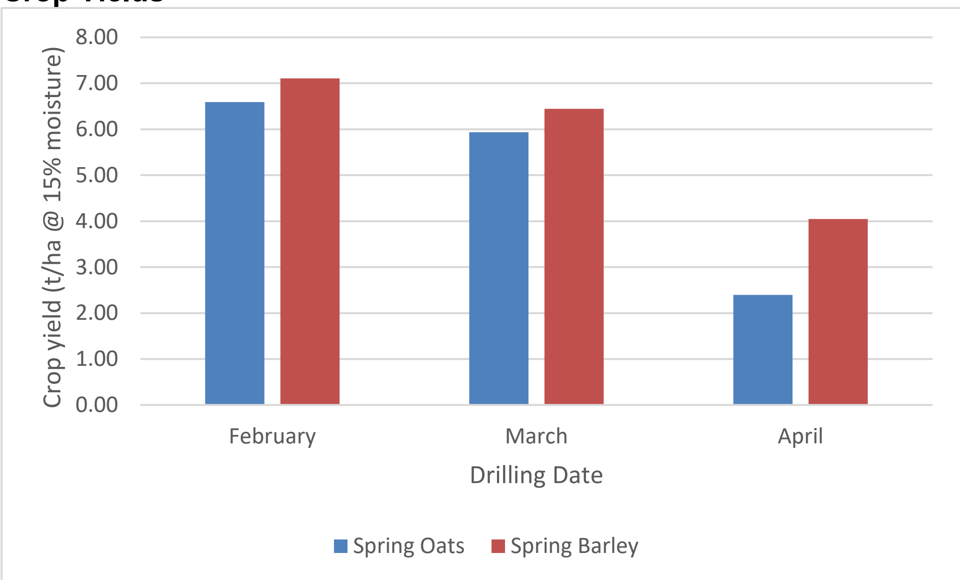
The power of spring cropping as a management tool is apparent however there does seem to be an opportunity to optimise the effectiveness of this strategy, whether by drilling date, crop species or the addition of herbicide. These data highlight the importance of maintaining high levels of crop production which is paramount to the overall success of any farming system.

The results from this trial reflect the particular conditions in the 2018/19 field season *see figure 1) and more work over a range of contrasting season is needed to produce more robust conclusions.

Drilling date

Figure 2. Overall average response to drilling date. The values are average values across the whole trial.

a. Crop Yields



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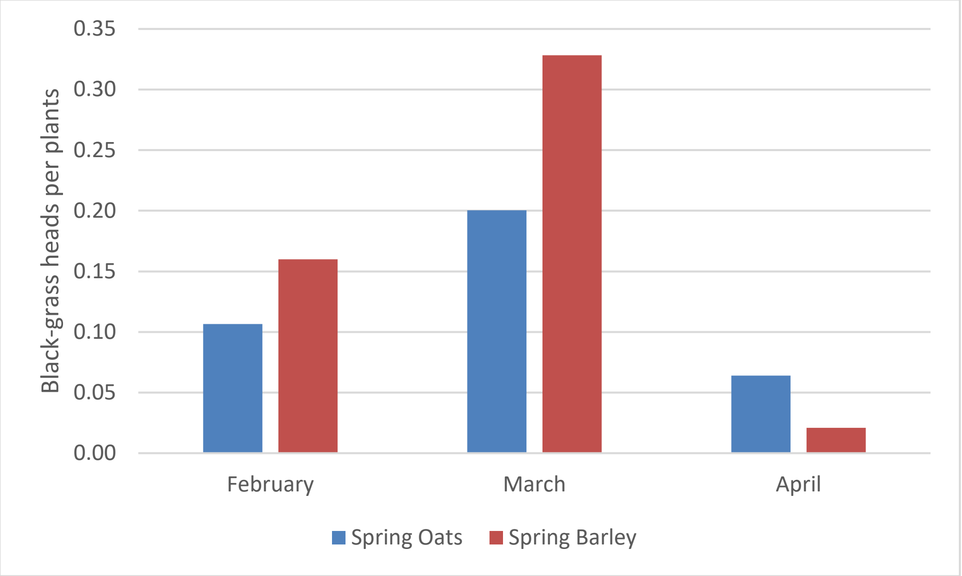
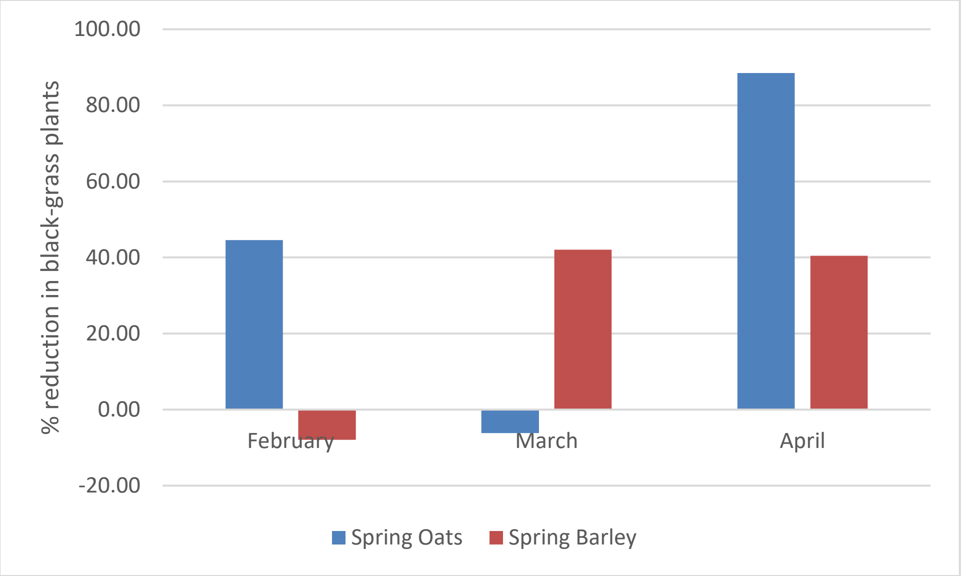
b. Black-grass plant size at maturity (heads per plant)



c. Herbicide efficacy (% control of plants)



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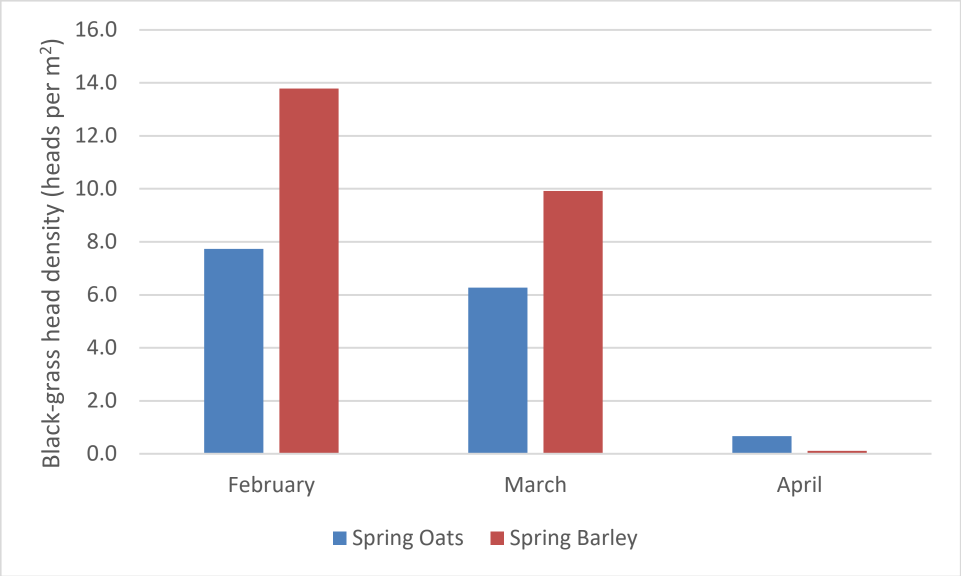
d. Black-grass heads per m^2



As in the autumn, drilling date is a major driver to reducing black-grass populations in spring-drilled crops. In this trial, the drilling date was the most significant factor, with a clear benefit to reducing black-grass populations by drilling later ($p<0.001$), reducing the average head count from 12.1 heads/m2 to 0.3 heads/m2. However, it is vital to view this decline within the context of crop performance. Crop yields were excellent across the trial (table 6.), which is in response to superb seedbed conditions, and sufficient rain shortly after drilling. There was a significant, but small, yield penalty by moving from February to March drilling date, and a far more drastic one moving to April, most obvious in the spring oats, which dealt much poorer with the dry conditions.

Herbicide effectiveness

Figure 3. Black-grass heads per m^2 at maturity and %reduction in black-grass heads relative to untreated plots.

a. Black-grass heads (per m2) treatment averages.

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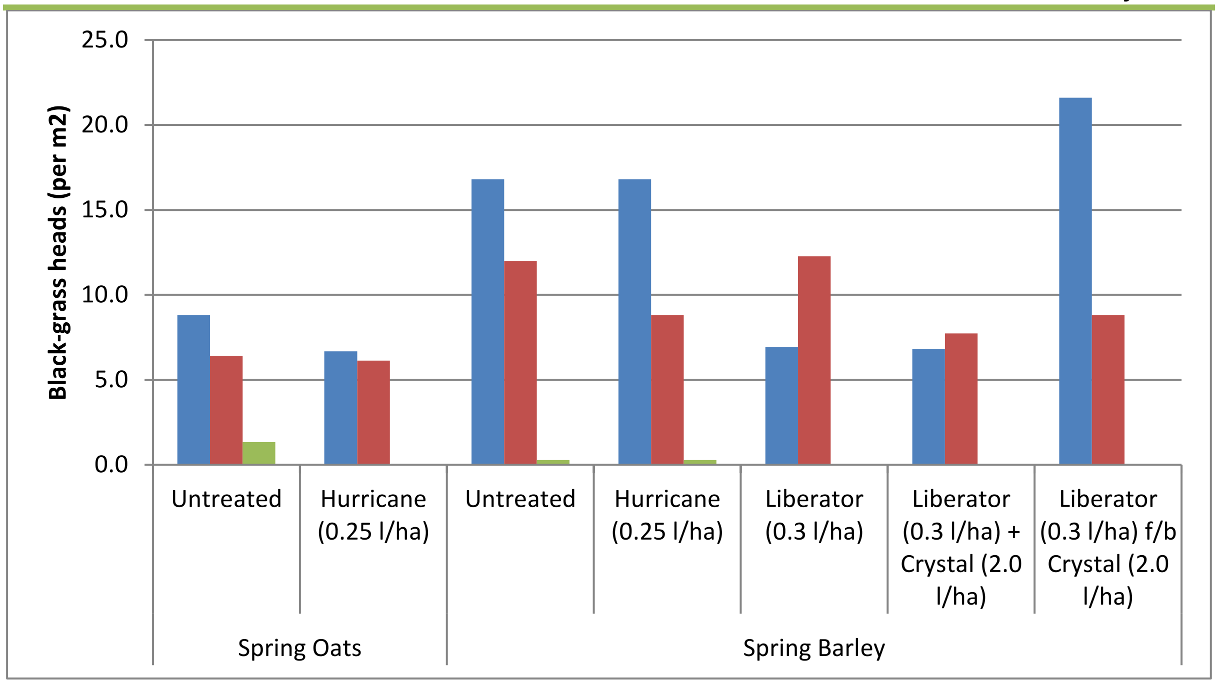
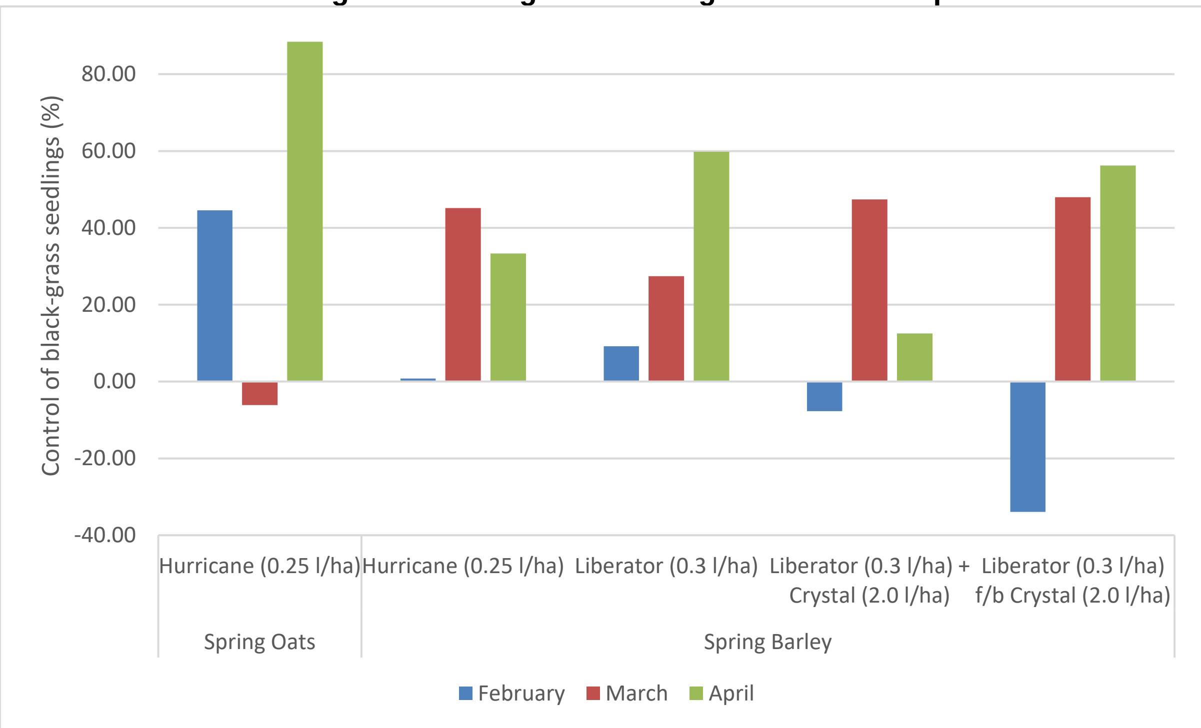


b. % reduction of black-grass seedlings with a range of herbicide options.



Herbicide efficacy in terms of %reduction in black-grass plants (figure 2c) and reduction in heads (figure 3b) was dramatically affected by drilling date. The trends in herbicide efficacy are different in the two different crop species, in both species there are signs of phytotoxicity

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of the herbicide resulting in increases in black-grass heads numbers (by reducing crop supressiveness) but these effects were observed at different drilling dates for the two crop species. For Spring Oats the use of a herbicide (the only graminicide option I that crop) at the march drilling date resulted in a reduction in yield (Table 6) as well as a very small increase in black-grass heads at maturity (figure 3b). For Barley there are clear signs of increasing herbicide input resulting in increased black-grass seed return at the first, February, drilling date (figure 3b) and indications of the potential for crop effect to out weight weed control at the second, march drilling date. There was no indication that herbicide use could potentially reduce crop yield (table 6).
It’s interesting to note the contrasting response of the two crops to herbicide use in relation to drilling date. For spring barley it’s also interesting to note that the trend in herbicide efficacy (increasing with later drilling date) was not as expected (where it had be assumed at the inception of the trials that potential herbicide efficacy would drop for later drilling date, although this may be a product of the unusual season rather than a consistent pattern. In addition crop effects were not associated with overall high levels of herbicide efficacy as one might expect. Instead at the drilling date where herbicides were least effective overall (February) there was the greatest indication of crop effect (inferred by the increased level of black-grass at maturity for higher herbicide input levels) whereas at the drilling date where the herbicide performance was greatest (March) there was no sign of crop effect.

By growing spring crops to help in the management of grass weeds, the bulk of the herbicide control is being done by the pre-drilling glyphosate, which reduces the reliance on in-crop herbicides. Perhaps the best advice based on this data is that pre-emergence grass weed herbicides may not be necessary if drilling any later than February and certainly that a relatively low grass weed herbicide input level is most appropriate for spring crops. One consideration for application of herbicides in spring crops is the need to control spring-germinating broadleaf species which can be very competitive in these crops, so selecting products that have some complementary activity is helpful in justifying any herbicide applications.

Crop Species

The two main options for spring crops, if black-grass is a concern, are spring oats and spring barley. Spring oats were the most effective option of the two, with the innate competitiveness reducing black-grass heads by over 60% when compared to spring barley (figure 2.). However, spring barley was the consistently higher yielding species, particularly in the latest slot, where the advantage was over 1.5 t/ha. The danger of relatively small grass weed herbicide inputs to Spring Oats was confirmed in this trial.

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