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STØTTET AF

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IX Longevity of seeds of blackgrass following different stubble cultivation treatments

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Blackgrass (*Alopecurus myosuroides)* is primarily a winter annual grass weed typically found in crop rotations with a high proportion of winter cereals in areas of the country with clayey soil types. Blackgrass is considered an increasing problem in grass seed production. Herbicide resistance is a significant problem, and a robust and resilient control strategy has to rely on a combination of chemical and non-chemical control methods. Efficient handling of blackgrass seeds can contribute to this goal. The purpose of the present study was to test the influence of different stubble treatments on the longevity of newly shed seeds of blackgrass. Two types of experiments were conducted, a field experiment using normal tillage implements and a small plot field experiment simulating the influence of various tillage treatments on placement of seeds in the soil profile. In the experiment simulating tillage treatments, samples of seeds were placed at distinct soil depths and the longevity of the seed samples following these treatments was assessed. In the field experiment using relevant tillage implements the working depth of the implement was controlled but the influence on the placement of the seeds in the soil profile following the treatment was not assessed. However, assessing blackgrass seedling emergence and longevity in the two types of studies gives an indication of how seed incorporation in the soil profile is influenced by the tillage implements. In both experiments newly harvested seeds of blackgrass were used. Both experiments were replicated two times in 2017 and 2018.

The field experiments were carried out in a stubble field after harvest of winter barley and removal of the straw. Treatments and assessments in the two years are shown in Table 1.

Table 1. Treatments and assessments in the field experiments.

Activity	2017	2018
Harvest of winter barley and removal of straw	28 July	9 July
Distribution of blackgrass seeds on stubble	28 July	13 July
1st stubble treatment	28 July	13 July
2nd stubble treatment	21 August	14 August
1st count of germinated blackgrass seedlings	20 September	13 September
Glyphosate application to control blackgrass	22 September	13 September
Seedbed preparation	17 October	1 October
2nd count of germinated blackgrass	17 January 2018	21 November

Blackgrass was sown in the stubble at a rate corresponding to approximately 200 seeds per m^2. The different stubble treatments included in the field trial are shown in Table 2. The implements used for stubble treatment and seedbed harrowing are shown in Photos 1-3. The seedbed preparation can be carried out a few days after the glyphosate application in September. However, due to the wet autumn in 2017 and very dry conditions in 2018 this treatment was delayed in both years. The seedbed treatment in October included driving with either a seedbed harrow or a direct drilling machine but without sowing of a crop. Seedlings of blackgrass were counted two times in the experiments (Tables 3 & 4). The first assessment in mid-September showed the influence of the stubble cultivation treatments on the establishment of blackgrass seedlings, and the late assessment in January (2018) and November (2018), respectively, was taken as an indicator of the effect of the stubble cultivation treatments on the longevity


Seedbed harrow.


Stubble harrow.


Flex-tine weeder.

of blackgrass seeds. The main conclusion from the results of the first assessment date in 2017 (Table 3) is that there was a reduced number of plants in treatments with stubble harrowing at 5 and 10 cm depth compared to treatments with no cultivation at all and the shallow treatments with the flex-tine weeder. This is probably caused by a deeper incorporation of a proportion of the seeds by the stubble harrowing. The results of the second assessment in January show very small numbers of blackgrass generally and only small and non-significant differences between most treatments. The density of seedlings at this assessment date is taken as an indication of the longevity of blackgrass seeds following the different stubble treatments. The density was, however, generally very low and therefore no significant differences between stubble treatments were found. In the 2018 trial, a larger number of blackgrass seedlings were counted at the first assessment in mid-September following all treatments. However, there was again a larger number of plants in treatments without any stubble tillage or treatments with superficial soil tillage with the flex-tine weeder and a significantly lower density of blackgrass following all treatments with the stubble harrow, indicating a deeper incorporation of at least a fraction of the seeds. The results of the second assessment in November 2018 show the lowest number of blackgrass following the treatment without any stubble tillage and the treatments using the flex-tine weeder at 1-2 cm depth. Larger numbers were counted in treatments with stubble harrowing and with deep flex-tine weeding.

It is supposed that some dormant seeds are remaining in the soil, and this would especially be expected following the two deeper stubble cultivations to 5 and 10 cm depth for which the first assessment indicates that a fraction of the blackgrass seeds have been incorporated to a depth from where the seeds cannot establish plants.

Table 2. Stubble treatment – timing, implement and tillage depth.

Treatment number	First stubble treatment immediately after winter barley harvest	Second stubble treatment, approximately 3 weeks after harvest	Seedbed preparation, October
1.	None	None	2 x seedbed harrowing 2-4 cm
2.	2 x flex-tine weeder 1-2 cm		2 x seedbed harrowing 2-4 cm
3.	2 x flex-tine weeder 2-4 cm		2 x seedbed harrowing 2-4 cm
4.	2 x stubble harrowing 5 cm		2 x seedbed harrowing 2-4 cm
5.	2 x stubble harrowing 10 cm		2 x seedbed harrowing 2-4 cm
6.		2 x flex-tine weeder 1-2 cm	2 x seedbed harrowing 2-4 cm
7.		2 x flex-tine weeder 2-4 cm	2 x seedbed harrowing 2-4 cm
8.		2 x stubble harrowing 5 cm	2 x seedbed harrowing 2-4 cm
9.		2 x stubble harrowing 10 cm	2 x seedbed harrowing 2-4 cm
10.	2 x flex-tine weeder 1-2 cm	2 x flex-tine weeder 1-2 cm	2 x seedbed harrowing 2-4 cm
11.	None	None	No-till drilling
12.	2 x flex-tine weeder 1-2 cm		No-till drilling

Table 3. Density of blackgrass seedlings following different stubble cultivations in 2017.

Immediately after harvest (28 July)	Approximately 3 weeks after harvest (21 August)	Seedbed mid-October (17 October)	No. of blackgrass seedlings per m² (20 September)	No. of blackgrass seedlings per m² (17 January)
None	None	Seedbed harrow 2-4 cm	9.0	1.0
Flex-tine weeder 1-2 cm		Seedbed harrow 2-4 cm	3.5	0.5
Flex-tine weeder 2-4 cm		Seedbed harrow 2-4 cm	6.5	1.0
Stubble harrow 5 cm		Seedbed harrow 2-4 cm	3.5	0.5
Stubble harrow 10 cm		Seedbed harrow 2-4 cm	2.0	2.0
	Flex-tine weeder 1-2 cm	Seedbed harrow 2-4 cm	9.0	1.5
	Flex-tine weeder 2-4 cm	Seedbed harrow 2-4 cm	9.0	4.0
	Stubble harrow 5 cm	Seedbed harrow 2-4 cm	4.0	0.5
	Stubble harrow 10 cm	Seedbed harrow 2-4 cm	5.0	2.5
Flex-tine weeder 1-2 cm	Flex-tine weeder 1-2 cm	Seedbed harrow 2-4 cm	16.0	3.0
None	None	No-till drilling	9.5	3.0
Flex-tine weeder 1-2 cm		No-till drilling	9.5	2.5
LSD (p=0.05)			6.9	3.3

Table 4. Density of blackgrass seedlings following different stubble cultivations in 2018.

Immediately after harvest (13 July)	Approximately 3 weeks after harvest (14 August)	Seedbed mid-October (1 October)	No. of blackgrass seedlings per m² (13 September)	No. of blackgrass seedlings per m² (21 November)
None	None	Seedbed harrow 2-4 cm	20	4.5
Flex-tine weeder 1-2 cm		Seedbed harrow 2-4 cm	19	6.5
Flex-tine weeder 2-4 cm		Seedbed harrow 2-4 cm	32	10.0
Stubble harrow 5 cm		Seedbed harrow 2-4 cm	7	7.0
Stubble harrow 10 cm		Seedbed harrow 2-4 cm	6	11.5
	Flex-tine weeder 1-2 cm	Seedbed harrow 2-4 cm	21	2.0
	Flex-tine weeder 2-4 cm	Seedbed harrow 2-4 cm	13	8.5
	Stubble harrow 5 cm	Seedbed harrow 2-4 cm	8	2.5
	Stubble harrow 10 cm	Seedbed harrow 2-4 cm	7	2.5
Flex-tine weeder 1-2 cm	Flex-tine weeder 1-2 cm	Seedbed harrow 2-4 cm	26	2.0
None	None	No-till drilling	25	4.0
Flex-tine weeder 1-2 cm		No-till drilling	17	3.0
LSD (p=0.05)			11	5.2

The small plot field experiment was carried out using seeds from the same seed lot. Samples of 400 seeds were counted and placed either at the soil surface or buried at different depths. This was done in the first week of August in the 2017 trial and in mid-July in the 2018 trial. Two treatments included placement of the seeds at the soil surface. In the first treatment seeds were left directly at the soil surface, whereas in the second treatment a shallow harrowing was carried out with the fingers to mimic shallow soil tillage. The treatments with placement of seeds at the soil surface were carried out in small pots, whereas the treatments including burial at different depths were carried out using samples with seeds mixed with soil and placed in fabric mesh bags. By the end of September all samples were collected from the field and a germination test was carried out in the laboratory. During the germination test soil samples were kept moist to ensure optimal conditions for germination. The number of germinated seedlings was counted when emergence ceased, and this figure is taken as an indication of the influence of the various field treatments on the longevity of blackgrass seeds. The results of the two years were very similar (Figures 1 & 2). The lowest viability was found in seeds left at the surface and there was no significant

influence of finger harrowing. Viability was generally much higher in incorporated seeds compared to seeds at the soil surface, and seeds incorporated to just 1 cm depth had a much higher viability than seeds placed at the soil surface. Obviously it seems that the "finger harrowing" had a limited influence on seed placement and hence longevity.

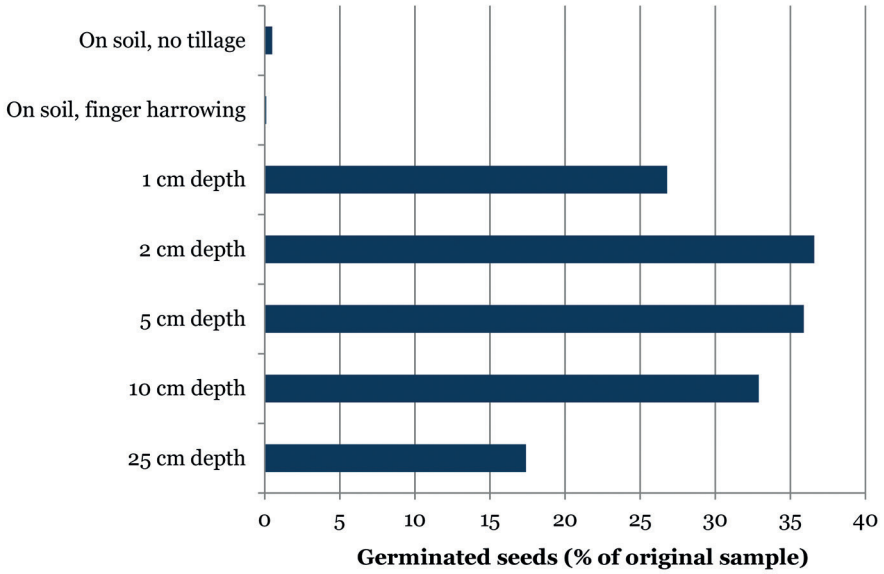

Figure 1. Germination of seeds of blackgrass from samples kept at different soil depths in the field from the beginning of August to the end of September 2017. The figure shows the number of plants in the germination test as a percentage of the original seed sample. LSD = 7.5.

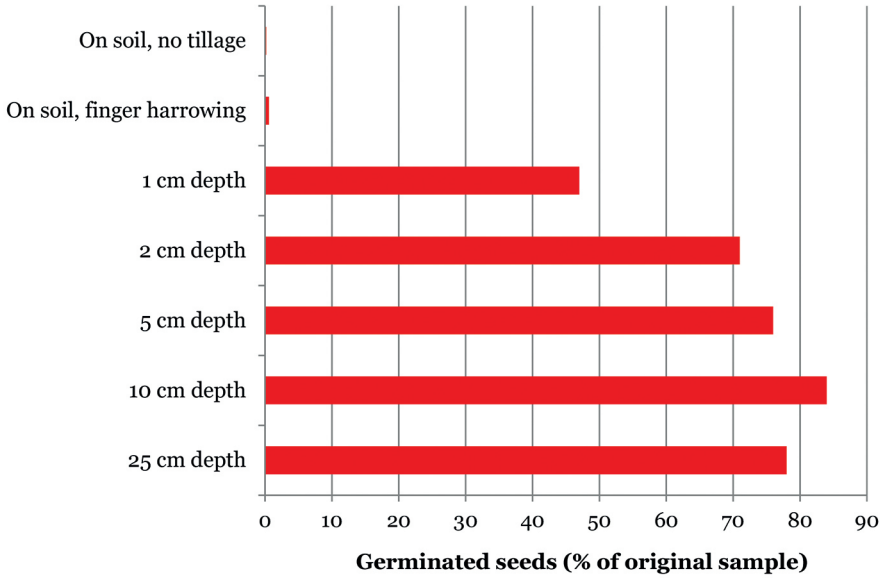

Figure 2. Germination of seeds of blackgrass from samples kept at different soil depths in the field from mid-July to the end of September 2018. The figure shows the number of plants in the germination test as a percentage of the original seed sample. LSD = 3.6.

Conclusion

The results of the two types of experiments conducted in 2017 and 2018 are parallel and support the general conclusion that a stubble treatment strategy can have a large influence on the persistence of newly shed seeds. The longevity of blackgrass seeds was very limited at the soil surface. When seeds were incorporated, a much higher percentage of the seeds survived. An important question is how superficial stubble treatments influence incorporation of seeds and hence longevity. The experiment with full-scale tillage implements as well as the experiment with simulated "finger harrowing" showed that there was no negative influence of a shallow tillage probably because neither the "finger harrowing" nor the flex-tine weeder incorporates the seeds. The full-scale field experiments indicate that stubble harrowing incorporates a fraction of the seeds deeper into the soil and hence incorporates this fraction of seeds into the more persistent seed bank.

The same conclusion was seen in 2015-2016 testing longevity of seeds of Italian ryegrass.