Use of competitive crops to reduce *Cirsium arvense*

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Key words: *Cirsium arvense*, crop rotation, competition, oilseed rape, fibre hemp, grass-clover

Abstract

Cirsium arvense is difficult to control and mechanical control may result in yield loss or nutrient leaching. Growing a competitive crop such as grass clover has earlier been seen to reduce the infestation. This paper describes a test of different competitive crops (oilseed rape and fibre hemp) comparing the infestation with that occurring with one or two years of grass clover. Oilseed rape did not grow well and was not very competitive, while C. arvense infestation was reduced the year after growing fibre hemp or grass-clover.

Introduction

Cirsium arvense (Canada thistle) is a problem in organic farming in Denmark and many other countries. *C. arvense* causes yield loss in many crops (Donald & Khan 1992) and the perennial weed is difficult to control. One control method is to carry out stubble cultivation after harvest. While this is the traditional way to control *C. arvense* in Denmark, results from a crop rotation experiment indicated that stubble cultivation did not reduce the *C. arvense* infestation more than growing a catch crop in the autumn (Rasmussen *et al.* 2005). In addition, this type of mechanical control may result in loss of nutrients. In the same experiment there was a tendency towards lower *C. arvense* infestations in a crop rotation with one year grass-clover as green manure, than in a rotation without grass-clover. However, in an arable crop rotation, growing grass-clover may result in lower total yield for the whole rotation, due to the grass-clover not being a cash crop. Thus, it would be interesting for organic farmers with arable rotations if they could grow a crop which was competitive against *C. arvense*, but at the same time gave a marketable yield. Fibre hemp is used for clothes and is becoming increasingly relevant, especially for organic hemp. Seed hemp, which is probably as competitive as fibre hemp, is relevant as oil and protein feed, which is needed for avoiding feedstuffs of foreign and/or non-organic origin. This paper describes a test of the effect of two competitive crops (oilseed rape (*Brassica napus*) and fibre hemp (*Cannabis sativa*)) against one or two years of grass-clover on the infestation with *C. arvense*.

Materials and methods

In plots, that had been run within a crop rotation experiment on a sandy loam at Research Centre Flakkebjerg (annual precipitation 600 mm) in Denmark since 1997 (Rasmussen *et al.* 2006), a test of different competitive crops was carried out. From

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1997 – 2004, the plots were in the rotation: 1) spring barley with undersown grass-clover, 2) one year of grass-clover, 3) winter wheat followed by catch crop and 4) sugar beets. Each crop was grown every year with two replicates. The rotation from 2004 can be seen in table 1. At the start of the test, the plots were in different crops, according to the crop rotation, see table 1. From 1997 to 2004 *C. arvense* had developed from a negligible to a problematic level. During this period, the only weed control of *C. arvense* carried out was that a tant hesis of the cereals, all visible *C.arvense* plants in the plots were pulled out. At this time, they were counted and weighed. From 2005 to 2008, stubble cultivation was carried out once or twice after winter wheat (or oats) before the catch crop was sown, and after potatoes. No *C. arvense* plants were pulled out in the growing season. In field 1, oilseed rape was sown at 24 cm row distance in August 2008. Row cultivation was carried out in the end of September and in the middle of April 2009. In March 2009, pelleted chicken manure corresponding to 30 kg N ha^{-1} was applied, and in the middle of April, pig slurry corresponding to 98 kg N ha^{-1} was applied. After harvest, no stubble cultivation was carried out, and volunteer oilseed rape was left to grow. Due to a dry autumn, very few emerged. In field 2 and 3, grass clover was left to grow for one year (2009) and two years (2008 and 2009), respectively. The plots were moved twice, once in the beginning of June, where the crop was removed, and once in the beginning of August, where the crop was left on the plot. In field 4, pig slurry corresponding to 98 kg N ha^{-1} was applied in the middle of April 2009. Fibre hemp was sown in the end of April at 12 cm row distance. Weed harrowing was carried out in the middle of May. The hemp grew to a height of > 2 m. It was harvested in the middle of September, and no stubble cultivation was carried out. All plots were ploughed in the end of November 2009. In 2010, they were all sown with spring barley in the end of April. In fields 1 and 4 pig slurry corresponding to 72 kg N ha^{-1} was applied prior to sowing.

During 2009, *C. arvense* was monitored in the test plots by counting, cutting, drying and weighing in 2-4 quadrates 0.25 or 0.5 m^2 during and/or after the growing season of the crops. When cutting and weighing, the crop was also cut and weighed. In 2010, all *C. arvense* plants in the plot were counted, and 4 quadrates of 0.5 m^2 were cut, split into crop, *C. arvense* and other weeds, dried and weighed. The spring barley

Tab. 1: Crop rotation in the four treatments from 2004-2010.

Year	Field 1	Field 2	Field 3	Field 4
2004	Sugar beets	S. barley	Grass-clover	W. wheat + catch crop
2005	S. barley	Grass-clover	Potatoes	S. oats + catch crop
2006	Grass-clover	Potatoes	W. wheat + catch crop	S. barley
2007	Potatoes	W. wheat + catch crop	S. barley	Grass-clover
2008	W. wheat + catch crop	S. barley	Grass-clover	Potatoes
2009	W. oilseed rape	Grass-clover	Grass-clover	Hemp
2010	S. barley	S. barley	S. barley	S. barley

was harvested in two subplots of each app. 21 m^2 and weighed. Statistical analysis was carried out using GLM of SAS (SAS Stat, 2007) where all the measured variables were dependent on the crop.

Results

Oilseed rape never became a very competitive crop and a lot of *C. arvense* plants were seen during the growing season. Compared to the corresponding rotation, where the crop was spring barley in 2009, there were almost 4 times as many *C. arvense* plants in the oilseed rape (data not shown). After harvest, the volunteer oilseed rape did not establish well, and the *C. arvense* plants left in the field had a good chance to grow. Fibre hemp grew very fast to above 2 m height and the few *C. arvense* plants in the crop withered away. No *C. arvense* plants were found in the field after harvest or later in the autumn. The plots with first and second year grass-clover had a low amount of *C. arvense* plants during the whole season. There were significantly more *C. arvense* plants in oilseed rape in June 2009 than in any of the other crops, see table 2. In the spring barley grown in 2010, there were also significantly more *C. arvense* plants in the plots, where oilseed rape had been grown the year before, see table 2.

There was no significant difference between the biomass of *C. arvense* at any of the harvest times, even though there were tendencies for more *C. arvense* biomass in the plots with oilseed rape in 2009 than in the other treatments, see table 2. There was a tendency for the *C. arvense* plants in the spring barley to be shorter, in the plots where fibre hemp had been grown in 2009, but this was not significant. There were no significant differences between the yield of the spring barley in the plots with different pre-crops.

Tab. 2: *C. arvense* number, weight and length at different times during the experiment

Crop 2009	*C. arvense*, no. m^{-2}		*C. arvense*, *g* m^{-2}		*C. arvense*, *mean length in cm*
	June 2009	July 2010	Nov. 2009	July 2010	July 2010
Oilseed rape	14.5[a]	49.0[a]	21.8[a]	453.8[a]	33.2[a]
Fibre hemp	1.3[b]	5.3[b]	0[a]	61.8[a]	17.7[a]
1st year grass-clover	0.3[b]	6.5[b]	2.3[a]	110.2[a]	32.8[a]
2nd year grass-clover	0.1[b]	7.3[b]	1.1[a]	72.1[a]	34.8[a]

Results within the same column with the same letter are not significantly different at $P<0.05$.

Discussion

The test of different crops confirmed that the competitiveness of a crop in one season had an effect on the infestation with *C. arvense* in the next season. We had earlier seen that one year of grass-clover could reduce the infestation compared to a crop rotation without grass-clover (Rasmussen *et al.* 2005), but the results from this experiment did not indicate that two years of grass-clover reduces the *C. arvense* infestation more than one year. A very competitive crop such as fibre hemp reduced the *C. arvense* infestation as much as grass-clover. Even though we found no significant differences between biomass of *C. arvense* in and after the different crops, there was the same tendency as in the number of *C. arvense* plants. Since there were only two replicates, this could be part of the reason why there were no significant differences despite high differences in the means. In an organic rotation with arable crops, where grass-clover may be a non-cash crop, growing a competitive crop which can reduce the *C. arvense* infestation, but also be sold, could be interesting. Since mechanical weed control may either cause yield loss or be very labour intensive (Graglia 2006) this could be an interesting alternative for organic arable farming.

Conclusions

Further work using competitive crops as a way of managing *C. arvense* should be carried out, since this work was only a small test. However the results indicate that in an organic arable rotation, competitive crops such as grass-clover or fibre hemp reduce the *C. arvense* infestation compared to less competitive crops, in this case oilseed rape. If the volunteer oilseed rape had been better established or had manure applied in the autumn, oilseed rape could possibly also have been a competitive crop.

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