Change in the weed seed bank during the first four years of a five-course crop rotation with organically grown vegetables

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Keywords: weed seed bank, red clover, yellow sweetclover , vegetables, crop rotation

Abstract

In a five-course rotation with organic vegetables (white cabbage, carrot and onion) the weed seed bank was reduced the year after two continuous years with red clover, mainly because of mowing and no soil cultivation the second year red clover. The year after the weedy yellow sweetclover the weed seed bank increased.

Introduction

The weed observations were an integrated part of the project 'Optimum crop rotation for secure organic vegetable production', started in 2002 at Bioforsk Arable Crops – Landvik, in the southern part of Norway. The project has focused on different N-sufficient crop rotation systems on a clay rich soil. Of five production years two have been used for green manure fertilisation with legumes. Our results have shown that the systems provide abundant levels of nitrogen for white cabbage, carrots and onions.

The soil seed bank is recognized as the primary source of annual weeds in arable land. The majority of seeds entering the seed bank come from annual weeds growing in the fields. The size of the seed bank reflects past and present field management (Cavers & Benoit, 1989). Albrect (2005) found that the number of weed seeds increased at sites with low crop cover and high density of weed plants at the soil surface. Winter cereals, sunflowers and lupins increased for example the weed seed bank by 30-40%. Grass-clover mixtures, however, reduced the seed bank by 39%. In an organic farmed six-course rotation investigation in Norway, the seed bank was reduced from a maxiumum of 17600 m^{-2} to a minimum of 7200 seeds m^{-2} after three years with perennial grass-clover ley (Sjursen, 2001).

The main objective of the present study was to evaluate the effect of two years with a N-fixing clover crop on the weed seed bank, either two continuous years with red clover or two alternating years with yellow sweetclover.

Materials and methods

The investigated area had four different fields with three replicates. Two of them had this rotation: Red clover, red clover, white cabbage, onion, followed by a last year with carrot. Two other fields had this rotation: yellow sweet clover (ribbed meliot), white cabbage, yellow sweet clover, onion and carrot. The plot size was 8 x 15 m. Soil

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samples down to 0.20 m for weed seed investigations were taken each year before the growing season started (around 25th of April). The seed number analysis were carried out by the seedling emergence method described by Sjursen (2001). Number of emerged weeds on the soil surface were counted in a frame 0,5 x 0,5 m (clover crops) or 0,1 x 1,0 m (vegetable crops) during the end of June – beginning of July. The fields were weed managed by common organic methods, like flaming before planting/sowing, inter-row hoing/ploughing, and manual weeding in vegetables, and two-three times mowing in clover leys.

Results

The weed seed bank in the whole investigated area increased the first three years by 11% from about 28000 to 31000 seeds m^{-2}, and was redused by 7% to 29000 seeds m^{-2} the fourth year. 23 weed species occurred in the seed bank. The most frequent species were *Spergula arvensis* L., *Filaginella uliginosum* (L.) Opiz., *Poa annua* L., *Capsella burs-pastoris* (L.) Medicus, *Chamomilla suaveolens* (Pursch) Rydb. and *Stellaria media* (L.) Vill. The same species were most frequent among the emerged species. The seed bank increased after one year with red clover, but was reduced after the second year of clover (figure 1 and 2). The seed bank increased the year after yellow sweetclover (figure 3 and 4). The density of emerged weed plants were high in the first year with red clover (figure 1 and 2) and in yellow sweetclover (figure 3 and 4).

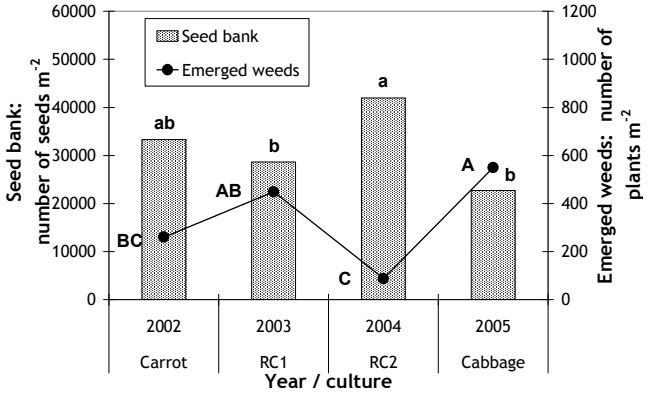

Figure 1. Weed seed bank in the soil (left hand y-axis) and emerged weeds (right hand y-axis) during two continuous years with red clover (RC1 and RC2) in rotation with carrot and white cabbage. Onion is the fifth year. Values with the same letter (lower case or upper case) are not significantly different at $p \leq 0.05$ (n = 6).

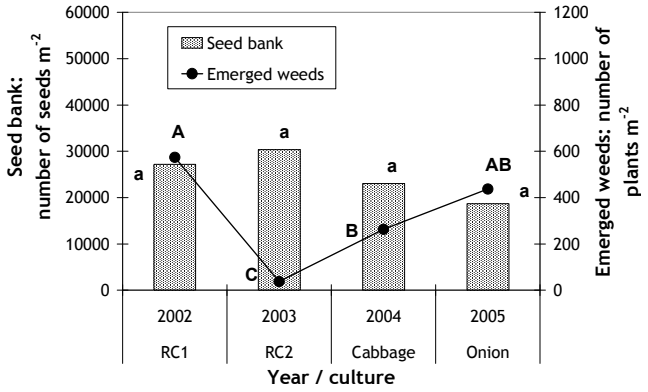

Figure 2. Weed seed bank in the soil (left hand y-axis) and emerged weeds (right hand y-axis) during two continuous years with red clover (RC1 and RC2) in rotation with carrot and onion. Carrot is the fifth year. See figure 1 for statistics.

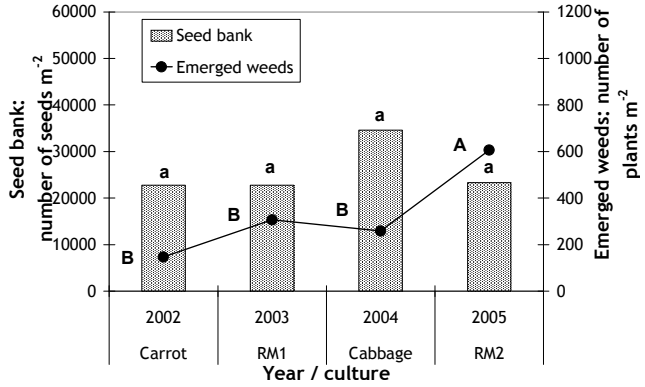

Figure 3. Weed seed bank in the soil (left hand y-axis) and emerged weeds (right hand y-axis) during two alternating years with yellow sweetclover (RM1 and RM2) in rotation with carrot and onion. Onion is the fifth year. See figure 1 for statistics.

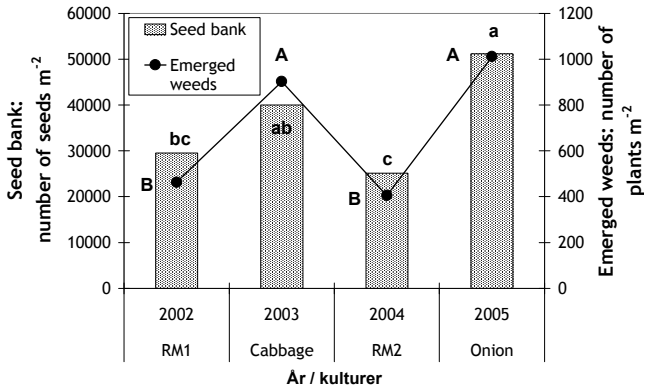

Figure 4. Weed seed bank in the soil (left hand y-axis) and emerged weeds (right hand y-axis) during two split-up years with yellow sweetclover (RM1 and RM2) in rotation with white cabbage and onion. Carrot is the fifth year. See figure 1 for statistics.

Discussion and conclusions

The results show that there are a close relation between the emerged weed plants at the soil surface and the seed bank the following year. The red clover was mowed two-three times the second year. This resulted in low emergence of annual weeds, and reduced seed bank the following year (figure 1 and 2), in accordance with the investigations by Sjursen (2001) and Albrecht (2005). This effect was not seen in yellow sweetclover. There was a tendency of weed seed bank reduction the year after white cabbage, which can be explained by the strong competition by the fast-growing cabbage leaves and the manual weeding. This effect was not seen the year after carrot and onion, which is known as low-competitive crops. Teasdale et al. (2004) force the importance for organic farmers to minimize opportunities for rapid buildup of the seed bank.

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