Integration of *Elymus repens* control and post-harvest catch crop growing in organic cropping systems

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Introduction

Elymus repens (L.) Gould constitutes a major perennial weed problem in organic cropping systems in many parts of Denmark with great negative impact on crop yield and quality. *E. repens* infestations are traditionally controlled by repeated stubble cultivation in the post-harvest period from harvest to ploughing, either early autumn before sowing a winter-sown crop or in late autumn. However, in organic farming, post-harvest tillage is undesirable due to the need for retaining nutrients, particularly nitrogen, in the cropping system. Thus, the soil is often cropped with catch crops, autumn-sown crops or perennial crops in that period, limiting opportunities for post-harvest tillage.

In this paper, a new control strategy (strategy I) against *E. repens* is presented that merges the objectives of achieving a significant reduction of *E. repens* while having the soil covered with plants during most of the post-harvest period. Strategy I contains an integration of rhizome fragmentation by soil cultivation within one or two days after harvest in early August with subsequent catch crop growing in late summer and autumn to suppress shoot growth from the weakened rhizome fragments. Strategy I is discussed in relation to another strategy (Strategy II) that also includes catch crop growing in late summer and autumn but is preceded by a mid-summer fallow period lasting 4-6 weeks where repeated soil cultivations are conducted to fragment, weaken and desiccate the rhizomes.

Materials and methods

<u>Strategy I</u>: Two field experiments were established on a coarse sandy soil just after harvest of spring barley in August, a) in 2002 and b) in 2003. Both experiments contained three factors. Factor 1: mechanical disintegration of rhizomes, 5 levels: 1. untreated, 2. disintegration and loosening by mouldboard ploughing to only 10 cm soil depth, 3. strong disintegration by p.t.o.-driven rotary cultivation, 4. disintegration and loosening by stubble cultivation, 5. loosening and uprooting by a newly developed Danish implement, the *"Kvik-Up"*, based on a cutting and loosening tool element followed by a rotating tool element for uprooting. Factor 2: catch crop growing, 3 levels: 1. no catch crop, 2. mixture of fodder radish (*Raphanus sativus* L.) and westerwolds ryegrass (*Lolium multiflorum* Lam. *var. westerwoldicum* Mansh.), 3. mixture of red clover (*Trifolium pratense* L.) and winter vetch (*Vicia villosa* Roth). Factor 3: timing of mouldboard ploughing, 2 levels: 1. late autumn, 2. spring. Factor 1 was conducted within two days after harvest and straw removal, and the catch crops were sown subsequently so that both rhizome disintegration and catch crop establishment were accomplished no later than a week after harvest. Spring barley was sown in the following spring and the overall effects on *E. repens* including barley yield were assessed at harvest.

<u>Strategy II</u> was conducted by the Danish Agricultural Advisory Service, National Centre, Crop Production (www.lr.dkT). The mid-summer fallow period was started around first of July by shallow mouldboard ploughing to 10 cm soil depth following the harvest of a whole crop for silage. Then tine cultivation once a week was conducted till early August where the fallow period was ended by mouldboard ploughing to 20 cm soil depth. A competitive catch crop (mixture of red clover, fodder radish, winter rye (*Secale cereale* L.) and winter vetch) was established to suppress *E. repens* shoot growth and to take up nutrients during autumn.

The effect was assessed the following year in spring barley. Results from a total of 5 experiments on fine or coarse sandy soils are reported in this paper.

Results and discussion

Rotary cultivation in strategy I caused the highest level of rhizome disintegration with an average rhizome length of 11.7 cm as compared with 30.7 cm on average for all the other treatments that did not differ significantly. Catch crop growth during the autumn of 2002 and 2003 suffered from very dry weather conditions resulting in poor establishment and canopy development. The radish/ryegrass mixture significantly suppressed weed growth in expt a) but none of the catch crops affected weed growth in expt b). Mechanical disintegration reduced growth of *E. repens* significantly in expt a). Rotary cultivation gave the highest growth reduction compared with untreated (Fig. 1A), but compared with the infestation level prior to starting the strategy, the reduction was only roughly 40%. Catch crop growing affected the crop's ability to compete with *E. repens* in the subsequent year as shown in Fig. 1B where barley grain yield is related to the amount of *E. repens* biomass that followed the treatments (1-5) under factor 1. The two regression lines have significantly different slopes (P<0.05), which show that the radish/ryegrass mixture had strengthened crop growth more than no catch crop and the clover/vetch mixture. Timing of ploughing had generally no effect and none of the three factors affected *E. repens* in expt b) because of wet and cold weather conditions during most of the summer of 2004, presumably promoting *E. repens* growth to an extent where the effects of previous year's treatments were eliminated.

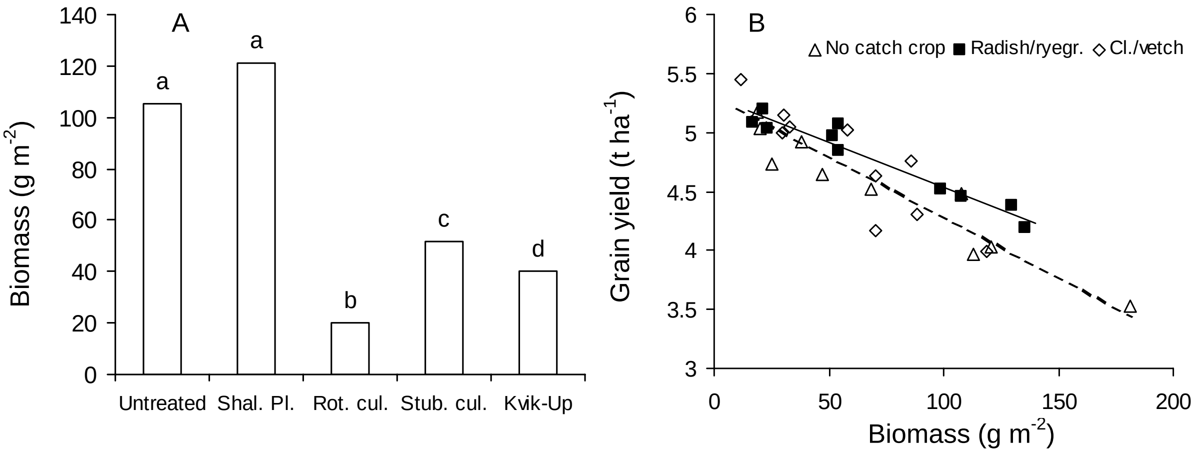

Figure 1. A: Aboveground *Elymus repens* biomass assessed close to barley harvest following previous year's mechanical treatments in expt a) (data averaging factor 2 and 3), columns with different letters are significantly different (P<0.05). B: Regression analyses of barley yield related to *E. repens* biomass in the year after conducting treatments 1-5 under factor 1 in expt a). (---) is no catch crop and clover/vetch, and (—) is radish/ryegrass.

Strategy II gave very high and consistent reductions of *E. repens* infestations, leading to 91-99 % efficacy compared with the infestation level prior to starting the strategy. A stronger weakening and desiccation of rhizomes took place during the mid-summer fallow period in strategy II than in the short-term mechanical treatment in strategy I. However, strategy II has been tested in long-term organic crop rotation experiments where high effects attained in the first year tended to decline rapidly in a few years' time. Also the rather long mid-summer fallow period may lead to some nutrient loss, (but still lower than with traditional *E. repens* control), through leaching after heavy rainfall events, which subsequently may give rise to crops that are less competitive against *E. repens*. In addition, the grower will have to desist from growing a full-season cash crop. These aspects should be counterbalanced against the urgency for *E. repens* control and other possible control options.