NJF Report • Vol. 1 • No 1 • 2005

Nordic Association of Agricultural Scientists

NJF-Seminar 369

Organic farming for a new millennium
-status and future challenges

Published by
Nordic Association of Agricultural Scientists (NJF),
Section I: Soil, Water and Environment
Swedish University of Agricultural Sciences

Alnarp, Sweden June 15-17, 2005

Electronic version available at www.njf.nu

ISSN 1653-2015

Nordic Association of Agricultural Scientists

Sonchus arvensis – a challenge for organic farming

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Abstract

Perennial sow-thistle (Sonchus arvensis L.) represents an increasing problem in Finland. Options for mechanical and cultural control of S. arvensis were studied in a 3 year field experiment on clay soil under organic production. The experiment consisted of different crop sequences: spring cereal (barley in 2001, oats in 2002) with or without inter-row hoeing and/or stubble cultivation, bare fallow, fibre hemp (*Cannabis sativa* L.), and ley with mowing. In 2003 the entire field was sown to spring wheat. Crop plant and *S. arvensis* dry mass prior to cereal harvest and crop yield were assessed. The control effect was rated: bare fallow > ley > cereal with or without inter-row hoeing > poor growth fibre hemp. Bare fallow was an effective but costly method to reduce *S. arvensis* infestation. Introduction of a regularly mown green fallow or silage ley in the crop rotation was beneficial. Mechanical weed control by inter-row hoeing in cereals limited *S. arvensis* growth. Infestation was also reduced by stubble cultivation in autumn. When managing S. arvensis using mechanical and cultural methods, appropriate options, including a competitive crop, should be chosen for the specific field and rotation.

Keywords: perennial weeds, *Sonchus arvensis*, mechanical control, crop rotation, inter-row hoeing

Introduction

Perennial weeds, including sow-thistle (*Sonchus arvensis* L.), are becoming increasingly problematic in Finland, particularly in organic farming (Salonen et al. 2001). Managing S. arvensis using non-chemical (mechanical and cultural) methods is not easy. However, crop competition and cultural practices, including mowing, hoeing and bare fallowing, provide some possibilities for managing *S. arvensis*. Information on the response of *S. arvensis* to various physical and cultural control measures is a prerequisite for successful management.

Much research has been carried out on mechanical weed control in cereals in Nordic countries (for example Rasmussen 1992, Rydberg 1995, Johansson 1998, Lötjönen & Mikkola 2000). These studies concentrate mainly on control of annual, but not perennial weeds. One reason for this is a patchy growing habit of perennial weeds. As a result, it is difficult to find a field where the perennials would be distributed evenly.

The aim of this study was to establish non-chemical methods for managing *S. arvensis*, particularly for organic cropping. The objectives were to 1) study the effect of crop, mechanical weed control and other management on *S. arvensis* biomass 2) study crop yield under different treatments and finally 3) provide some recommendations for crop rotations.

Material and methods

A three-year field experiment was set up in 2001 at Vihti, southern Finland. It was conducted on a clay soil (containing 6–12% organic matter) heavily infested with S. arvensis. The field had been in organic production since 1997. The previous crop in 2000 was spring wheat.

The experiment had seven treatments (see Table 1) and two levels of stubble cultivation (yes/no) organized in a strip-plot design with five replicate blocks. Stubble cultivation and treatment strips were randomized separately in each block. The plot size was 3 m × 25 m, except for fibre hemp it was 5 × 25 m. In 2003 the entire experimental area was sown to spring wheat to establish the subsequent effects of the treatments. In 2003 no weed control was carried out.

Table 1. The treatments during the years 2001-2003. The treatments remained at the same locations throughout the experiment. Sc means stubble cultivation in autumn.

Abbreviation of treatment	**Year 2001**	**Sc in autumn**	**Year 2002**	**Sc in autumn**	**Year 2003**
Cer	Barley	(sc)	Oats	(sc)	Spring wheat
CerH	Barley + hoeing	(sc)	Oats + hoeing	(sc)	Spring wheat
Cer-Ley	Barley with ley	-	Ley	-	Spring wheat
Ley	Ley	-	Ley	-	Spring wheat
Bf-Cer	Bare fallow	-	Oats	(sc)	Spring wheat
Cer-Bf	Barley	(sc)	Bare fallow	-	Spring wheat
Hemp	Fibre hemp	-	Fibre hemp	-	Spring wheat

All cereal and fibre hemp plots were ploughed at the depth of 20 cm in every autumn. The whole experimental field was fertilised every spring with pig slurry (60–100 kg $N_{soluble}$ ha^{-1}) applied using a band spreader. The plots were drilled every year between 16–27 May.

The leys were mowed three times per summer. Bare fallow was cultivated with S-tine harrow as soon as *S. arvensis* reached 5–7 leaves (6–7 times per summer), which is regarded as an optimum time for cultivation (Håkansson 1995). Inter-row hoeing was performed 2–3 times per summer. It uses the row spacing of 18.0 cm compared to the normal of 12.5 cm. Half of the cereal plots were stubble-cultivated with S-tine harrow after harvesting. Prior to harvesting cereals the number and total dry mass of *S. arvensis* per area were assessed. The yields of ley and cereal were measured.

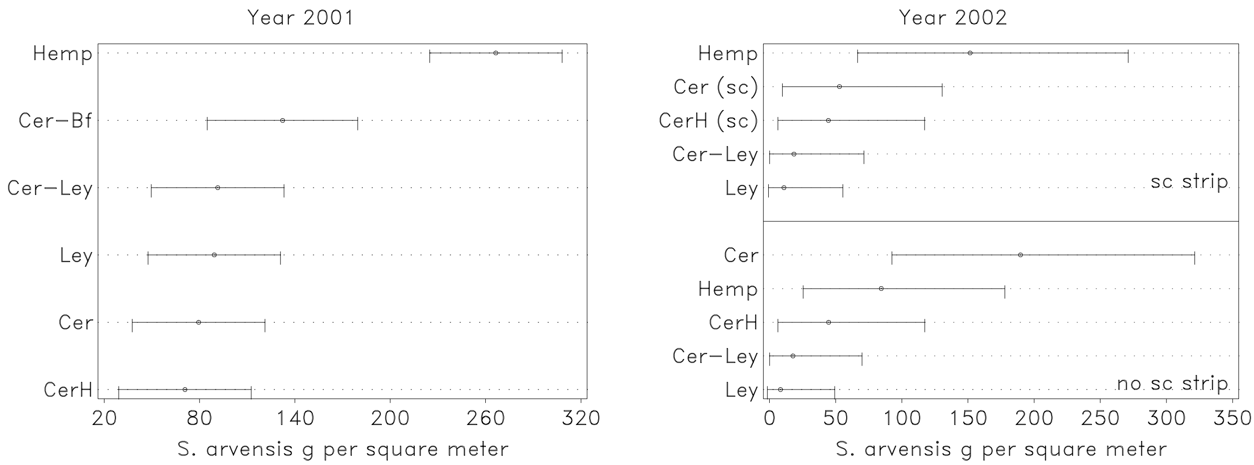
The statistical models were fitted to the data using PROC MIXED of the SAS System version 8.2. Model assumptions were checked graphically: equality of variances by plotting residuals against fitted values, and normality of the response variables by inspecting model residuals using the box-plot technique. The results are presented by plotting the estimated means and 95% confidence intervals of the means. Statistical differences are not presented in this paper.

Results

Several treatments had a significant effect on *S. arvensis* biomass (Fig 1). Bare fallow (Bf-Cer in 2001, Cer-Bf in 2002) reduced the biomass of *S. arvensis* considerably, destroying all or nearly all *S. arvensis* plants. The subsequent effect of bare fallow was also very good. Leys

(Cer-Ley, Ley) reduced *S. arvensis* biomass and had good subsequent effects, especially after the ley sown on bare soil (Ley).

Inter-row hoeing (CerH) was not as effective as the treatments mentioned above and its efficacy varied. The subsequent effect (in 2003) of hoeing was poor. The growth of hemp was unsatisfactory in the experimental field, and *S. arvensis* density was higher in 2001 in hemp compared with that in standard cereal (barley). *S. arvensis* biomass in spring wheat in 2003 was highest after poorly grown hemp.



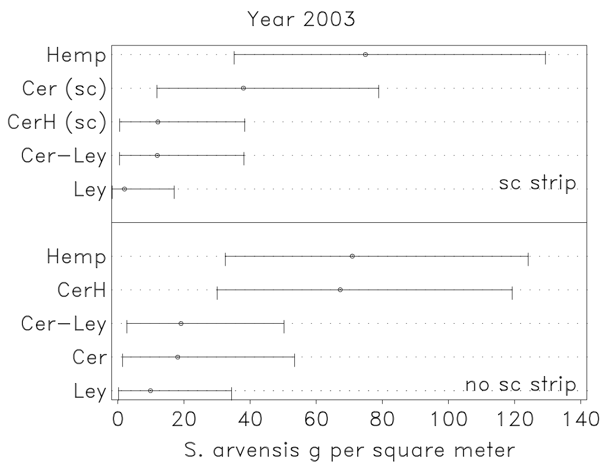


Fig. 1. Air-dried biomass (g m-²) of S. arvensis, showing the estimated means and 95% confidence intervals of the means. Due to zero or very low values, the treatments Bf-Cer and Cer-Bf were excluded from the analysis and graphs for 2002 and 2003. Key to abbreviations is in Table 1.

Stubble cultivation in the previous autumn reduced *S. arvensis* biomass in some cases but not always. The rating of the treatments based on the subsequent control effect in 2003 was: bare fallow > ley > cereal with or without inter-row hoeing > poor growth fibre hemp. Stubble cultivation was not directly comparable with the other treatments, but it seemed to fall between ley and inter-row hoeing.

The treatments had some effect on cereal yields either directly or through *S. arvensis* biomass (Fig. 2). In 2003, wheat yield after failed fibre hemp was significantly lower, and after the previous year's bare fallow and leys significantly higher than after standard cereal. Stubble cultivation slightly increased the yield of treatments, which had plenty of *S. arvensis* in 2002.

Conclusions

Overall, the results suggest that the following management measures could be implemented in order to suppress *S. arvensis* infestation: 1) Mowing the leys would suppress *S. arvensis* biomass production. 2) A crop should be selected that is competitive not only generally, but also under the conditions of a given field. 3) Bare fallow is an effective method to reduce S. arvensis infestation, but it is costly and can damage the soil structure. 4) Inter-row hoeing seems to impede *S. arvensis*, but it has not long-term effects. 5) Stubble cultivation in autumn may be used in order to reduce *S. arvensis* vigour in the next season. The advantages of synergy of different control measures, as well as long-term effects, should be taken into account when planning crop rotations to control *S. arvensis*.

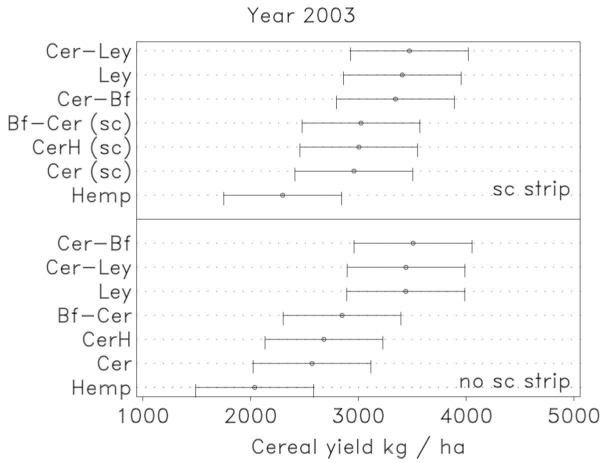


Fig. 2. Cereal yields in 2003 (converted to 14 % moisture), showing the estimated means and 95% confidence intervals of the means.

More information is needed for each control method to establish the optimal timing of control. The effect and importance of tillage methods on weed control should be studied. Tillage and other machinery should be developed with a view to manage perennial weeds. There are many new machine types suitable for stubble cultivation and bare fallow tillage that should be evaluated in field experiments.

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