# THE EFFECT OF HARROWING ON THE WEEDINESS AND YIELD OF SPRING BARLEY IN ORGANIC FARMING

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## Abstract

Field trials were carried out on organic farming fields at the Research Institute of Agriculture of the Latvia University of Agriculture (LLU). The influence of harrowing (without harrowing, before emergence, at the stage of tillering, before emergence and at the stage of tillering) depending of pre-crop (red clover, winter rye for grain, bare fallow, bare fallow and green manure,) and use of stable manure (60 t $ha^{-1}$ or without) on the weediness and yield of spring barley 'Sencis' was tested during 2003 – 2004. In spring barley, 18 species of weeds were established at the stage of earing during 2003 – 2004. The most widespread of perennial weeds were *Elytrigia repens* (L.) Nevski and *Sonchus arvense* L. The dominant annual weeds were *Chenopodium album* L, *Stellaria media* L., *Capsella bursa-pastoris* L., *Polygonum* spp., and *Matricaria inodorum* L. The number of annual weeds at the stage of earing differed during the years 50–160 (in 2003) and 33 –118 (in 2004) annual weeds per $m^{-2}$. The influence of harrowing on the number of annual weeds was different during the testing years. The influence of harrowing on the grain yield was negligible during 2003 and 2004.

**Key words:** organic farming, spring barley, stable manure, harrowing, previous plants.

## Introduction

The aim of weed management strategies in organic farming systems is to maintain weeds at a manageable level by structural measures (rotation design, variety choice, sowing date) (Millington et al., 1990).

It is stated that influence of weeds on grain yields is different at the different growth stages of cereals. The increasing of number of weeds in the period from tillering to earing influence significantly the grain yields (Терещук, 1997).

Weed harrowing before and after crop emergence is used widely in arable crops. Timing of harrowing is critical and determines whether weed or crop dominates the system (Petraitis, 1994). In cereals, plug harrow may be used for 'blind harrowing', which is carried out after drilling but before crop emergence to kill the first flush of small emerging weeds. The aim is to give the crop an early advantage over the weeds and to aid selectivity in subsequent weeding operations. Post-emergence harrowing may cause crop injury (Bond W., Grundy AC., 2001).

The aim of field trial was to investigate the influence of harrowing on the weediness and yield of spring barley in organic farming.

## Methods

The three-factorial field trials were carried out on certified organic fields during 2003 and 2004.

The influence of harrowing (without harrowing, before emergence, at the stage of tillering, before emergence and at the stage of tillering) depending of pre-crop (red clover, winter rye for grain, bare fallow, bare fallow and green manure,) and use of stable manure (60 t $ha^{-1}$ or without) on the weediness and yield of spring barley 'Sencis' was tested.

The field trials were studied on turf podsolic soil: $pH_{KCl}$ – 6.75, $P_2O_5$ – 162 mg $kg^{-1}$, $K_2O$ – 158 mg $kg^{-1}$, organic matter content – 32.5 g $kg^{-1}$ and $N_{total}$ – 1.1 g $kg^{-1}$. The content of nitrogen was determinated before sowing of barley in spring.

The object of research: spring barley 'Sencis'. Seed rate was 500 germinating seeds per $m^{-2}$. Before sowing, grains were treated with 1.5 kg of ashes of foliage trees and 1.5 l of water per 100 kg of grain. Sowing date was 19.05.2003. and 30.04.2004. The number of replications was four, random plot layout, plot size 42 $m^2$ and testing plot size – 26.18 $m^2$. The harvest was done on 11.08.2004. and 10.08.2004., adjusted to 14 % moisture content and 100% purity.

After previous plant bare fallow + green manure, 15 t $ha^{-1}$ (2004) and 17°t $ha^{-1}$ (2003) of biomass of winter rye were incorporated into soil. The chemical content of winter rye biomass: dry matter – 169.3 (2003) and 178.3 (2004) g $kg^{-1}$, $P_2O_5$ – 60 and 65 mg $kg^{-1}$, $K_2O$ –254 and 302 mg $kg^{-1}$ and total content of nitrogen – 277 and 287 mg $kg^{-1}$. Winter rye was sown in autumn (10.09.2002. and 15.09.2003.) but was incorporated in spring at the stage of tillering. In the trial, variants with stable manure were included (60 t $ha^{-1}$). The chemical content of stable manure: dry matter – 169.7 (2003) and 387.7 (2004) g $kg^{-1}$, $P_2O_5$ – 64 and 88 mg $kg^{-1}$, $K_2O$ 97and 183 mg $kg^{-1}$ and total content of nitrogen – 238 and 377 mg $kg^{-1}$.

Weed assessment was done 3 weeks after harrowing using a 0.20 $m^2$ big frame.

Meteorological conditions are summarised in Figures 1–2.

The year 2003 was very favourable for growth and development of spring barley. April was rainy and cold, which hampered the time of sowing. In May, the air was getting warmer gradually, at nights the temperature was under 10 °C, and frosts were frequent on the soil surface. Barley germinated and tillered quickly. In June, the average air temperature was 0.7 degrees lower than the long-term average, but the amount of precipitation made 75 % of the norm. July with average air temperature 19 °C was the second warmest middle-summer month during the last 80 years in Latvia.

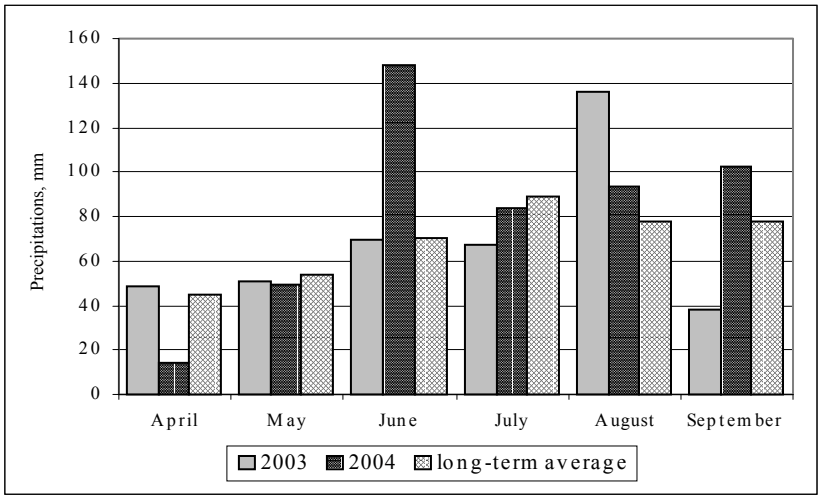


Fig. 1. The amount of precipitation during the vegetation period, mm, 2003-2004.

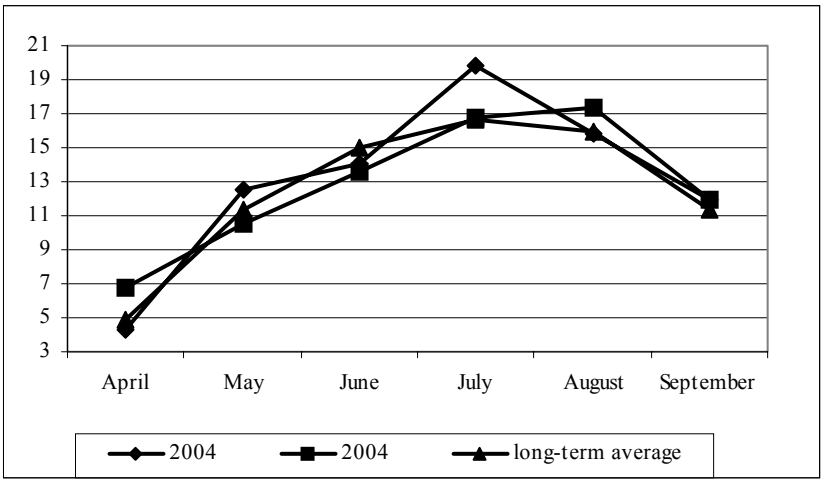


Fig. 2. The average air temperature during the vegetation period, °C, 2003-2004.

In April of 2004, the average air temperature was 1.7 degrees higher than the norm. The first decade of May was one of the warmest decades during the last 80 years in Latvia. The second decade of May was 3.1 degrees lower but the third decade – 3.6 degrees lower than the norm. In this time, frosts were frequent on the soil surface. In May, the amount of precipitations made 80% of the norm. In June, the average air temperature was 1.3 degrees lower than the norm, but the amount of precipitation made 152% of the norm. Very wet conditions were observed in the third decade of June (223% of the norm). In August, the average air temperature was 1.7 degrees higher than the norm. Barley grew and developed well and produced good and qualitative grain yields.

ANOVA (two factor with replication) was used for data analysis.

## Results

For establishment of effectivity of harrowing on the weediness of barley, the weeds were ascertained at the stage of earing (3 weeks after harrowing). Altogether 18 species of weeds were established in the sowings during 2003 -2004. In 2003, six perennial weed species were established in spring sowings, the most widespread of which were *Elytrigia repens* (L.) Nevski and *Sonchus arvense* L. After red clover, a higher number of weeds was established compared to other previous plants. Sowings of previous plant red clover were sparse, which favoured fast spread of perennial weeds. In 2004, the number of perennial weeds was negligible.

From annual weeds, *Chenopodium album* L, *Stellaria media* L., *Capsella bursa-pastoris* L., *Polygonum* spp. and *Matricaria inodorum* L. were ascertained in all variants. In some variants, *Spergula arvensis* L., *Viola* spp., *Galeopsis speciosa* Mill., *Raphanus raphanistrum* L. and *Thlaspi arvense* L. were established, though the number of these weeds was negligible.

The number of annual weeds depending of pre-plants, time of harrowing and use of stable manure is presented in Figures 3 and 4.

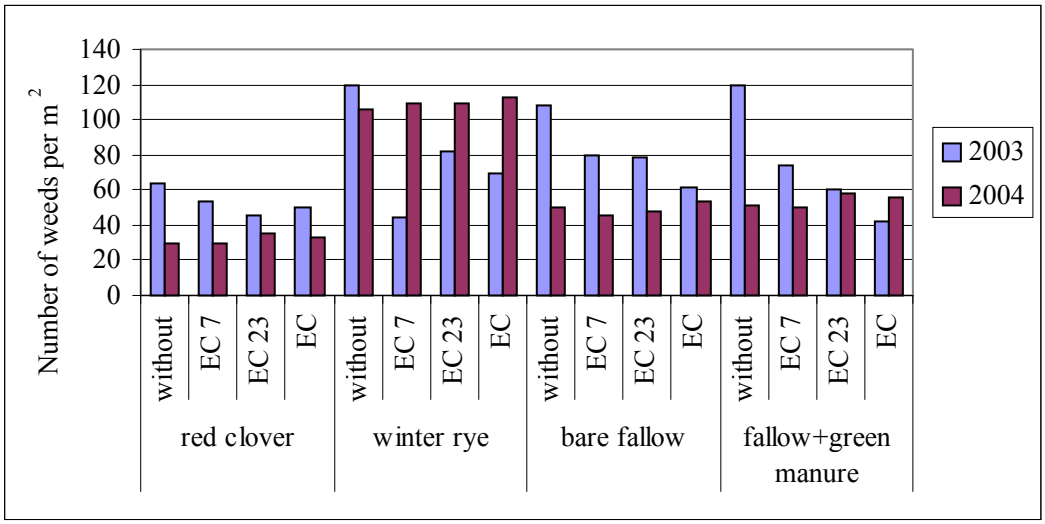


Fig 3. The number of annual weeds at the stage of earing, depending on pre-crop and harrowing variant and without use of stable manure during 2003 – 2004.

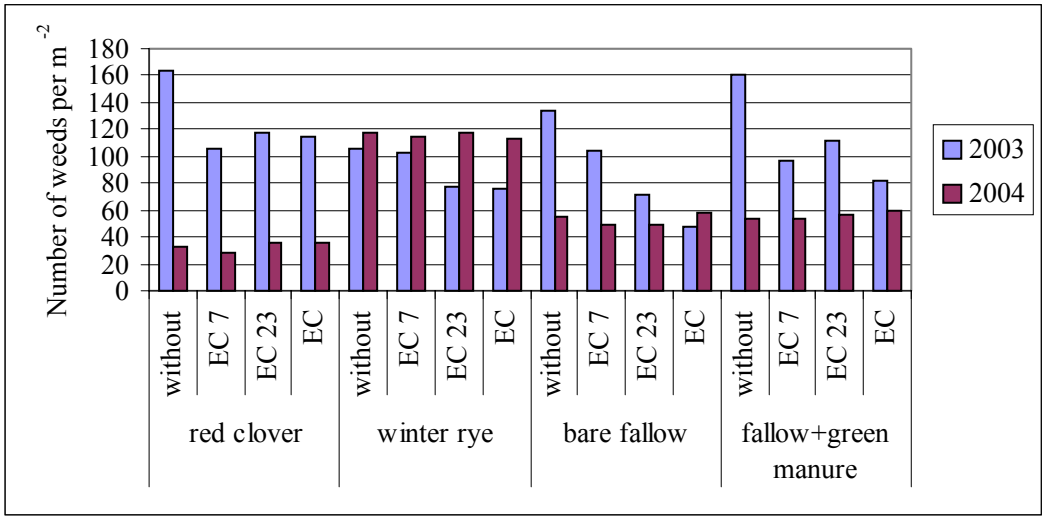


Fig 4. The number of annual weeds at the stage of earing, depending on pre-crop and harrowing variant and with use of stable manure 60 t $ha^{-1}$, during 2003 – 2004.

The number of annual weeds at the stage of earing differed during the years (p-value < 0.05). In 2003, in sowings 50 – 160 annual weeds per $m^2$ were established, but in 2004 the number of annual weeds was significantly lower – only 33 – 118 annual weeds per $m^2$.

The influence of stable manure on the number of annual weeds was significant during the testing year (p-value < 0.05). A significantly higher number of annual weeds was ascertained in variants with stable manure on average 104 weeds per $m^2$ in 2003 and 64 weeds per $m^2$ in 2004).

The influence of pre-plants on the number of annual weeds was different during testing years (p-value < 0.05). In 2003, the previous plant did not influence the total number of weeds if spring barley was grown without stable manure. After use of stable manure the number of weeds increased significantly when barley was grown after red clover (on average + 65 weeds $m^2$) and after winter rye for green manure (+ 39 weeds $m^2$).

In 2004, in barley after bare fallow and bare fallow + green manure, the number of annual weeds was similar – 49 – 50 weeds per $m^2$. A significantly higher number of annual weeds was ascertained in barley after winter rye – 109 weeds per $m^2$. In barley after bare fallow, the number of annual weeds was low – 32 weeds per $m^2$.

The influence of harrowing on annual weeds was different during the testing years (p-value < 0.05).

In 2003, harrowing significantly decreased the number of weeds after all previous plants. After bare fallow without stable manure, double harrowing decreased the number of weeds significantly but only in variants without harrowing. In variants with stable manure, harrowing decreased

the number of weeds significantly at the stage of tillering (EC 23) and if barley was harrowed twice before germination (EC 7) and at the stage of tillering (EC 23). After winter rye for green manure, the time of harrowing had no influence on the number of weeds. After winter rye without stable manure harrowing at the stage of tillering and double harrowing decreased the number of weeds, but in variants with stable manure the time of harrowing did not influence the number of weeds.

In 2003, the harrowing decreased the number of *Chenopodium album* L. significantly, but the time of harrowing influenced the number of *Chenopodium album L.* insignificantly.

In 2004, harrowing did not significantly decrease the number of weeds. At the time of second harrowing (at the stage of tillering, (EC 23)) there was high amount of precipitation and harrowing only loosened the soil but did not kill the weeds. Excess precipitation and warm weather at the stage of tillering favoured fast development of barley and suppression of weeds.

The data in figure 5 shows that the influence of harrowing on the grain yield was negligible both years. In 2003, the pre-plants and use of stable manure influenced the grain yield similarly. In 2004, the main factor, which influenced grain yields, was pre-crops.

Depending on the variants, the yields in the field trial varied from 1.56 to 3.85 t $ha^{-1}$ (Fig. 6).

The influence of stable manure on spring barley yield was significant (p-value < 0.0001). Grain yields increased by 0.47–0.99 t $ha^{-1}$ (2003) and 0.33–0.87 t $ha^{-1}$ (2004) on average. Use of stable manure for barley after winter rye provided the highest yield increase on average by 0.92 t $ha^{-1}$ during 2003–2004.

The influence of previous plants on spring barley yield was significant (p-value < 0.0001) and differed during years (p-value <0.0001). In 2003, the highest yields were

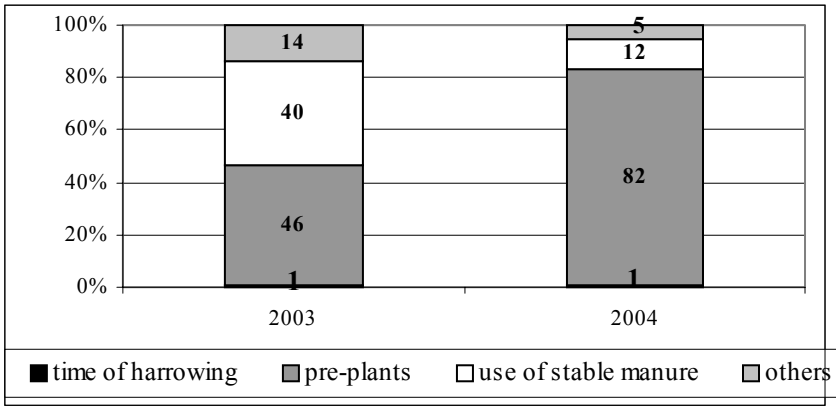


Fig 5. The effects of pre-plants, use of stable manure and time of harrowing on the grain yield of spring barley 'Sencis' during 2003–2004,h %.

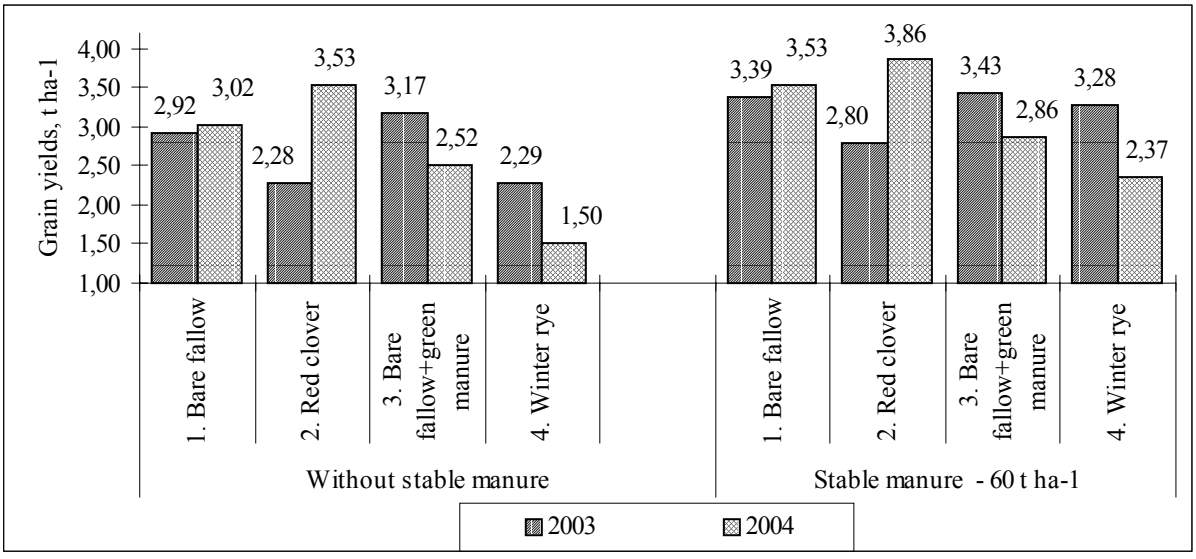


Fig. 6. The grain yield of spring barley 'Sencis' depending on the use of stable manure and pre-plants.

obtained after winter rye for green manure and after bare fallow in both variants, with stable manure and without it.

In 2004, the highest yields were obtained after red clover and bare fallow in both variants, with stable manure and without it.

Harrowing increased the grain yields significantly only after winter rye for green manure with stable manure, whereas time of harrowing had no significant influence on the grain yield.

In 2003, the number of annual weeds had a positive strong and statistically significant correlation with the spring barley grain yield only after red clover without stable manure (r = 0.86).

In 2004, there was a strong negative correlation between the number of annual weeds and spring barley grain yield (r= –0.84) only after winter rye in variants without stable manure (equation of relationship y = –0.0281x + +4.5765, $R^2$ =0.71) and in variants with stable manure after bare fallow + green manure (r= –0.83, equation of relationship y = –0.0733 x + 6.9057, $R^2$ = 0.69).

## Conclusions

1. In spring barley, 18 species of weeds were established at the stage of earing during 2003–2004. The most widespread of perennial weeds were *Elytrigia repens* (L.) Nevski and *Sonchus arvense* L.

2. The dominant annual weeds were *Chenopodium album* L, *Stellaria media* L., *Capsella bursa-pastoris* L., *Polygonum* spp., and *Matricaria inodorum* L. The number of annual weeds at the stage of earing differed during the years 50–160 (in 2003) and 33-118 (in 2004) annual weeds per $m^2$.

3. The influence of harrowing on the number of annual weeds was different during the testing years. In 2003, harrowing significantly decreased the number of weeds after all pre-plants. In 2004, harrowing did not significantly influence the number of weeds.

4. The influence of harrowing on the grain yield was negligible during 2003 and 2004. In 2003, harrowing increased the grain yields significantly only after winter rye for green manure with stable manure, whereas time of harrowing had no significant influence on the grain yield.

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