THE EFFECT OF SOIL TILLAGE, SOWING TECHNOLOGY AND HERBICIDE APPLICATION ON WEED INFESTATION IN SPRING BARLEY

Dainis Lapinš, Andris Bērziņš, Jānis Kopmanis, Renāte Sanžarevska
Latvia University of Agriculture, Department of Soil Management, e-mail: lapins@cs.llu.lv

Abstract
Field trials were carried out at the Research and Study farm (RSF) “Vecauce” of the Latvia University of Agriculture (LLU) during 2002–2003. The effect of soil deep loosening, sowing technology and weed control on the yield of spring barley was studied on sod podzolic (2002) and sod carbonate leached (2003) loam soils with humus content 14 g kg⁻¹ (2002) and 20 g kg⁻¹ (2003), soil reaction pHKC₃ 6.0 and 6.6, content of phosphorus 204 and 207 mg kg⁻¹, content of potassium 96 and 105 mg kg⁻¹, respectively. Spring barley was grown in recurrent sowing. Following treatments were investigated in the trial: Factor A — usage of herbicide Glifoss in autumn in treatments with direct sowing (done before the trial year): A₁ — without Glifoss (untreated); A₂ — Glifoss 0.5 L ha⁻¹; A₃ — Glifoss 2.0 L ha⁻¹; A₄ — soil ploughing at the depth of 18–22 cm; Factor B — sowing technologies: B₁ — using a disc driller and local deposition of mineral fertilizers (except ammonium fertilizers) (“Rapid 400 C”, hereafter “Rapid”); B₂ — using an anchor-type driller with a rototiller at the depth of 5–7 cm and dispersion of mineral fertilizers before sowing (“Amazone AD-403 super”, hereafter “Amazone h1”); B₃ — using an anchor-type driller with a rototiller at the depth 7–10 cm and dispersion of mineral fertilizers before sowing (“Amazone AD-403 super”, hereafter “Amazone h2”).

Diverse meteorological conditions in the trial years had determinative importance to the effect of soil tillage, application of Glifoss and sowing technologies on weed infestation in sowings and growth and development of spring barley. Significant decrease in the number of annual weeds was observed by increasing the depth of the rototiller from 5–7 cm to 7–10 cm using sowing machine “Amazone AD-403 super”. A significant negative effect on the growth and development of spring barley was caused by increased number of Elytrigia repens (L.) Desv. ex Nevski. The negative effect of weed infestation with annual weeds on the growth and development of spring barley was not significant.

Key words: spring barley, soil tillage, sowing, herbicide application.

Introduction
Direct sowing of spring barley or minimal soil tillage becomes a very popular method worldwide. Such sowing technology allows economizing resources hereto not decreasing yields of cereals. This fact has also been approved in earlier researches made by the scientists of the Department of Soil management of the Latvia University of Agriculture (LLU) (Lapins et al., 2000; 2001). Similar researches have been made in Lithuania (Maikštienė, 2000; Stancevičius et al., 2000) and Estonia (Lauringson et al., 2001). Earlier researches have shown that one of the yield’s limiting factors is increased numbers of annual and perennial weeds, especially Elytrigia repens (L.) Desv. ex Nevski when direct sowing is used.

The aim of this work is to evaluate the effect of soil tillage, herbicide application and sowing technology on the yield of spring barley and weed infestation in sowings.

Materials and Methods
Field trials were carried out at the Research and Study farm (RSF) “Vecauce” of the Latvia University of Agriculture (LLU) during the years 2002 and 2003. The effect of soil deep loosening, sowing technology and weed control on the yield of spring barley was studied on sod podzolic (2002) and sod carbonate leached (2003) loam soils with humus content 14 g kg⁻¹ (2002) and 20 g kg⁻¹ (2003), soil reaction pHKC₃ 6.0 and 6.6, content of phosphorus 204 and 207 mg kg⁻¹, content of potassium 96 and 105 mg kg⁻¹, respectively. Spring barley was grown in recurrent sowing. Following treatments were investigated in the trial: Factor A — usage of herbicide Glifoss in autumn in treatments with direct sowing (done before the trial year): A₁ — without Glifoss (untreated); A₂ — Glifoss 0.5 L ha⁻¹; A₃ — Glifoss 2.0 L ha⁻¹; A₄ — soil ploughing at the depth of 18–22 cm;

Factor B — sowing technologies: B₁ — using a disc driller and local deposition of mineral fertilizers (except ammonium fertilizers) (“Rapid 400 C”, hereafter “Rapid”); B₂ — using an anchor-type driller with a rototiller at the depth of 5–7 cm and dispersion of mineral fertilizers before sowing (“Amazone AD-403 super”, hereafter “Amazone h1”); B₃ — using an anchor-type driller with a rototiller at the depth of 7–10 cm and dispersion of mineral fertilizers before sowing (“Amazone AD-403 super”, hereafter “Amazone h2”).
Fig. 1. Amount of precipitation, LLU RSF “Vecauce”, 2002—2003, mm

**Characterization of meteorological conditions**

There was a lack of precipitation from the second decade of April till the second decade of May in both trial years (Fig. 1). Very dry weather was in 2002 when from the third decade of July till the end of October total amount of precipitation was less than 40 mm. Differences in the average air temperature were not so remarkable. Particularly dry weather in the autumn of 2002 was complemented by rapid decrease in temperature — from 12 °C in the second decade of September to 2 °C in the second decade of October (Fig. 2).

Fig. 2. Average air temperature, LLU RSF “Vecauce”, 2002—2003, °C

**Spring barley growing technologies**

Soil was ploughed by Overum-6 DVL combined with Pakomat DK-205-335 CM. Herbicide Glifoss was applied on 06.09.2001. and 19.09.2002. Spring barley cv. Klinta was sown on 22.04.2002. and 02.05.2003. Sowing rate was 400 fertile seeds per m². Mineral fertilizers N_pK_30 300 kg ha⁻¹ and NH_4NO_3 150 kg ha⁻¹ (2002) were used, but in year 2003 — N_pK_30 300 kg ha⁻¹ and NH_4NO_3 200 kg ha⁻¹. Pneumatic diffuser “Amazone” dispersed mineral fertilizers. Herbicide Duplozans super 2 L ha⁻¹ was applied on 23.05.2002., but in 2003 mixture Granstars 10 g ha⁻¹ + Primuss 60 ml ha⁻¹ + Kontaks (adjuvant) 100 ml per 100 L water (28.05.2003.) was used. Insecticide Fastaks 0.15 L ha⁻¹ was used in 2002 because of serious infestation of aphids.

Dry weight of shoot of spring barley was determined for 30 plants from each treatment. The number and length of lateral roots and coefficient of tillering were determined for 25 plants from each treatment. Weed assessment was done two times in the growing season using a 0.1 m² big frame.

The yield was harvested with trial harvester “Hege-140”, adjusted to 14% moisture content and 100% purity. Data analysis was done using three factor analyses of variance.
Results and Discussion

Results in year 2002 show that a significant increase in the number of annual weeds was observed in the treatment with sowing after ploughing. Such results are obtained in both weed assessments — at the beginning and at the end of spring barley life cycle (Fig. 3). In the treatment where the disc-sowing machine was used, the number of annual weeds was smaller than in treatments with the anchor-type driller with a rotortiller after intensive soil tillage. Data show that in treatments with a greater number of annual weeds in early growth stages of spring barley before herbicide application, the number of annual weeds will be greater also in late stages. This coherence is verified by the coefficient of correlation between the numbers of annual weeds in both growth stages of spring barley ($r_{xy} = 0.677 > r_{0.05} = 0.231$).

Fig. 3. The number of annual weeds in spring barley, 2002

Usage of glyphosate in the stubble-field provided a smaller number of annual weeds in 2002 at spring barley 1—2 leaf stage. There are no significant differences between the applied dosages of Glifoss — both provided similar efficiency. Increased depths of the rotortiller for sowing machine “Amazone” made significant decrease in the number of annual weeds in the treatment with direct sowing after applying Glifoss at the dosage of 0.5 L ha$^{-1}$ (Fig. 4).

Fig. 4. The number of annual weeds at spring barley 1—2 leaf stage, 2002

There were no significant differences in the number of annual weeds among treatments with direct sowing before harvesting in 2002.

Usage of the disc sowing machine and anchor-type driller with the rotortiller at deeper working depths in direct sowing provided a significant decrease in the number of *Elytrigia repens* (L.) Desv. ex Nevski at spring barley.
1—2 leaf stage. In treatments with autumn ploughing, the average number of *Elytrigia repens* (L.) Desv. ex Nevski was below one plant per square meter. Even a small number of *Elytrigia repens* (L.) Desv. ex Nevski in treatments with usage of glyphosate made a significant increase of this weed during the growing season. The same increase was observed in treatments with autumn ploughing (Fig. 5).

Fig. 5. The number of *Elytrigia repens* (L.) Desv. ex Nevski. in spring barley, 2002

Analyses of correlation allow concluding that only number of *Elytrigia repens* (L.) Desv. ex Nevski at spring barley 1—2 leaf stage made a significant negative impact on the development and yield of spring barley in 2002. The number of annual weeds at spring barley 1—2 leaf stage had positive correlation with indicators of spring barley development but relationship with the spring barley grain yield was insignificant (Table 1). There was a significant negative correlation between the numbers of *Elytrigia repens* (L.) Desv. ex Nevski at both barley growth stages and the grain yield.

Table 1

<table>
<thead>
<tr>
<th>Resultant indications ($j$)</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of annual weeds at spring barley 1-2 leaf stage ($x$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of spring barley roots at tillering stage</td>
<td>0.4834 *</td>
<td>0.2416 *</td>
</tr>
<tr>
<td>Weight of spring barley roots at tillering stage</td>
<td>0.3992 *</td>
<td>0.2596 *</td>
</tr>
<tr>
<td>Weight of spring barley plant at tillering stage</td>
<td>0.3992 *</td>
<td>0.2486 *</td>
</tr>
<tr>
<td>Spring barley grain yield</td>
<td>0.2679 *</td>
<td>−0.1657</td>
</tr>
</tbody>
</table>

| **Number of *Elytrigia repens* (L.) Desv. ex Nevski at spring barley 1-2 leaf stage ($x$)** | | |
| Length of spring barley roots at tillering stage | −0.4962 * | 0.2046 |
| Weight of spring barley roots at tillering stage | −0.3919 * | −0.0781 |
| Weight of spring barley plant at tillering stage | −0.4000 * | −0.0073 |
| Spring barley grain yield | −0.6440 * | −0.2344 * |

| **Number of annual weeds before harvesting ($x$)** | | |
| Spring barley grain yield | 0.05189 | −0.3589 * |

Number of *Elytrigia repens* (L.) Desv. ex Nevski before harvesting ($x$)

| **Spring barley grain yield** | | |
| Number of *Elytrigia repens* (L.) Desv. ex Nevski before harvesting ($x$) | | |
| Spring barley grain yield | −0.5250 * | −0.6482 * |

$r_{0.05}$

| 0.231 | 0.231 |

* correlation coefficient significant at 95% probability.

The number of annual weeds before harvesting in 2002 was very small because of lack of precipitation, therefore correlation with spring barley grain yield was insignificant. Relationship between the number of *Elytrigia repens* (L.) Desv. ex Nevski at spring barley 1—2 leaf stage and before harvesting is also described by the results of analyses of regression (Figs. 6 and 7). In both cases, equations of linear regression are statistically significant.
Ecological approach of modern weed control systems

Comparison of the coefficients of linear regression from the relationships between the number of *Elytrigia repens* (L.) Desv. ex Nevski before harvesting and the grain yield in 2002 and 2003 shows that the noxious effect of *Elytrigia repens* (L.) Desv. ex Nevski was significantly higher in 2003 (Figs. 7 and 8). Linear relationship between the number of *Elytrigia repens* (L.) Desv. ex Nevski before harvesting and the grain yield in 2003 was also statistically significant.
Fig. 8. Relationship between the number of *Elytrigia repens* (L.) Desv. ex Nevski. before harvesting and the spring barley grain yield, 2003

A considerably lower but also a significant negative effect on spring barley grain yield was determined for the number of annual weeds before harvesting in year 2003. Comparison of the results of analyses of regression between both trial years shows that the noxious effect of weed infestation in sowings increases at higher levels of grain yield.

Fig. 9. Relationship between the number of annual weeds before harvesting and the spring barley grain yield, 2003

A significant negative effect of annual weeds on the development and grain yield of spring barley was determined only before harvesting in 2003. Treatments with application of Glifoss at dosage of 2.0 L ha⁻¹ and sowing after autumn ploughing show better results. A significantly higher number of annual weeds was observed in treatments where sowing was done with the anchor type driller ("Amzone") with a rotortiller at the lowest working depth (5—7 cm) (Fig. 10).
Increasing the depth of the rototiller for drillers “Amazone” from 5—7 cm to 7—10 cm provided a significant decrease in the number of annual weeds in sowings of spring barley.

Conclusions
Diverse meteorological conditions in the trial years had determinative importance to the effect of soil tillage, application of Glifoss and sowing technologies on weed infestation in sowings and growth and development of spring barley.

Significant decrease in the number of annual weeds was observed by increasing the depth of the rototiller from 5—7 cm to 7—10 cm using sowing machine “Amazone AD-403 super”.

A significant negative effect on the growth and development of spring barley was caused by increased number of Elytrigia repens (L.) Desv. ex Nevski. This regularity was determined both at barley 1—2 leaf growth stage and before harvesting.

The negative effect of sowing infestation with annual weeds on the growth and development of spring barley was not significant at barley 1—2 leaf stage. The effect of weed infestation before harvesting differs between the trial years.

An increased number of annual weeds at barley 1—2 leaf stage also caused greater weed infestation before harvesting.

References