tīrsējā sētai austrumu galegai un sējas lucernai. Sētie tauriņzieži zelmenī saglabājās labi. Piektajā izmantošanas gadā tie veidoja 73-93 % no sausnas ražas. Auzeņairene bija palikusi tikai 1-2 %. Kad zelmenis tika pļauts divas vai trīs reizes, tika saražota līdzīga zaļmasas raža. Pļaujot biežāk, zelmenis izretinājās vairāk un bija novērojama lielāka nezāļu invāzija, no kurām dominēja *Taraxacum officinale*. Visjutīgāk uz biežāku pļaušanu reaģēja sējas lucerna.

OPTIMIZATION OF SOIL TILLAGE AND WEED CONTROL IN WINTER WHEAT

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Abstract
Weed infestation in cereals is still one of the problems for growers despite of many tools and possible methods both chemical and non-chemical to control them. This article describes the results obtained in three years experiments (2001 – 2003) carried out at farm Dobele Agra SIA located in Dobele region of Latvia. Trials established in two different crop rotations (Factor A): 1. winter wheat sown after winter wheat, 2. winter wheat sown after winter rape. Three different soil tillage and sowing methods compared (Factor B): 1. – minimal conservation soil tillage in 10 – 15 cm deep with mixing of soil, 2. – direct sowing into stubble without any soil cultivation before, 3. – traditional soil tillage with ploughing on 25 cm with cultivation before sowing. Additionally the impact of those soil tillage methods on weed infestation in winter wheat was compared (Factor C): 1. - used herbicide Secator 0.3 kg ha^{-1}, 2. – without herbicide treatment. A significantly smaller total number of weeds were observed in treatments where winter wheat was grown in recurrent sowing. Mainly it was caused by differences in number of oil seed rape plants in this treatment. Also significantly smaller number of weeds was observed after traditional soil tillage with ploughing. The data analysis show a significant linear negative correlation between winter wheat yield and the amount of total weed infestation in several weed species - *Stellaria media* (L.) Vill., *Sinapis arvensis* L., *Matricaria perforata* Merat. and *Lamium purpureum* L. The highest impact to changes of winter wheat grain yield was made from herbicide use – 64.1 %.

Key words: winter wheat, minimal soil tillage, direct drilling, ploughing, weed infestation

Introduction
Conventional ploughing at the depth of 22 – 24 cm is expensive and labour – consuming work. In the world's soil tillage practice attempts have been made to replace ploughing by subsurface cultivation, rototilling, and chisel ploughing as well as reduced depth of ploughing (Rubenis et al., 1995). A big profit from reduced soil tillage is saving resources and working time. In the Rot Amsted research farm (U.K.) it was found that growing cereals working time can decrease two times using reduced tillage methods but using direct sowing – 3 – 4 times (Cannel, 1985).

Methods
The three years experiments (2001 – 2003) were carried out at farm Dobele Agra SIA located in The Dobele region of Latvia. The soil there is sod podzolic loam soil. Trials established in two different crop rotations (Factor A): 1. winter wheat sown after winter wheat, 2. winter wheat sown after winter rape. Three different soil tillage and sowing methods compared (Factor B): 1. – minimal conservation soil tillage in 10 – 15 cm deep with mixing of soil, 2. – direct sowing into stubble without any soil cultivation before, 3. – traditional soil tillage with ploughing on 25 cm with cultivation before sowing. Additionally compared impact of those soil tillage methods on weed infestation in winter wheat (Factor C): 1. - used herbicide Secator 0.3 kg ha^{-1}, 2. – without herbicide treatment.
The winter wheat variety 'Zentos' sown on 25.09.2000., 29.09.2001. and 30.09.2002 with pneumatical seed driller Vaderstad Rapid 600P. Soil ploughing was done with 6 furrow conventional plough Kwerneland, cultivation done with equipment Vaderstad Rexius. Minimal soil

tillage was carried out with heavy disc harrows Simba Discs 34C 4.6 together with press Simba double press 4.6. Herbicide Secator with rate 0.3 kg ha^{-1} were used during the tillering stage of winter wheat. Yield was harvested with Claas combine harvester.

There were variable weather conditions with large differences from long time averages during the experiments. That caused large differences in the results between three years with different impact of various factors.

Autumn 2000 were long and warm with a significant amount of precipitations. Those conditions were favourable for the active growth and development of crops and weeds. In the variant where winter wheat were sown after winter rape using minimal soil tillage and direct sowing, there was a significant invasion of winter safety weeds like *Matricaria perforata* Merat. Those conditions effected the growth and the development of the winter wheat because of high weed competitiveness. In the spring, those weeds were already big in size and the effectiveness of herbicide was low. Also a high amount of precipitations during June and July of 2001 (115 un 118 mm, SIA Dobele Agra weather station data) caused additionally active growth of weeds and that factor affected the productivity of winter wheat yield results. The trials of second year were established under conditions with high soil moisture, caused by high amount of precipitations during the summer 2001 (309 mm, SIA Dobele Agra weather station data). Those conditions were not favourable for quality of soil tillage work, in comparison with the previous year. Winter wheat crop growth and development were different from previous year. Spring 2002 was favourable for winter wheat crop growth and development, but the summer months were sunny and very dry (June 37 mm, July 30 mm, August 0 mm, Dobele Agra weather station data). In those conditions efficiency of herbicides were high in variants, where was used traditional soil cultivation with ploughing. The third year experiments were established under very dry soil conditions, caused by the dry summer 2002. There was drought period of 60 days. Under such conditions there were difficulties to do qualitative direct sowing. Cold winter with a big amplitude of temperatures negatively effected winter hardiness of the winter wheat. Hot temperatures in July and heavy rainfalls in August effected harvesting results. Those variables in the whether conditions gave wide experience of using of different soil tillage methods in different weather and soil conditions.

Three factor ANOVA, correlation and regression analysis were used for data analyse.

Results

The averages of the three years results shows significantly highest received yields of winter wheat grown in crop rotation after winter rape (1st wheat). Herbicide use in both cases of crop rotation gave significant yield increases comparde with untreated case (Fig. 1).

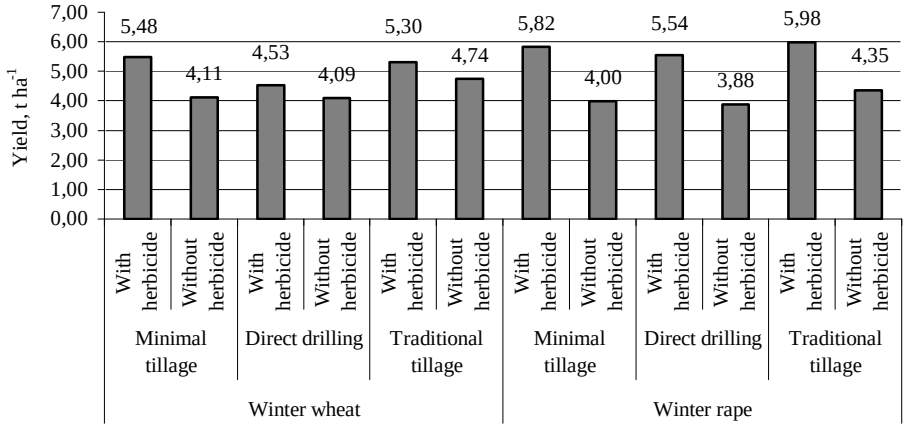

Figure 1. The yield of winter wheat depending on soil tillage and weed control technologies in the years 2001-2003: $\gamma^{A}_{0.05} = 0.130$; $\gamma^{B}_{0.05} = 0.159$; $\gamma^{C}_{0.05} = 0.130$

In trials of 2nd wheat (wheat after wheat in crop rotation) together with herbicide use the highest yield was in variant with minimal soil tillage, which was significantly higher than yield in variants with direct drilling and traditional soil tillage.

Highest winter wheat yield in variants where herbicide was not used in case of traditional soil tillage. Yield differences with minimal tillage and direct drilling were lower than critical difference.

The highest yield of 1st wheat together with herbicide use was in the variant with traditional soil tillage, which was significantly higher than yield in the rest of the variants. The same tendencies were in the variants without herbicide use. The lowest winter wheat yield was in the variants where used direct drilling. In case of herbicide use it was significantly lower, in the case without herbicide – not significantly.

When comparing the influence of different factors on the yield of winter wheat (Fig. 2) we show that the highest impact was from herbicide use – 64.1 %.

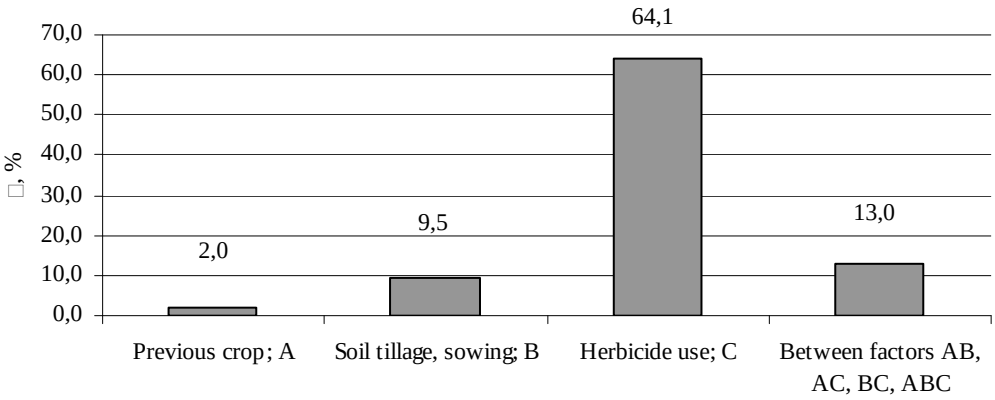

Figure 2. Impact of different factors on winter wheat yield, average 2001-2003

The impact from soil tillage was 9.5 %, but from previous crops just 2.0 %. This indicates the demand of use of different weed control methods and technologies when using different soil tillage technologies. The noxious effect of weeds has the main impact on formation of winter wheat yield. The previous statement certifies strong correlation between number of weeds per m^2 and winter wheat grain yield (Fig. 3).

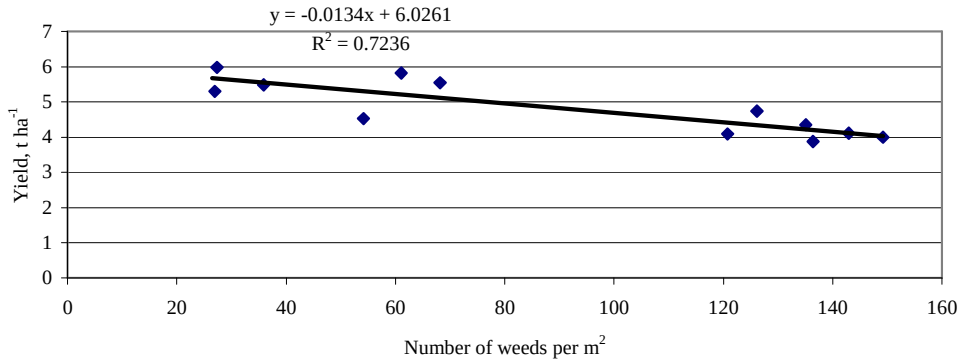

Figure 3. Coherence between the number of weeds per m^2 and the winter wheat yield, average 2001-2003

Analysing the impact of different factors to separate weed species we find that herbicide application has a significant effect against all dominant species. An especially high impact was observed for total weed infestation in winter wheat – 80.8 % (Table 1). The distribution of oil seed rape as weed mainly was affected by the previous crop.

Table 1 Impact of different factors to changes of the number of some weed species (average 2001-2003), η %

Weed species	Factors						
	Previous crop (A)	Soil tillage (B)	Herbicide application (C)	Interaction between factors			
				AB	AC	BC	ABC
Oil seed rape	37.7	10.3	6.5	11.5	3.0	0.5*	1.0*
Stellaria media (L.) Vill.	2.3	0.3*	41.7	1.9*	0.8*	2.5*	0.7*
Sinapis arvensis L.	0.0*	3.4	59.4	0.4*	0.1*	3.8	1.9
Galium aparine L.	0.2*	0.2*	34.2	2.7*	1.6*	4.9	0.1*
Matricaria perforata Merat.	0.3*	5.5	34.5	1.4*	0.5*	3.2	1.7*
Lamium purpureum L.	0.0*	1.5*	51.8	0.7*	0.4*	1.6*	2.3*
Others	0.0*	5.1	41.0	2.3*	0.5*	5.5	1.3*
All weed species	1.4	2.7	80.8	0.3*	0.0*	2.5	0.3*

*-impact is not significant at 95 % probability level

We will exclude herbicide application as factor in the next calculation because it has the main affect on changes in the weed flora. Soil tillage has shown a higher impact on weed infestation in winter wheat compared to previous crop. Such coherence was observed for the total number of weeds and for *Sinapis arvensis* L., *Matricaria perforata* Merat. and other weed species what were observed in the trial. Soil tillage had a higher effect to changes of the number of *Galium aparine* L. and *Lamium purpureum* L. compared to the effect of the previous crop, but this impact was insignificant at the 95 % probability level (Table 2).

Table 2 Impact of previous crop and soil tillage to thr number of weeds per m^2 (average 2001-2003), η %

Weed species	Previous crop (A)	Soil tillage (B)	Interaction (AB)
Oil seed rape	49.9	13.7	15.2
Stellaria media (L.) Vill.	7.1	1.1*	6.1*
Sinapis arvensis L.	0.0*	19.1	2.2*
Galium aparine L.	0.4*	0.6*	7.9*
Matricaria perforata Merat.	0.7*	11.8	3.1*
Lamium purpureum L.	0.1*	7.6*	3.7*
Others	0.0*	16.9	7.6*
All weed species	11.7	22.7	2.1*

*-impact is not significant at 95 % probability level

A significantly smaller total number of weeds was observed in treatments where winter wheat was grown in recurrent sowing. Mainly it was caused by differences in the number of oil seed rape plants in these treatments – many rape seed were left on the surface of the soil in treatments with reduced soil tillage after winter rape. That mainly caused significant differences between soil tillage treatments – significant smaller number of weeds was after the traditional soil tillage with ploughing. Previous crop had significant impact to number of *Stellaria media* (L.) Will. also. A smaller amount of this weed was observed in treatments after winter rape (Table 3).

Data analysis show a significant linear negative correlation between winter wheat yield and the number of some weed species. There are no significant differences for coefficient b_1 among separate weed species and total weed infestation. Coefficient b_0 are significantly smaller for the total number of weeds at 95 % confidence level. That means the slope describing this coherence is more flat than others and weed species what had an insignificant correlation with winter wheat grain yield.

Table 3. Number of some weed species, p m^{-2} (average 2001-2003)

Previous Crop (A)	Soil tillage, sowing (B)	Oil seed rape	*Stellaria media* (L.) Vill.	*Sinapis arvensis* L.	*Galium aparine* L.	*Matricaria perforata* Merat.	*Lamium purpureum* L.	Others	Total
Winter wheat (A1)	Minimal tillage (B1)	0.93	13.27	15.53	8.80	11.33	17.73	16.27	89.40
	Direct drilling (B2)	1.20	16.80	9.53	9.93	13.27	16.40	11.72	87.45
	Traditional tillage (B3)	1.53	16.20	10.78	12.77	9.33	12.27	8.80	76.55
	Average, A1	1.22	15.42	11.95	10.50	11.31	15.47	12.26	84.47
Winter rape (A2)	Minimal tillage (B1)	21.60	13.60	14.07	11.20	9.40	15.87	13.00	105.13
	Direct drilling (B2)	22.60	8.53	9.47	9.73	17.33	16.33	12.00	102.27
	Traditional tillage (B3)	4.87	12.73	12.87	8.67	10.73	15.07	11.53	81.20
	Average, A2	16.36	11.62	12.13	9.87	12.49	15.76	12.18	96.20
Average, B1		11.27	13.43	14.80	10.00	10.37	16.80	14.63	97.27
Average, B2		11.90	12.67	9.50	9.83	15.30	16.37	11.86	94.86
Average, B3		3.20	14.47	11.83	10.72	10.03	13.67	10.17	78.88
$\gamma^{A}_{0.05}$		2.691	3.607	2.402	2.482	3.506	2.578	2.121	7.456
$\gamma^{B}_{0.05}$		3.296	4.418	2.942	3.039	4.294	3.158	2.598	9.132

Equations describing significant coherences between winter wheat yield and separate weed species are the same at 95 % confidence level (Table 4).

Table 4. Equations of regression between winter wheat yield and number of some weed species

Weed species	$y = b_0x + b_1$	b_0 95 % confidence interval		b_1 95 % confidence interval	
		Upper limit	Lower limit	Upper limit	Lower limit
Stellaria media (L.) Vill.	y = -0.0634x + 5.676	-0.0267	-0.1002	6.2719	5.0802
Sinapis arvensis L.	y = -0.06 x + 5.5409	-0.0277	-0.0923	6.0410	5.0407
Matricaria perforata Merat.	y = -0.0813x + 5.785	-0.0353	-0.1273	6.4213	5.1492
Lamium purpureum L.	y = -0.067x + 5.865	-0.0303	-0.1038	6.5205	5.2093
All weed species	y = -0.0134x + 6.026	-0.0076	-0.0192	6.6182	5.4341

Conclusions

A significantly smaller total number of weeds was observed in treatments where winter wheat was grown in recurrent sowing.

A significantly smaller number of weeds was observed after traditional soil tillage with ploughing.

The data analysis show significant linear negative correlation between winter wheat yield and the number of total weed infestation and several weed species - *Stellaria media* (L.) Vill., *Sinapis arvensis* L., *Matricaria perforata* Merat. and *Lamium purpureum* L.

The highest impact to changes of winter wheat grain yield made herbicide use – 64.1 %.

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AUGSNES APSTRĀDES UN NEZĀĻU KONTROLES OPTIMIZĀCIJA ZIEMAS KVIEŠOS

Stašinskis Ē.

Neraugoties uz daudzām iespējām nezāļu ierobežošanā, to invāzija vēl joprojām ir liela problēma. Rakstā atspoguļoti trīs gadu (2001.-2003.) izmēģinājumu, kuri veikti Dobeles SIA Agra laukos, rezultāti. Izmēģinājumi iekārtoti divās atšķirīgās augu sekās (faktors A): 1) ziemas kvieši sēti pēc ziemas kviešiem, 2) ziemas kvieši sēti pēc ziemas rapša. Tika salīdzinātas trīs augsnes apstrādes un sējas metodes (faktors B): 1) minimālā augsnes apstrāde 10-15 cm dziļi ar augsnes sajaušanu, 2) tiešā sēja rugainē bez augsnes iepriekšējas apstrādes, 3) tradicionālā augsnes apstrāde ar aršanu 25 cm. Papildus tika pētīta šo paņēmienu ietekme uz nezāļainību ziemas kviešos (faktors C): 1) ar herbicīda lietošanu, 2) bez herbicīda lietošanas.
Būtiski mazāks nezāļu daudzums tika konstatēts variantos ar atkārtotu kviešu augšanu un pēc tradicionālās augsnes apstrādes. Datu analīze uzrāda būtisku negatīvu lineāru korelāciju starp ziemas kviešu ražu un kopējo nezāļainību un atsevišķām nezāļu sugām- *Stellaria media* (L.) Vill., *Sinapis arvensis* L., *Matricaria perforata* Merat. un *Lamium purpureum* L.

PHYSIOLOGICAL ASPECTS OF THE WHEAT YIELD OBTAINED FROM SEEDS TREATED WITH PHOSPHORUS

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Abstract
The Germination of the spring wheat 'Triso' seeds treated with phosphorus and the seeds of their next generation were investigated during the vegetation experiments. The germination process of seeds treated with phosphorus decreased compared to the control seeds. The concentration of chlorophyll increased in the first leave of shoots from seeds treated with phosphorus. In the next generation of seeds treated with phosphorus, a positive post-effect on the germination quality (germination dynamics, germination energy) and the concentration of chlorophyll in the leaves was observed.) The field experiments were carried out with spring wheat 'Triso' seeds treated with phosphorus, using various fertiliser applications. The grain yield, obtained from seeds treated with phosphorus, using various fertiliser applications, increased by 2.6-102 per cent. The vegetation