INVESTIGATION OF TECHNOLOGICAL PROCESSES OF WINTER WHEAT SOWING IN DIFFERENT AGRICULTURAL SYSTEMS

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Abstract. In 2005 – 2006 the trials of technological processes of winter wheat sowing using different agricultural systems were carried out in Padovinys agricultural community Marijampole region and in the farm of Egidijus Palaima in Ustukiai village Pasvalys region. The research objective was to test the introduction of the winter wheat seeds with the disk coulters in the hard clay ploughed and unploughed soils of various regions. Having in mind erratic meteorological weather conditions the influence of different soil tillage technologies and sowing techniques was tested during the trials as well as the seed introduction depth and germination indices. The indices of seed bed preparation and seed introduction were defined by the method proposed by Sweden scientists Kritz/Hakannson that estimated the evenness of the soil tillage and seed introduction depth, the composition of the soil lumps and moisture content of the soil above the seeds, below then and at the depth of the seed introduction.

The trials enabled to conclude that if you need to introduce the winter wheat seeds with disk coulters of the seeder into the hard clay loam untilled soil the harvest residue from the soil surface should be evenly introduced into the soil before sowing. When the influence of the various agricultural systems on the indices of seed introduction and germination has been estimated the conclusion was made that this influence is insignificant. Meteorological climate conditions, soil characteristics and other criteria have greater impact. In the soil with insufficient moisture content (< 3%) it becomes hard, the structure of big clods form, thus the seeder coulters cannot always form the due seedbed and to evenly introduce the seeds.

Key words: winter wheat, soil tillage, sowing, seedbed, seed germination ability.

Introduction

Europe quickly introduces the non-tillage sowing technologies. The main advantages of these technologies are the smaller expenditures of fuel and working hours, less soil compression, better soil structure, and smaller soil erosion, etc. [1, 2, 3]. Prof. F. Tebrugge [2] trials show that fuel consumption during soil tillage and sowing when the soil is not tilled might be less from 2 to 6 times if compared with the sowing into tilled and cultivated or otherwise prepared soil. The smaller number of soil preparation operations before the sowing during favourable weather conditions enable to sow the plants earlier in spring. The longer vegetation time of the plants may by 10 – 20% increase the yield [1]. German scientists noticed that when the soil is ploughed and later on hoed by various soil preparation implements and sowing afterwards the tractor wheels compress from 90 to 95% of the soil surface. In minimally tilled soil only 20 – 30% of the area is compressed [4]. V. Gruber stated that the tractor (the mass of which is 6.4 tons, tyres 18.4 R 34, and pressure in the tyres 160 kPa) compressed the untilled soil by 20% less in the depth of 200 and 400 mm if compared with the tilled and hoed soil [5]. R. Haberland states that when the crops are sown into untilled soil the soil structure improves, its biological activity becomes better, and the soil density is less [6]. J. Epperlein and R. Metz defined that after two years the worm number in the untilled soil was 2.3 times greater and the humus quantity by 0.2% greater if compared with the untilled soil [7].

But the use of new soil tillage and sowing technologies one of the most important problems arise how to introduce the crop seeds into the soil contaminated with yield residues, i.e., often the harder soil surface. Many scientists state that the seeds introduced by special types of coulter of conventional seeders have the best germination abilities. But these types of coulters are suitable for seed introduction only in the loose soil. Besides they are very sensitive to the uneven soil looseness and the smallest obstacle pull them into the top soil surface layer thus the seed introduction evenness changes [8]. The coulters of some other types are introduced into the soil in an acute angle. They can be used in hard soils but they are slowly introduced with yield residues and do not provide the even depth of soil introduction [3, 8]. Disk coulters are the best for introduction of seeds into the untilled soil. They easily cut the soil surface and form the notch for the seed introduction. The diameter of disk coulters of conventional seeders used in the Baltic States for seed introduction into the bed is from 350 to 500 mm. To improve the engagement of coulters with the soil and better cutting of the yield residue the seeders have provided with the disks with cut blades. The disk may have from 8 to 22 notches [3].
The technique of crop introduction into untilled soil in Lithuania has been started to use only in the last decade. Until now the technological processes of the operation of the crop seeders was insufficiently tested by the trials in differently prepared soil, their influence to the formation of the seedbed and crop germination. Thus the trials were carried out in 2005 – 2006 the goal of which was to test the technological processes of the winter wheat sowing into tilled and untilled soil in various regions of Lithuania.

Materials and methods

In the clay loam soils of Marijampolė and Pasvalys regions the winter wheat sort “ADA” was sown (the sowing rate 250 kg ha⁻¹). The sowing trials in Marijampolė region were carried out on the 9th of September, 2005 and 26th of September, 2006, and in Pasvalys region on the 6th of September 2005 and 19th of September, 2006.

The first variant (ploughed): the soil was shaved by the share scuffler “Kverneland” or “Kverneland” plough, and tilled with “Carrier” cultivator. The second variant (unploughed): the soil was twice hoed with “Carrier” cultivator.

The seeders “Vaderstad” and “Rapid A 600C” with disk sowing coulters were used for the sowing of winter wheat seeds. The coulter diameter was 410 mm. Every disk of the coulter had 20 notches in the blades. The indices of the seedbed are defined by the Karitz/Hakannson method (Sweden) [9]. This method was used to determine the seed introduction depth, ridgeness of the soil surface above seeds, the composition of seedbed clods, moisture content and seed introduction evenness in various soil layers. The frame (of the height 250 × 400 mm, 100 mm) with the tipped-up frame (400 × 400 mm, 100 mm height) was used. The frame was pressed into the soil and its horizontal position was tested by a spirit-level. The frame was pressed above the sowing line, when the spade 2 dig three soil layers of 15 mm. This soil was spread on 5 mm (top) and 2 mm (bottom) sieves. When the soil layer is separated through the sieves three soil clod fractions are found: > 5 mm, 2 – 5 mm, and < 2 mm soil clods. When separate fractions were poured into 2 litre measurement flasks the per cent volume clod fraction composition was determined. In every sieved layer found grains were counted and the evenness of the grain distribution in seedbed was defined. The trials were in various soil places with 3 – 5 replications.

To define the soil moisture in the separate layers 3 samples were taken from each soil layer and their weight was defined. The soil hardness was defined in differently ploughed soils with Reviakin hardness tester. The crop germination ability was estimated by counting all the winter wheat stems in four trial plots (0.5 × 0.5 m).

Results and discussion

Soil hardness in the seed introduction depth is very important factor ensuring seed introduction quality. The soil hardness depends on the soil ploughing method, soil moisture, yield waste amount, etc. The fulfilled trials showed that in the upper soil layer (up to 50 mm) before the sowing the hardness of the ploughed soil (Fig. 1) in different regions were insignificant if compared with the untilled soil (Fig. 2).

![Fig. 1. The soil hardness in different depth in 2005 – 2006](image-url)
Only in the deeper layers the hardness of the ploughed soil increased more evenly than the untilled one. In the untilled soil the greater increase of the noticed soil hardness in the depth where the soil cultivation ends. In 2005 soil hardness was about 200 kPa greater than in 2006 due to moisture lack in the introduction depth (30 – 45 mm).

After the winter wheat sowing when the soil moisture was defined in the seedbed layers it was noticed that the precipitation lack in the autumn of 2005 had great influence owing to the fact that the moisture evaporated from the soil. The least soil moisture was in Marijampolė region where the soil moisture in the depth of seed introduction was less than two per cent (Fig. 3). In 2006 the soil moisture in different seedbed layers was several times greater than in 2005 but insufficient to ensure good seed germination conditions. The recommended soil moisture should be from 10 to 22.

The trials showed that the moisture losses can be reduced when the soil is not ploughed and the yield waste was cultivated in the soil layer with cultivator “Carrier”. In 2005 when the moisture quantity was insufficient when the seeds were sown in the untilled soil its moisture in Marijampolė region was about 3.0 – 4.0 times, and in Pasvalys region about 1.5 – 2.0 times greater than in the soil ploughed in the same year (< 15 mm). The soil moisture was 30% greater in the non-ploughed soil if compared with the ploughed soil.

**Fig. 2. The hardness of unploughed soil in different depth in 2005 – 2006**

**Fig. 3. Moisture of ploughed soil in various layers of seedbed 2005 – 2006**

**Fig. 4. Moisture of unploughed soil in different depth of seedbed 2005 – 2006**
In 2005 in Marijampolė region the winter wheat seeds were introduced not evenly in the greater hardness of dried ploughed soil. In the various seedbeds the seed distribution was from 20 to 41% (Fig. 5). Past of the seeds (about 5%) were not introduced. It could be noticed the best in the hilly soil on the hill tops. In those places even the disk coulters of the seeders were unable to form the seedbed meeting the sowing requirements. In some soil places the coulters used to cut the hard soil surface and made the seedbed but the introduced seeds remained in the bottom of the bed as the soil loam fine fraction was insufficient to bury the introduced seeds.

In other ploughed soils the seeds were introduced rather evenly from 72 to 82% in the soil layer of 30 – 45 mm depth, and the rest part in 10 – 30 mm depth.

In unploughed soils winter wheat seeds were mostly introduced in the soil layer of 15 – 30 mm depth (Fig. 6). In 2005 in Pasvalys region due to the increased seed introduction depth 78 % of the seeds were introduced in the depth of 30 – 45 mm.

The composition of the soil clods is very important factor that influences seed germination. The bigger factions of soil clods should prevail in top soil surface. This better protects the soil surface from wind erosion and crust formation. In the depth of seed introduction more fine clods (< 2 mm) should be in the soil. Small clods should more evenly burry seeds as this improves soil and seed contact, the seeds swell and germinate more quickly.

In 2005 in Marijampolė region 88% of the clods in the ploughed soil surface layer (< 15 mm depth) were greater than 5 mm diameter (Table 1). This could be one of the reasons why the clod structure on the soil surface had negative influence to the seed introduction. In 2006 in unploughed soil in the depth of 10 – 30 and 30 – 45 mm the number of fine clods was by 20% less. In Pasvalys region both in unploughed and ploughed soils the ratio of clod distribution was better. The amount of fine clods (< 2 mm) in the depth of seedbed was by 30 – 40% less. The clods which were bigger than 5 mm on soil surface were from 40 to 60%.

Seed germination is one of the main results summarizing the seed introduction quality. In 2005 there was not enough moisture and the soil was hard, the clod ratio in the soil was not balanced, the seed introduction both in ploughed and unploughed soil was more complicated and the winter wheat seed germination was different (Fig. 7). The reasons mentioned above determined that in 2006 despite the fact that such soil preparation method used the seed germination was two times less than in 2006.
Table 1. Clod composition in various seedbed layers of ploughed and unploughed soil

<table>
<thead>
<tr>
<th>Soil tillage</th>
<th>System</th>
<th>Years</th>
<th>Seedbed layers mm</th>
<th>Soil aggregates, %</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td></td>
<td>&lt; 15</td>
<td>15 – 30</td>
</tr>
<tr>
<td>Ploughed</td>
<td>Marijampole</td>
<td>2005</td>
<td>5.6</td>
<td>24.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>20.3</td>
<td>30.0</td>
</tr>
<tr>
<td>Not-ploughed</td>
<td></td>
<td>2005</td>
<td>12.1</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>13.8</td>
<td>19.3</td>
</tr>
<tr>
<td>Ploughed</td>
<td>Pasvalys</td>
<td>2005</td>
<td>27.5</td>
<td>32.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>36.6</td>
<td>39.2</td>
</tr>
<tr>
<td>Not-ploughed</td>
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<td>16.5</td>
<td>32.3</td>
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<tr>
<td></td>
<td></td>
<td>2006</td>
<td>11.2</td>
<td>28.6</td>
</tr>
</tbody>
</table>

Fig. 7. The influence of various soil preparation methods for the winter wheat seed germination

Conclusions
1. The uniform introduction of the winter wheat seed with the disk colters of seeders depends on the soil hardness, soil moisture content, soil clod composition, the method of the yield waste introduction into the soil and other factors.
2. When seeds were introduced into unploughed top soil layer more than 30% of moisture content than in ploughed soil. In especially dry year (as in 2005) the soil moisture content was reduced up to 4 times.
3. The method of soil preparation and sowing had no significant influence to winter wheat seed germination. Meteorological conditions had greater impact on seed germination.

References