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# STUDIES ON THE ESTABLISHMENT OF CONSERVATION TECHNOLOGIES OF TILLAGE MECHANIZATION USED IN WHEAT CROP, UNDER SOIL SPECIFIC CONDITIONS OF THE N-E AREA OF ROMANIA

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**ABSTRACT** – In the autumn of 2007, for establishing the conservation technologies of tillage mechanization in wheat crop, in the North-Eastern Romania, six variants of technologies were tested. In every variant, we have determined the qualitative indices for each equipment and the energetic and exploitation indices for each unit. After sowing, we have determined for each variant soil resistance to penetration, mean diameter of soil structure and hydrostability of these elements. We have also determined the fuel consumption per hectare for the mechanized tillage, necessary for establishing the field crops. In order to establish the mechanization technologies of soil tillage, we had to take into account the way of plant growth and the obtained yields. Therefore, we have determined the number of raised plants per square meter, measured the plant height and, finally, we have established the seed yield per hectare. Based on the results obtained in these trials, we have evaluated the variants of technologies and established which of them corresponded to the requirements of soil conservation in wheat crop.

**Key words:** technologies, mechanization, soil tillage, soil conservation, soil penetration, soil structure, fuel consumption

**REZUMAT – Cercetări privind stabilirea tehnologiilor conservative de mecanizare a lucrărilor solului la cultura grâului, pentru condițiile de sol specifice zonei de N-E a României.** În vederea stabilirii tehnologiilor conservative de mecanizare a lucrărilor solului pentru zona de N – E a României, la cultura de grâu, în toamna anului 2007, s-au experimentat şase variante de tehnologii. La fiecare variantă s-au determinat indicii calitativi ai lucrării, pentru fiecare utilaj de lucru, şi indicii energetici şi de exploatare pentru fiecare agregat agricol. După însămânțarea culturii, la o anumită perioadă de timp, s-au determinat, la fiecare variantă, rezistența

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solului la penetrare, diametrul mediu ponderat al elementelor de structură ale solului şi stabilitatea hidrică a acestor elemente. De asemenea, la fiecare variantă s-a determinat consumul de combustibil la hectar, pentru efectuarea mecanizată a lucrărilor necesare înfiinţării culturii de câmp. S-a considerat, de asemenea, că la stabilirea tehnologiilor de mecanizare a lucrărilor solului, trebuie să se ţină seama de modul în care are loc creşterea plantelor şi de producţiile obţinute. Pentru aceasta s-a determinat numărul de plante răsărite pe un metru pătrat, s-a măsurat înălţimea plantelor, iar, în final, s-au stabilit producţiile de seminţe la hectar. Pe baza rezultatelor obţinute în cadrul experimentărilor efectuate s-au evaluat variantele de tehnologii şi s-a stabilit care din acestea corespund cerinţelor privind asigurarea conservării solului, la cultura de grâu.

**Cuvinte-cheie:** tehnologii, mecanizare, lucrări sol, conservare, penetrare sol, structură sol, consum de combustibil

## INTRODUCTION

For establishing the conservation technologies of tillage mechanization in wheat crop and the adequate equipment system, aligned at the concept of sustainable agriculture, it is necessary to carry out adequate experimental studies. The mechanization technologies and the proposed units (designed by the research team or already found in production) must be tested under laboratory and field conditions, to establish if they correspond to the requirements.

For solving these problems, the research team proposed more variants of technologies for soil tillage mechanization and wheat sowing. These technologies were tested to establish which of them corresponded at the highest degree to the concept of sustainable agriculture and ensured the protection, conservation and improvement of agricultural lands. For this, each variant of mechanization technologies, which includes unconventional, conservation soil tillage, using adequate equipments, will be compared with a control variant, where the classical conventional technology of soil tillage mecanization is applied. The comparison was also made with the others technologies.

Each variant of the mechanization technology includes soil tillage in wheat crop and work equipments, which are involved in this activity. Basic soil tillage, superficial tillage for soil maintenance and seedbed preparation are also included. Sometimes, soil tillage is reduced, like in the case of direct sowing (fallow, unprepared and unploughed soil).

Because most of the experimental technologies include combined, complex work equipments, which also have sowing equipments in their structure, sowing will be present at all the technologies.

## MATERIALS AND METHODS

The experiments regarding the mechanization technologies of soil tillage in wheat crop were conducted in 2006, 2007 and 2008, at Rediu and Ezăreni farms of the Experimental Didactic Station within the University of Agricultural Sciences and Veterinary Medicine, Iaşi.

At the trial carried out at the beginning of September 2006, we considered that the results were influenced by draught (during September-December 2006 and April-July 2007, the rainfalls being lower than the monthly multiannual means). Therefore, in September 2007, we carried out a new trial with mechanization technologies of soil tillage in wheat crop. This time, the trial took place in normal conditions regarding rainfall quantities, recorded during the vegetation period.

The soil on which tests were made is a cambic meso-calcaric chernozem to baticalcaric type, with a clayey-loam texture and mean values of the apparent density and moisture. The field is a mean slope of two degrees. The used predecessor plant was sunflower.

At all the mechanization technologies of soil tillage and sowing, applied in wheat crop, crop residues were chopped with SR 250, thus normal conditions for soil tillage and sowing being created.

Six variants of technologies for the mechanization of soil tillage and sowing were tested. These are presented in *Table 1.*

**Table 1 - Variants of technologies for the mechanization of soil tillage and sowing in wheat crop**

| Used equipments | Variants of technologies |
|---|---|
| • Valtra T-190 tractor + Opal 140 reversible mouldboard plough<br>• U-650 tractor + GD-3.2 easy disk harrow + 2 GCR-1.7 tooth harrow (3 passes)<br>• U-650 tractor + SUP-29 universal sowing machine | $V_1$ (control) |
| • Valtra T-190 tractor + Opal 140 reversible mouldboard plough<br>• Valtra T-190 tractor + AGPS-24 complex unit (FRB-3 rotary hoe + SUP-24 DR sowing machine), 540 rot/min at tractor power plug | $V_2$ |
| • Valtra T-190 tractor + GD-4.2 heavy disk harrow<br>• Valtra T-190 tractor + AGPS-24 complex unit (FRB-3 rotary hoe + SUP-24 DR sowing machine), 540 rot/min at tractor power plug | $V_3$ |
| • U-650 tractor + PC-7 chisel<br>• Valtra T-190 tractor + AGPS-24 complex unit (FRB-3 rotary hoe + SUP-24 DR sowing machine), 540 rot/min at tractor power plug | $V_4$ |
| • Valtra T-190 tractor + soil loosening organs mounted on AGPS-24 complex unit (540 rot/min at tractors power plug) | $V_5$ |
| • Valtra T-190 tractor + MCR-2.5 combined machine for soil tillage in rows and sowing (direct sowing in unploughed soil), 1000 rot/min at tractor power plug | $V_6$ |

$V_1$ is the control variant, because it represents the technology for mechanization of soil tillage and sowing, which is generally applied in production. It is the classic and the conventional technology of soil tillage.

In each variant of technology for the mechanization of soil tillage and for each unit (machine or tool), the quality indexes of the done work were determined. In each variant, we also determined the energetic and the exploitation indices for each unit. The obtained results were compared with the limits imposed by the agro-technical requirements, in order to see if they were proper. Based on the values of indices, each technology was compared with the control technology and with the other ones, in order to establish the best technology.

For selecting the mechanization technologies of soil tillage, we have determined for each, after wheat sowing, the soil resistance to penetration and the stability of soil structural elements. We consider that these indicators, soil resistance to penetration and, especially, stability of soil structural elements (expressed by the mean weighted diameter of soil structural elements and the hydrostability of these elements) are very important, because, on their basis, they can establish the contribution of each tillage technology to soil degradation.

For choosing the best technologies for the mechanization of soil tillage, we calculated for each technology the fuel consumption per hectare for mechanized tillage and sowing.

We also considered that for the selection of technologies for the mechanization of soil tillage, we must take into account the way of plant growth and the obtained yields. Therefore, we determined the number of raised plants per square meter, plant height, and, finally, seed yield per hectare.

## RESULTS AND DISCUSSION

When choosing the technologies for the mechanization of soil tillage, which are recommended to be applied in production, one must take into account the soil crumbling degree at seedbed preparation, soil resistance to penetration, mean weighted diameter of soil structural elements, hydrostability of these elements, fuel consumption per hectare for soil tillage and sowing, number of raised plants per 1 $m^2$ and their height and seed yield per hectare.

We consider that one of the most important working indices is soil crumbling degree. The problems, which issued at seedbed preparation, were mainly caused by the fact that a proper soil crumbling was not assured. The diminution in soil crumbling degree at lower values than the minimum limits, imposed by the agro-technical requirements, appears, especially, at seedbed preparation for the crops, which are sown in autumn.

As concerns the energetic and exploitation indices of the agricultural units, the most important one is the fuel consumption per area unit.

**The soil crumbling degree at seedbed preparation** varied from 70% to 100%, according to the applied technology (*Table 2*).

If we have in view the agro-technical requirements, which impose that soil crumbling degree at seedbed preparation should be the lowest of 90%, $V_1$ variant (control) could not be applied. At this variant, soil crumbling degree was not within the limits established by the agro-technical requirements (Toma and Sin, 1987).

**Table 2 - The soil crumbling degree obtained at seedbed preparation for winter wheat**

| Variant of technology | Soil crumbling degree, % |
|---|---|
| $V_1$ (control) | 70 |
| $V_2$ | 90 |
| $V_3$ | 92 |
| $V_4$ | 93 |
| $V_5$ | 95 |
| $V_6$ | 100 |

The other variants had adequate values for soil crumbling degree. Among these, $V_6$ variant was the best, the soil crumbling degree being, in this case, of 100%.

**Soil resistance at penetration** was determined the next day after wheat sowing. *Table 3* shows the obtained results regarding the soil resistance at penetration for different applied technologies.

**Table 3 - Soil resistance at penetration, in case of different technologies used for mechanization of soil tillage and sowing (winter wheat)**

| Variants of technology | Depth (cm) | | | | | |
|---|---|---|---|---|---|---|
| | 5 | 10 | 15 | 20 | 25 | 30 |
| | Soil resistance at penetration, daN/cm$^2$ | | | | | |
| $V_1$ (control) | 1.3 | 1.4 | 1.7 | 2.4 | 4.8 | 8.3 |
| $V_2$ | 2.4 | 2.9 | 3.3 | 3.7 | 4.6 | 4.7 |
| $V_3$ | 2.2 | 6.8 | 7.3 | 7.8 | 9.1 | 9.5 |
| $V_4$ | 1.5 | 1.5 | 1.9 | 2.5 | 5.1 | 8.6 |
| $V_5$ | 2.3 | 4.2 | 7.6 | 8.0 | 8.5 | 8.8 |
| $V_6$ | 7.5 | 7.7 | 9.1 | 9.3 | 11.1 | 10.2 |

The agro-technical requirements established more value classes for the soil resistance at penetration: very low = below 11 daN/cm$^2$, low = 11 – 25 daN/cm$^2$, medium = 26 – 50 daN/cm$^2$, etc (Canarache, 1990). By comparing these requirements with the obtained results, we found that the soil resistance at penetration was "very low" in all the variants.

At the depth of 0 – 20 cm, the soil resistance at penetration varied between 1.3 daN/cm$^2$ and 9.3 daN/cm$^2$, according to the applied variant of technology. The lowest values of this index were recorded in $V_1$ variant, and the highest ones, in $V_6$.

We consider that for a correct understanding of the obtained results, one must take into account the depth at which the active organs of units worked. The highest depth for soil tillage was recorded at the mouldboard plough. However, in this case, the working depth did not exceed 20 cm. It means that the soil resistance at penetration, recorded at depths of 25 cm and 30 cm, even if it had higher values, was not influenced by the plough. In case of direct sowing ($V_6$), the work depth of the horizontal rotary hoe was of 8 cm and soil was tilled only on one third of its surface, showing that the soil resistance at penetration of 9.1…11.1 daN/cm$^2$, recorded at depth of 15…30 cm, was not influenced by the MCR-2.5 combined machine.

Working conditions, predecessor plant and moment at which the soil resistance at penetration was determined must be also taken into account. The last one is very important, because, during the vegetation period, an increase in this index was recorded. In addition, when the predecessor plant is a row crop, soil, until a certain depth, has a relatively reduced penetration resistance, because of hoeing.

The very low values of soil resistance at penetration were caused by the fact that soil had enough moisture, due to the rainfalls, which exceeded the monthly multiannual means. Soil was loosened at surface, because of hoeing done in the predecessor plant (sunflower) and the determination of soil resistance at penetration was done the next day after sowing.

The agro-technical requirements establish that at the soil resistance at penetration of 25 daN/cm$^2$ , the plant roots grow normally (Canarache, 1990). By comparing these requirements to the obtained results, we might say that all the variants had conditions for a normal growth of wheat roots.

**The mean weighted diameter of soil structural elements** was determined the next day after sowing, for three depths: 0 – 10 cm, 10 – 20 cm and 20 – 30 cm. In *Table 4*, we present the obtained results regarding the mean balanced diameter of soil structural elements, for different applied technologies and depths.

**Table 4 - The mean weighted diameter of soil structural elements, for different applied technologies (winter wheat)**

| Variants of technology | Depth (cm) | | | |
|---|---|---|---|---|
| | 0 - 10 | 10 – 20 | 20 - 30 | Mean |
| | The mean weighted diameter of soil structural elements, mm | | | |
| $V_1$ (control) | 4.86 | 4.08 | 5.15 | 4.70 |
| $V_2$ | 4.45 | 3.92 | 5.28 | 4.55 |
| $V_3$ | 3.52 | 5.80 | 5.35 | 4.89 |
| $V_4$ | 3.79 | 5.96 | 5.48 | 5.08 |
| $V_5$ | 3.63 | 6.04 | 5.95 | 5.21 |
| $V_6$ | 4.28 | 6.52 | 6.16 | 5.65 |

In the case of the mean weighted diameter of soil structural elements, the highest interest, from the agronomical point of view, was focused on soil structural elements, having a diameter of 2 – 5 mm (even over 5 mm). By comparing the obtained results to these requirements, we found that the mean weighted diameter of soil structural elements was proper in all the variants and depths (Guş et al., 2001).

The 20-30 cm soil layer did not present a great interest, because the active organs of the agricultural units did not till at that depth. At the 10-20 cm soil layer, the mean weighted diameter of soil structural elements was adequate, being found within the limits established by the agro-technical requirements in all the technological variants. At that depth, except the variant at which direct sowing was applied ($V_6$), only the active organs of the agricultural unit worked (soil was tilled once).

In the case of soil layer at depth of 0 – 10 cm, except the $V_6$ variant, soil was tilled more times. For example, in $V_1$ variant (control), we used in this layer the active organs of the mouldboard plough, then the active organs of the disk harrow plus the ones of the tooth harrow, the two harrows tilling soil for 3 times. For this reason, with two exceptions, in the 0 – 10 cm soil layer, the mean weighted diameter of soil structural elements was lower than the one in the 10 – 20 cm soil layer. This can be explained by the fact that repeated tillage determined the fragmentation of some soil structural elements. Exceptions are $V_1$ and $V_2$ variants, where the mouldboard plough was used, because it turned upside-down the 0 – 20 cm soil layer, bringing at surface the soil with bigger structural elements.

At the variants at which the mouldboard plough was not used, the highest value of this index was recorded in $V_6$ variant, and the lowest one, in $V_3$. In case of $V_6$ variant, the diameter of soil structural elements was the highest, because soil was the least mobilized, the fragmentation of structural elements being minimum.

**Moisture stability of soil structural elements** was also determined the next day after sowing, for three depths: 0 – 10 cm, 10 – 20 cm and 20 – 30 cm. In *Table 5*, we present the obtained results on the hydrostability of soil structural elements, for different technologies and depths.

The agro-technical requirements establish that, if the hydrostability of soil structural elements is of 40 – 60%, then this index could be classified in the “very high” class; when this index exceeds 60 %, then it is classified in the “extremely high” class (Canarache, 1990). By comparing the obtained results to the agro-technical requirements, we may say that the hydrostability of soil structural elements is very good at all the variants and depths.

At the variants in which the mouldboard plough was not used, the highest value (the best one) of the index was recorded in $V_6$ variant, and the lowest value, in $V_3$. The order of the variants, starting with the best one was $V_6$, $V_5$, $V_4$, and $V_3$.

**Table 5 - Hydrostability of soil structural elements, for different applied technologies (winter wheat)**

| Variants of technology | Depth (cm) | | | |
|---|---|---|---|---|
| | 0 - 10 | 10 – 20 | 20 - 30 | Average |
| | Hydrostability of soil structural elements, % | | | |
| $V_1$ (control) | 78.6 | 75.5 | 85.1 | 79.7 |
| $V_2$ | 77.9 | 75.7 | 84.8 | 79.4 |
| $V_3$ | 74.4 | 82.6 | 85.8 | 80.9 |
| $V_4$ | 75.7 | 82.8 | 86.1 | 81.5 |
| $V_5$ | 76.4 | 83.0 | 86.7 | 82.0 |
| $V_6$ | 78.0 | 84.7 | 87.2 | 83.3 |

The highest value of the hydrostability of soil structural elements, obtained in $V_6$ variant (direct sowing), could be explained by the fact that soil was less mobilized, so the fragmentation of the structural elements was reduced.

In case of 20 – 30 cm soil layer, which was not tilled by agricultural units, the hydrostability of soil structural elements was higher in all the technological variants. For the 10 – 20 cm soil layer, which, except $V_6$, was tilled only once, the hydrostability of soil structural elements was lower, because more soil aggregates were affected. In the 0 – 10 cm soil layer, which was tilled many times (except $V_6$), the value of this index was the lowest, because soil repeated tillage led to the amplification of the structural element fragmentation. Variants $V_1$ and $V_2$ are exceptions, because the mouldboard plough turned upside-down the 0 – 20 cm soil layer, bringing at surface soil with a greater hydrostability of the structural elements.

**Fuel consumption per hectare.** We consider that this index is of great importance in the selection of the tested technologies for tillage mechanization and sowing. This index is obtained by summing up the Diesel oil quantities consumed for the mechanization of soil tillage and sowing per hectare. *Table 6* shows the fuel consumption per hectare for all the six technological variants.

**Table 6 - Fuel consumption per hectare for soil tillage and sowing (winter wheat)**

| Variants of technology | Fuel consumption per hectare for soil tillage and sowing, l/ha |
|---|---|
| $V_1$ (control) | 33.670 |
| $V_2$ | 25.800 |
| $V_3$ | 16.350 |
| $V_4$ | 16.870 |
| $V_5$ | 11.160 |
| $V_6$ | 7.697 |

We consider that in all the tested technological variants, the fuel consumption per hectare for soil tillage and sowing was adequate. A higher consumption was recorded in

$V_1$ variant, while the lowest one, in $V_6$.

Analysing the fuel consumption, we found a continuous diminution from $V_1$ (control) to $V_6$.

By comparing $V_1$ and $V_6$, we found a very great diminution in fuel consumption per hectare: in $V_6$ variant, the fuel consumption was by 4.4 times lower that the one in $V_1$. A great difference was recorded between $V_1$ and $V_5$; thus, in $V_5$ variant, the fuel consumption per hectare for soil tillage and sowing was by 3.2 times lower than the one obtained in $V_1$. This great difference regarding the fuel consumption was caused by the number of passages of the agricultural units: five passages in $V_1$ and only one passage in variants $V_5$ and $V_6$.

It is necessary to establish which of $V_3$ and $V_4$ variants was the best. It looks that the best variant was $V_3$ variant, because fuel consumption was lower with 0.520 l/ha than in $V_4$. Working depth is of almost 20 cm for chisel ($V_4$) and only 10 cm at heavy disk harrow ($V_3$). Therefore, in chisel case, soil was loosened at a higher depth, thus creating better conditions for plant root growth. The soil crumbling degree was higher in $V_4$ variant, compared with the one recorded in $V_3$. In addition, in $V_4$ variant, the soil resistance at penetration was lower and the mean weighted diameter of soil structural elements and hydrostability of these elements were higher, compared with the values obtained in $V_3$ variant. The variant at which the chisel was used ($V_4$) showed better results than the one that used the heavy disk harrow, as concerns plant growth and seed yield per hectare. Having in view the obtained results for all these indices, we assess that $V_4$ variant was better than $V_3$, even if the difference between the fuel consumption was about 0.520 l/ha in favour of $V_3$.

**Plant growth and development.** The studies regarding the wheat growth were carried out 41 days after sowing. *Table 7* shows the obtained results regarding the number of raised plants per 1 $m^2$ and their height, in all the six variants of technology.

**Table 7 - Number of raised plants per 1 $m^2$ and their height (winter wheat)**

| Variants of technology | Number of raised plants per 1 $m^2$ | Plant height, cm |
|---|---|---|
| $V_1$ (control) | 295 | 9.0 |
| $V_2$ | 309 | 9.2 |
| $V_3$ | 318 | 9.6 |
| $V_4$ | 324 | 9.9 |
| $V_5$ | 364 | 11.3 |
| $V_6$ | 416 | 12.7 |

Analysing the obtained results, we found that both the number of raised plants per 1 $m^2$ and the plant height recorded a continuous increase (the lowest values of the two indices were recorded in $V_1$ variant, and the highest ones, in $V_6$). The best results regarding the wheat growth were obtained in variants $V_3 \ldots V_6$, at which the conservation tillage was used, while the mouldboard plough was not used.

**The seed yield** depended on many factors, among which we mention soil tillage system. *Table 8* shows the results concerning the seed yield obtained at different technologies for the mechanization of soil tillage.

**Table 8 - The seed yield obtained at different variants of technology**

| Variants of technology | Seed yield | |
|---|---|---|
| | kg/ha | Compared with the control (classical variant), % |
| $V_1$ (control) | 4602 | 100.00 |
| $V_2$ | 4650 | 101.04 |
| $V_3$ | 4692 | 101.95 |
| $V_4$ | 5171 | 112.36 |
| $V_5$ | 5452 | 118.47 |
| $V_6$ | 5515 | 119.84 |

The wheat seed yield has varied according to the applied variant of technology, from 4602 kg/ha to 5515 kg/ha. The highest seed yield was obtained in $V_6$ variant, at which direct sowing was applied, and the lowest one, in $V_1$ (mouldboard ploughing, followed by seedbed preparation with GD-3.2 disk harrow, three passages, and sowing with SUP-29).

In case of unconventional tillage system, where the mouldboard plough was not used, the order of variants was established, starting with the best one (having in view only the seed yield): $V_6$, $V_5$, $V_4$, $V_3$.

In order to emphasize the differences to $V_1$ (control) of variants $V_2 \ldots V_6$, regarding the seed yield, yields were presented as percentage, considering that the yield of $V_1$ is 100%. Thus, we found that in $V_2$ variant, the wheat seed yield increased by 1.04%, compared to the one of the control variant. In $V_3$ variant, the yield increased by 1.95%, compared to $V_1$. In case of $V_4$, $V_5$ and $V_6$ variants, we found that the seed yield has significantly increased, compared to the control variant. The increases were of 12.63% - 19.84%.

**Applied variants of technology.** Until now, all the variants of technology for the mechanization of soil tillage were separately analysed, for each index. For establishing the applied technologies and their order, we had in view more indices: soil crumbling degree at seedbed preparation, mean weighted diameter of soil structural elements, hydrostability of these elements, fuel consumption per hectare and sowing, number of raised plants per 1 $m^2$ and their height and seed yield per hectare.

For each index, we established the applied variants of technology, variants with lower results and order of the variants, starting with the best one and variants that are not recommended to be used, taking into account all the above-mentioned indices.

We must mention that it is necessary to use the conservation, unconventional mechanized tillage systems, without turning upside-down the mobilized soil layer, in order to avoid the usage of mouldboard plough.

When conditions were favourable for using tillage conservation systems, we consider that the applied variants, starting with the best one, are $V_6$, $V_5$ and $V_4$. If $V_6$ variant cannot be applied, we will use $V_5$; if neither $V_5$ could be used, we will apply $V_4$ variant.

When there are not conditions for applying unconventional systems for soil tillage, we recommend that soil should be tilled by turning upside-down the soil layer (in this case, the mouldboard plough must be used), $V_2$ variant being applied. $V_1$ (control) is not recommended to be used, because the fuel consumption per hectare for soil tillage and sowing is too high and soil crumbling degree at seedbed preparation is not adequate, being found much below the minimum limit imposed by agro-technical requirements.

## CONCLUSIONS

At the technological variants $V_2 \dots V_5$, soil crumbling degree at seedbed preparation was adequate. In the case of $V_1$ variant, the soil crumbling degree was not found within the limits imposed by the agro-technical requirements.

The soil resistance at penetration, which was determined the next day after wheat sowing, was "very low" (very good) at all the six tested variants of technology. The lowest values were recorded in $V_4$ variant, and the highest ones, in $V_6$. We consider that in all the technological variants, there are conditions for the normal growth of plant roots.

The mean weighted diameter of soil structural elements is adequate in all the six variants and for all the three soil layers. In the variants at which the mouldboard plough was not used, the highest value (the best one) of the index was recorded in $V_6$ variant, and the lowest one, in $V_3$ variant (the explanation was that in $V_6$ variant, soil was less mobilized).

The hydrostability of soil structural elements is very good in all the technological variants. In the group of variants at which the mouldboard plough was not used, the highest value (the best one) of the index was recorded in $V_6$ variant and the lowest one, in $V_3$ variant.

The fuel consumption per hectare for soil tillage and sowing, determined in all the six experimental variants of technologies for wheat growing, was adequate. The highest fuel consumption was recorded in $V_1$ variant (control), and the lowest one, in $V_6$. In $V_6$ variant, the fuel consumption per hectare was by 4.4 times lower that the one in $V_1$ variant.

The lowest values of the number of raised plants per 1 $m^2$ and of plant height were recorded in $V_4$ variant, and the highest ones, in $V_6$. The values of the two indices were greater in case of the variants at which the mouldboard plough was not used.

The highest seed yield was obtained in $V_6$ variant, at which direct sowing was applied, and the lowest one, in $V_1$, where the classical system for soil tillage was used. In $V_4$, $V_5$ and

$V_6$, the seed yield increased by 12.36 %- 19.84 %, compared to the control.

If there are favourable conditions for using the conservation systems for mechanized soil tillage (without the mouldboard plough), the variants which could be applied, starting with the best one, are $V_6$, $V_5$ and $V_4$.

When there are no conditions for applying unconventional systems for soil tillage, it is recommended that soil should be tilled by turning upside-down of soil layer (when mouldboard plough must be used) and $V_2$ variant will be applied.

## REFERENCES

**Axinte Stela et al., 2004** – *Ecosisteme agricole convenționale şi sustenabile (Conventional and sustainable farming systems).* Edit. Politehnium, Iaşi

**Canarache A., 1990** – *Fizica solurilor agricole (Physics of farming land).* Edit. Ceres, Bucureşti

**Guş P. et al., 2001** – *Sisteme neconvenționale de lucrare a solului (Unconventional soil tillage systems).* Edit. Risoprint, Cluj-Napoca

**Guş P. et al., 2003** – *Lucrările neconvenționale ale solului şi sistema de maşini (Unconventional soil tillage and machine system).* Edit. Risoprint, Cluj-Napoca

**Jităreanu G., 1995** – *Ingineria conservării solului şi a apei (Engineering of soil and water conservation*), vol. 1. Universitatea Agronomică Iaşi

**Jităreanu G. et al., 2007** – *Tehnologii şi maşini pentru mecanizarea lucrărilor solului în vederea practicării conceptului de agricultură durabilă (Technologies and machines for soil tillage mechanization, for practicing the concept of sustainable agriculture).* Edit. "Ion Ionescu de la Brad", Iaşi

**Roşu Gh., 1981** – *Modificarea hidrostabilității structurii solului sub influența plantelor, îngrăşămintelor şi lucrărilor solului (Modification of the hydrostability of soil structure, as influenced by plants, fertilizers and soil tillage).* Lucrări ştiințifice, vol. 25, Seria Agronomie, Institutul Agronomic Iaşi

**Rusu I., 1975** – *Cercetări cu privire la stabilitatea (mecanică şi hidrică) a structurii la două tipuri de sol din județul Timiş (Investigations on mechanical and hydric stability of the structure on two soil types of the Timiş County).* Edit. Ceres, Bucureşti

**Stănilă S.et al., 2003** – *Tehnici şi tehnologii de mecanizare a lucrărilor în sistem de conservare a solului (Mechanization techniques and technologies of soil conservation tillage).* Edit. Alma-Mater, Cluj-Napoca

**Şandru A. et al., 1983** – *Exploatarea utilajelor agricole (Exploitation of farming equipments).* Edit. Didactică şi Pedagogică, Bucureşti

**Toma Dr., Sin Gh., 1987** – *Calitatea lucrărilor agricole executate mecanizat pentru culturile de câmp (Quality of mechanized tillage for field crops).* Edit. Ceres, Bucureşti