Journal of Agricultural Sciences
Vol. 55, No. 2, 2010
Pages 165-181

DOI: 10.2298/JAS1002165E
UDC: 631.3
Original scientific paper

RESEARCH RESULTS OF LONG-TERM USE OF NEW LINE OF MACHINES AND TOOLS FOR LAND SURFACE AND DEPTH ARRANGEMENT

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Abstract: This paper presents the results of the application of the machines and tools for new technologies in plant production for two years of research. The comparative analysis of the influence of new technologies and new types of machines was done, and also the effect of conventional tillage systems on several agricultural crops (sunflower, commercial maize and wheat). During the experiment, we analysed the effects of application of new line of machines to: physical properties of soil, morphological features of crops, use of energy and yield, and we also analysed the economic aspects of the application. On the control plots, a conventional tillage system was simultaneously applied for comparative analysis of the previously mentioned factors. Trials were conducted on production plots of Maize Research Institute "Zemun Polje" in Krnješevci from October 2008 until July 2010.

Key words: conservation tillage, types of machines, new technologies.

Introduction

Soils with heavy mechanical texture – soils HMT require the processing system that ensures conservation of natural resources of fertility and prevents soil degradation processes, especially in terms of optimisation of energy use, action and water.

A large number of researchers who have studied this type of soil (Vasić et al, 1991; Radojević et al., 2006; Kovačević et al., 2009a), point out that soil HMT possesses a number of specific characteristics, especially unfavourable physical and water-air properties. Because of the wide distribution of this type of soil, there is a need to modify existing methods of treatment, with a combination of existing and new technologies in the production process of the most important crops (Antončić, 1990; Ercegović et al., 2008, 2009a, b).

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The world today pays great attention to the development of agricultural machinery for the application of new technologies in the processes of exploitation of soil HMT. The Institute of Agricultural Engineering of the Faculty of Agriculture in Belgrade has been working on developing new technologies and agricultural engineering solutions for soil HMT on the surface and depth for a long time period.

These researches are directed to define and verify the technological parameters of machines and tools, test endurance of soil tillage HMT, test the effect of the implementation of new solutions to the physical-mechanical properties and water properties of that soil, test use of energy, resources and crop yields.

Researches with a new processing techniques that are applied to soil HMT, are aimed at examining the possibility of unfavourable physical and hydro-physical properties in order to raise fertility of these soils and crop yields (Kovačević et al., 2008; Kovačević et al., 2009b). Bearing in mind that in Serbia we have more than 400,000.00 ha of soil HMT and approximately 1 million hectares of degraded soil in different ways, these kinds of researches are important and useful from the standpoint of science, and even more from the standpoint of applying this research to practice.

Materials and Methods

Location and period of experiment performance with the applied technique

Experimental researches of application of new types of machines and tools were made in the production areas of the Maize Research Institute "Zemun Polje", O.D. Krnješevci in Krnješevci, on the production plot T-XVII, type of soil - meadow chernozem and humogley. The highest point of this field is 77.0 m and the lowest 74.9 m above sea level. Although there is no evidence of special micro-depression, there are sites where water retains (Profiles No. 14, 29, 33) (Vasić et al., 1991), probably due to the small coefficient of surface water runoff.

The experiment was conducted during 2008, 2009 and 2010 on the experimental plot, T-XVII, area 45.68 ha, where experimental and control plots were set (Figure 1). Previous crop on this soil during the production year of 2007 was a sunflower, and in the year of 2008 it was the malting barley. For the production year of 2009 the experimental plots were set up for two kinds of crops: sunflower (hybrid Albatre) and commercial maize (hybrid ZP SC 360 Ultra) and accompanying control plots, where the size of both experimental and control plot was 5 ha. For the production year of 2010 experimental and control plots were set up for one culture – wheat. Experimental plot occupied the area of 9.45 ha and the control plot occupied the area of 6.67 ha. The exact value of the area and elevation for marked plots was determined by measuring, using modern high-precision GPS device-Garmin Vista HCx.

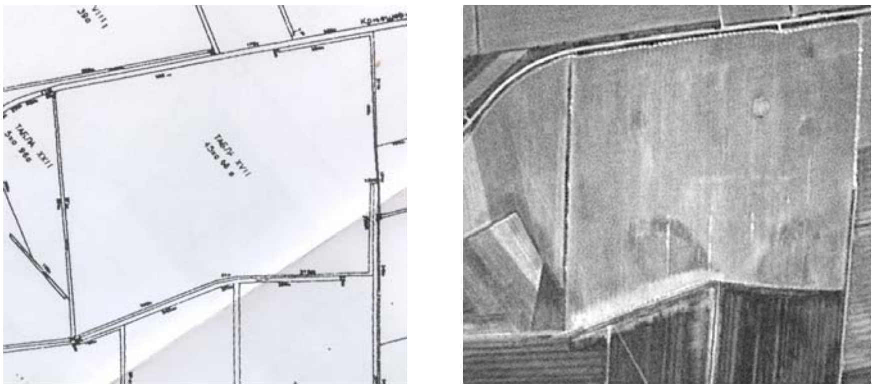

Figure 1. Geodetic (Vasić et al., 1991) and satellite image of production area, T-XVII.

Micro-depressions are able to be noticed and isolated because of the state of crops that were planted in them and that almost always lagged behind or completely failed due to excessive water retention. It was noted that they could be partially processed and that they could be only planted in the autumn period with less rainfall. However, since huge humidity that almost always appears in early spring, due to strong mutual influence of rainfall, drain and high groundwater, sown crops are often damaged or largely destroyed. Therefore, it is obvious that depression sites in this area are among the key issues that require an adequate resolution of the regulation of water regime and improvement of conditions for agricultural production. The limiting factor for the successful agricultural production on this plot is over-wetting of the soil, and so in the spring, it is almost impossible to do a complete sowing at the optimum time.

In addition to the conventional agricultural machinery, new types of machines for cultivation and soil tillage HMT were used in the experiment: Soil leveling scraper (Figure 2), Drainage plough DP-4 (Figure 3) and Vibrating subsoiler VR 5/7 (Figure 4).

Figure 2. Soil leveling scraper.

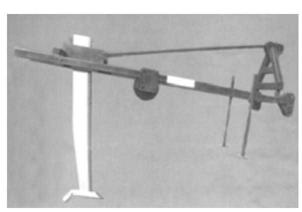

Figure 3. Drainage plough DP-4.

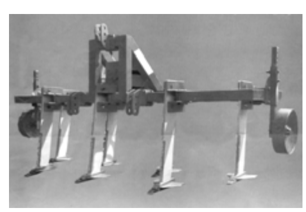

Figure 4. Vibrating subsoiler VR 5/7.

The experiment is based on the identity of all agrotehnical measures on the experimental and the control plot, except that the new types of machines for soil HMT on the surface and depth were used on the experimental plot. A conventional technology of soil tillage was used on the control plot. Conservation tillage involves the absence of ploughing as primary tillage, and the use of the drainage plough and vibrating subsoiler instead.

In the first year of the research (the production year of 2009) a preparation of drainage channel was achieved by using the drainage plough at a depth of 60-80 cm. The distance between the drainage channels was 5 m. Vibrating subsoiler (Figure 4), was used in the version with 5 working bodies (the distance between the working bodies is 60 cm), with working width of 3 m at a depth of 50 cm. After this treatment, harrowing of the soil was started by using heavy harrow 'Lemind' – 4.5 m. On the control plot ploughing was carried out by using a rotary plough 'Lemken EuroPal 8', at a depth of 30-35 cm.

This type of preparation of plots was done in the first year of testing (the production year of 2009), while in the second year of testing (the production year of 2010), the conventional methods of processing were applied both on the experimental plot and on the control plot. By using the new types of machines, the effects of prolonged application of methods for conservation of soil tillage were examined in this way.

In the first year of research (the production year of 2009), after different tillage systems on the experimental and control plots, all identical agrotechnical measures were applied.

The amount of rainfall during the experiment

It should be noted that during the execution of the experiment, the amount of rainfall during the year was monitored and that these results indicate a moderate and properly distributed rainfall throughout the year (Figure 5).

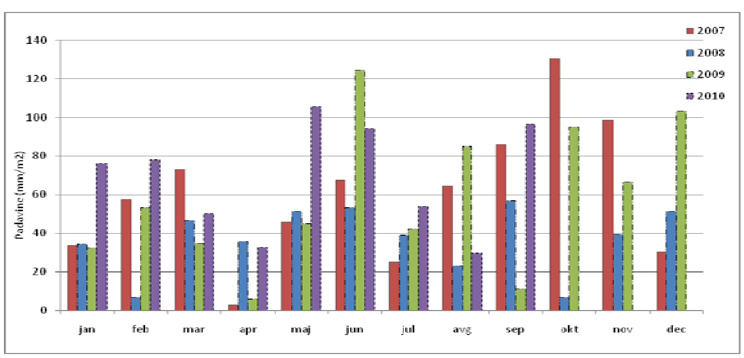

Figure 5. Distribution of rainfall on the plot T-XVII during the performance of the experiment.

Moderate amount of rainfall and its relative distribution over the year at a time of performing experiments on the production plot T-VII have reduced the effects of the drainage on the production plot. Better effect of soil drainage can be seen in the years or periods of years when it is a matter of over-wetting of soil, while during the production years, with regular and moderate rainfall, as these years were, during the experiments, the effects were minimised.

Influence examination of the application of new types of machines on the physical properties of the soil

In the researched areas, an important and limiting factor for the successful production is over-wetting of the soil. This fact does not allow the respect of fundamental agrotechnical terms of timely tillage, planting, and normal conditions for growth and development of plants or crop harvesting. Poor infiltration or permeability of soil can be the reason for water retention for a long time, which leads to suppression of crops, lack of normal operation of machinery (jamming and deterioration of the tractor up to the height of the wheels on some depressions). Field trials were set up and conducted during the period of 2008 to 2009.

Two variations of soil tillage were examined: Variation 1 – Experiment. Conservation processing by using the new types of machines – leveling with soil leveling scraper (Figure 6), then for manufacture of drainage channels drainage plough DP-4 (Figure 7) was used, processing by using vibrating subsoiler VR-5 (Figure 8) and in the end pre-sowing preparation of the soil; Variation 2 – Control. Conventional soil tillage. Conventional plough tillage and pre-sowing preparation of the soil.

Figure 6. Soil leveling scraper in working.

Figure 7. Drainage plough in working.

Figure 8. Vibrating subsoiler in working.

In the first phase, leveling was realised with soil leveling scraper. In the second phase, from 21-23 October 2008, the system of drainage channels with drainage plough was made at a depth of 60-80 cm with a spacing of 5 m. All drainage channels were connected to a central drainage channel. Primary tillage was performed on 24 October 2008 using as the new solution, the vibrating subsoiler VR-5. Conservation tillage was not performed on the control plots, but conventional tillage with reversible fully mounted plough was performed at the depth of 30-35 cm on 18 October 2008.

Samples for testing soil in undisturbed condition, were taken with cylinders Kopecky (100 cm^3), in two periods during the growing season of maize, immediately after the first inter-row cultivation on 10 June 2009 and after the second inter-row cultivation on 17 July 2009. Samples were taken from the arable layer of maize from the depths of 0-10 cm, 10-20 cm, 20-30 cm. During the testing period, the following standard methods were used (Bošnjak et al., 1997; Kovačević et al., 2008).

Soil volume with cylinders of 100 cm^3 and Kopecky method (Figure 9); soil specific mass with Albert-Bogs method; total porosity − calculated on the basis of the volume and specific mass; the amount of water according to the formula:

$$W = \frac{(10.000 \cdot h \cdot v \cdot b)}{100}$$

where W stands for water content in soil, m^3/ha, h stands for soil layer thickness, m; c stands for soil volume, g/cm^3; b stands for instant moisture, wt%.

Figure 9. Equipment for taking samples of soil (cylinders Kopecky).

Influence examination of the application of new types of machines on the morphological characteristics of cultivated plants

This study was aimed at determining the influence on the important morphological characteristic of grown plants. Experimental and control plots were prepared as previously described. As for other agrotechnical measures it is necessary to mention that in pre-sowing preparation, which was realised on 6 April 2009, by disking and harrowing, the entire amount of nitrogen with AN and Urea mineral fertilisers (112 kg/ha of active substance), was applied to the experimental and the control plot.

Sowing of sunflower hybrid Albatro was carried out on 9 April 2009, at a density of 56.022 (70 x 25.5 cm) and at the depth of 6 cm. Sowing of maize was carried out on 28 April 2009 with hybrid ZP SC 360 Ultra, at a density of 58.309 (70 x 24.5 cm) and at the depth of 5-6 cm. In the fight against weeds, herbicides were applied to the sunflower – Acris 2.8 l/ha on 14 April 2009 and to the maize – the combination of herbicide Atrazine+Acetomark+2.4 D (2.16+2.16+1.9 l/ha) with 150 l/ha of water on 21 April 2009. With the same aim, in both crops two inter-row cultivations were carried out, the first one on 21 May 2009, and the second one on 10 June 2009. Samples of monitoring the morphological and productive characteristics were taken twice, from the experimental and the control plot during the growing season of sunflower and maize. The first sampling was carried out at the end of vegetative growth stage of sunflower (bud was formed separated from apial rosettes) and maize.

Wet weight of maize roots and the other plant parts (leaf, stem and cob) were measured individually (Figures 10, 11 and 12).

Figure 10. Maize roots.

Figure 11. Maize roots in water.

The same actions were taken in sunflower plants, but the mass of roots, stem, leaf, leaf number and weight of bud was measured (Figures 13 and 14). After drying all parts in the drying chamber, the measurements were repeated in an absolutely dry state.

Figure 12. Parts of the maize stem.

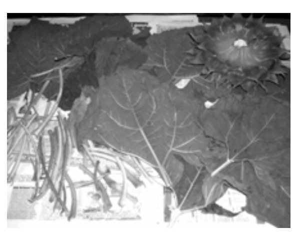

Figure 13. Leaves of sunflower.

Figure 14. Plants of sunflower.

The same procedure was applied to the tested variants of sunflower and maize, during the second sampling in the reproductive stage, precisely at the time of full flowering of sunflower and silking stage of maize.

Results and Discussion

Influence of the application of new types of machines on the physical properties of the soil

All data about the obtained physical properties of soil were analysed using the statistic method-analysis of variance. LSD test was used for individual comparisons. The results of the influence of conservation tillage on important physical properties of soil are presented in Tables 1 and 2.

Table 1. Research results of the influence of conservation tillage on physical properties of soil before inter-row cultivation.

Variations (A)	Depth (cm) (B)	Bulk density (g/cm^3)	Porosity (%)	MWC (% vol.)	% humidity		Amount of water (m^3/ha)
					vol.	mass	
Conservation tillage (a1)	(b1) 0-10	1.08	57.8	40.6	27.1	21.9	714
	(b2) 10-20	1.34	48.5	41.2	27.8	20.9	837
	(b3) 20-30	1.35	48.7	36.6	29.7	21.9	892
Average	0-30	1.26	51.6	39.5	28.2	21.6	814
Control (a2)	(b1) 0-10	1.44	43.9	34.4	29.6	20.6	888
	(b2) 10-20	1.42	45.6	37.1	34.9	24.5	1042
	(b3) 20-30	1.42	45.6	36.1	28.4	20.0	851
Average	0-30	1.43	45.0	35.8	31.3	21.9	927
LSD A	0.005	0.038	1.476	1.980	4.736	0.724	32.376
	0.001	0.053	2.069	2.775	6.641	1.014	45.393
LSD B	0.005	0.054	2.087	2.780	6.698	1.023	45.787
	0.001	0.076	2.926	3.925	9.391	1.435	64.195
LSD AB	0.005	0.076	2.952	3.959	9.473	1.447	64.754
	0.001	0.108	4.139	5.551	13.281	2.289	90.786

Higher bulk density is an indicator of the increased density. On the soil, to which new types of machines were applied, a significantly lower bulk density was obtained in each period compared with the control. In the first period of research there is a significant difference between the two examined variations and the examined depth, except for the third (20-30 cm). Greater soil loosening in the experimental area can be seen from the higher porosity. Higher porosity allows better air flow and rapid infiltration of water. This can be seen from the moisture content. Higher moisture content on the control variation is a result of higher density of individual layers. The total amount of water has significantly contributed to this. It can be seen that the control variation at all depths has larger amount of water. In loam soils it does not mean higher availability of water. This circumstance at higher rainfall could be the limit on fast water flow.

Based on the data it can be seen that the tested soil properties have their own dynamics during the growing season of maize. These values are lower in the period after the first inter-row cultivation. The second inter-row cultivation will be done after the gradual growth, a month after that.

In the second observation period (Table 2), values of the bulk density at all depths and examined layers, are higher than values in the first observation period. The resulting difference between the variant and examined depths is statistically very significant. It shows the positive results of derived impacts of conservation tillage.

Table 2. Research results of the influence of conservation tillage on physical properties of soil before the second inter-row cultivation.

Variations (A)	Depth (cm) (B)	Bulk density (g/cm^3)	Porosity (%)	MWC (% vol.)	% humidity		Amount of water (m^3/ha)
					vol.	mass	
Conservation tillage (a1)	(b1) 0-10	1.19	54.2	43.6	19.1	16.9	592
	(b2) 10-20	1.44	43.8	39.1	21.8	15.3	656
	(b3) 20-30	1.45	44.4	36.5	28.7	19.9	865
Average	0-30	1.38	47.5	39.7	23.2	17.4	704
Control (a2)	(b1) 0-10	1.44	44.3	40.0	28.4	20.2	860
	(b2) 10-20	1.51	44.9	36.8	25.1	16.7	755
	(b3) 20-30	1.45	45.0	41.3	29.4	20.7	892
Average	0-30	1.46	43.8	39.6	27.7	19.20	836
LSD A	0.005	0.065	2.566	1.493	2.962	2.777	43.169
	0.001	0.092	3.597	2.093	4.153	3.892	60.524
LSD B	0.005	0.093	3.629	2.112	4.189	3.927	52.871
	0.001	0.130	5.088	2.961	5.873	5.505	74.771
LSD AB	0.005	0.131	5.132	2.986	5.924	5.553	74.771
	0.001	0.184	7.195	4.187	8.305	7.786	104.830

Tillage system that was used, consisted of leveling of the field, building the drainage canals by using drainage plough and tillage with vibrating subsoiler, has resulted in an increased soil loosening as we can see from significantly lower values of bulk density, higher total porosity and better connection between the solid liquid and gaseous phases in both test periods. The soil properties were improved in the first year and it became more favourable habitat for growing crops, however, the prolonged effect on the other crops in the coming years should be noted.

Influence of the application of new types of machines on the morphological characteristics of cultivated plants

Results of the effects of conservation tillage on the morphological characteristics of sunflower in the vegetative stage of growth during the butonisation, as a characteristic stage of plant growth, are shown in Table 3. According to the data, a high statistical significance can be seen between examined characteristics, starting with the mass of roots, stem, leaves and buds in the raw condition, and after drying chamber in absolutely dry condition.

Table 3. Influence of application of new types of machines on major morphological and productive characteristics of sunflower at the end of budding.

Variations	Mass of root (g)		Total stem height (cm)	Mass of stem (g)		Number of leaves	Mass of leaves (g)		Mass of bud (g)	
	wet	dry		wet	dry		wet	dry	wet	dry
Conservation	87.00	13.01	93.50	361.82	34.12	24.00	371.85	62.00	13.45	1.72
Control	79.75	10.47	91.50	322.67	28.37	21.75	337.50	53.10	10.47	1.40
LSD 0.05	3.342	2.083	8.177	35.036	2.480	0.998	75.185	9.703	1.913	0.451
LSD 0.01	5.063	3.155	12.387	53.077	3.758	1.513	113.900	14.699	2.899	0.683

Table 4 presents the data about morphological parameters of sunflower in the reproductive stage, precisely at the time of flowering and opening of three floral zones. Differences in the monitored parameters, although they were in favour of conservation tillage, were less pronounced. In fact, conservation tillage influenced the mass of stem and the mass of heads. This difference was statistically justified.

Table 4. Influence of application of new types of machines on major morphological and productive characteristics of sunflower in flowering and fertilisation stage.

Variations	Mass of root (g)		Total stem height (cm)	Mass of stem (g)		Number of leaves	Mass of leaves (g)		Mass of head (g)	
	wet	dry		wet	dry		wet	dry	wet	dry
Conservation	396.95	116.65	154.0	948.35	166.80	25.50	563.65	112.65	574.01	63.4
Control	379.40	102.30	140.0	924.65	160.35	22.25	532.15	108.60	534.70	62.1
LSD 0.05	25.185	7.456	14.128	10.567	19.161	0.934	33.594	15.576	22.252	7.857
LSD 0.01	38.153	11.295	21.400	16.008	29.028	1.415	50.892	23.599	33.710	10.994

In the first examination phase of maize – the so-called vegetative phase, the effects of conservation tillage on biomass of root, stem and leaf, in a wet and absolutely dry state were followed. The data are presented in Table 5. Under the influence of conservation tillage, the mass of root was increased as a result of soil loosening and favourable physical properties. Greater differences in the mass of stem and leaves are statistically significant.

Table 5. Influence of application of new types of machines on important morphological features in the late vegetative stage of maize.

Variations	Mass of root (g)		Total stem height (cm)	Mass of stem (g)		Number of leaves	Mass of leaves (g)	
	wet	dry		wet	dry		wet	dry
Conservation	37.67	4.00	111.50	133.52	9.40	14.0	99.25	18.03
Control	33.15	3.52	110.25	113.25	7.27	13.0	94.10	15.95
LSD 0.05	3.584	0.996	2.421	11.830	1.596	0.712	6.372	2.420
LSD 0.01	5.430	1.509	3.668	17.921	2.418	1.068	9.653	3.660

Morphological features of root, stem, leaf, young maize tassels and cob, total stem height and stem height to the cob (Table 6) were followed in the generative phase of maize. From the presented data we can clearly see the difference in favour of conservation tillage regarding all tested parameters. High statistical significance was found in the mass of root, stem, number, mass of leaf and length of cob in wet, but not in the absolutely dry state. The total stem height and cob height were not statistically significant.

Table 6. Influence of application of new types of machines on the important morphological characteristics of maize in the reproductive growth stage (silking stage).

Variations	Mass of root (g)		Total stem height (cm)	Mass of stem (g)		Number of leaves	Mass of leaves (g)		Mass of maize panicle (g)		Cob height (cm)	Cob length (cm)
	wet	dry		wet	dry		wet	dry	wet	dry		
Conservation	341.0	87.10	282.10	523.5	108.50	18.00	209.01	69.50	16.00	4.70	94.0	38.3
Control	307.0	78.60	271.95	455.5	105.00	17.25	193.50	66.10	13.60	4.60	91.0	36.0
LSD 0.05	9.939	3.211	11.933	9.608	7.640	0.612	2.896	1.579	1.854	0.412	2.912	1.368
LSD 0.01	15.058	4.864	18.077	14.555	11.575	0.927	4.387	2.393	2.809	0.624	4.412	2.072

Based on the analysis of data on the influence of the application of new types of machines and soil tools for soil tillage HMT, on more important morphological characteristics of sunflower and maize (mass of roots, stems, leaves and reproductive organs, sunflower heads and maize cob and maize tassels) in their important stages of increase, at the end of vegetative and reproductive stage, it can be concluded that the applied tillage system had a positive effect on the observed morphological characteristics and productivity of maize and sunflower. As the final result of the impact on all analysed morphological features of both crops, a significant increase in grain yield of both crops was achieved. All soil characteristics were significantly improved. This tillage system affected soil loosening. Better characteristics of the soil of reduced compaction made it more favourable habitat for growing crops of sunflower and maize in the very first year.

Influence of the application of new types of machines on yield

The tests, conducted in the first year (the production year of 2009), on experimental and control plot of sunflower and commercial maize, have showed a significantly higher yield on the experimental than on the control plot, i.e. a higher yield was achieved using the new machines for arrangement of soil surface and depth compared to the conventional method of soil tillage. Test results are shown in Table 7 and Figure 15.

Table 7. Surface area and grain yield of sunflower and maize, in the production year of 2009, after using conservation and conventional tillage method.

Tillage method	Sunflower			Maize		
	Total surface area (ha)	Total yield (kg)	Yield (kg/ha)	Total surface area (ha)	Total yield (kg)	Yield (kg/ha)
Conservation tillage method (experimental plot)	5.09	15,328.38	3,011.47	4.80	34,000.00	7,083.33
Conventional tillage method (control plot)	7.21	19,850.43	2,753.18	4.95	31,580.00	6,379.80

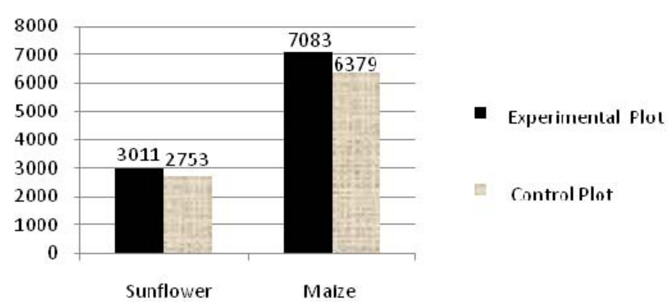

Figure 15. Total grain yield of sunflower and maize (kg) during the first production year of 2009.

In the second year of research (the production year of 2010), the influence of the prolonged effects of conservation tillage with the new types of machines and tools, was investigated. The grown crop was wheat (variety Dragana) on the experimental plot, where conservation tillage was used during the previous year on the surface area of 9.45 ha and on the control plot of 6.67 ha. The results of achieved yield are shown in Table 8 and Figure 16.

Table 8. Surface area and the yield of wheat in the second year of research (the production year of 2010).

Tillage method	Wheat		
	Total surface area (ha)	Total yield (kg)	Yield (kg/ha)
Conservation tillage method (experimental plot)	9.45	42,750.00	4,525.00
Conventional tillage method (control plot)	6.67	23,860.00	3,577.00

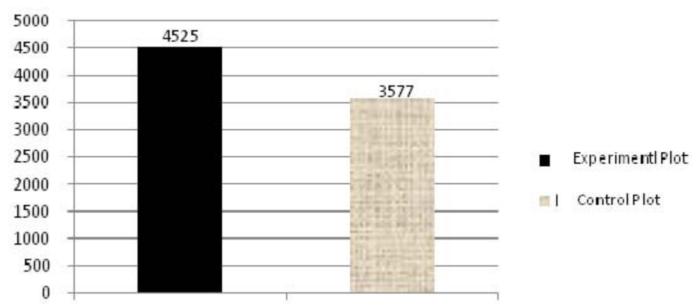

Figure 16. Total yield of wheat (kg) in the second year of research (the production year of 2010).

A significant increase of yield on the experimental plot can be attributed to the prolonged effect of conservation tillage derived from new types of machines and tools. The beneficial effect of prolonged tillage effect is predicted for the next four years from the date of application, and after that period it is necessary to repeat conservation tillage.

Analysis of economic aspects of the application

The sum of invested energetic parameters (fuel consumption) reduced per unit area, is a major indicator of energy investment in certain types of production. In addition to these investments, there are investments in the purchase of seeds, fertilisers and pesticides, etc., which are identical, both on the experimental and on the control plot. Because of that, these investments are not currently interesting from the standpoint of consideration of the total investment in certain types of products for the system of soil tillage.

In the first year of research (the production year of 2009), in the production of sunflower and commercial maize, the ratio of energy invested in manufacturing, realised yield, energy prices and products, according to the methods of cultivation can be seen from Table 9.

Table 9. The relation of exploitation, energetic and economic parameters in the production of sunflower and commercial maize, depending on the method of tillage (the production year of 2009).

Tillage method	Sunflower				Maize			
	Total fuel consumption (l/ha)	Total fuel cost (RSD/ha)	Gained yield (t/ha)	Total profit from the yield (RSD/ha)	Total fuel consumption (l/ha)	Total fuel cost (RSD/ha)	Gained yield (t/ha)	Total profit from the yield (RSD/ha)
Conservation Tillage method (experimental plot) 1	119.78	11,738.00	3,011.00	51,187.00	125.11	12,261.00	7,083.00	56,672.00
Conventional tillage method (control plot) 2	107.70	10,554.00	2,753.00	46,801.00	113.03	11,077.00	6,380.00	51,040.00
1 > 2 in %	10.01		8.6		9.07		9.9	

In the second year of research (the production year of 2010), experimental and control plots were subjected to conventional method of tillage, due to the research into the influence of prolonged effect conservation methods of tillage, so it was not possible to make a comparative review of energy and operational parameters, as in the first year of testing. Table 10 presents energetic and economic parameters in wheat production (the production year of 2010).

Table 10. Energetic and economic parameters in wheat production in the second year of research (the production year of 2010).

Plot	Wheat			
	Total fuel consumption (l/ha)	Total fuel cost (RSD/ha)	Gained yield (t/ha)	Total profit from the yield (RSD/ha)
Experimental plot (conventional tillage)	52.57	6,046.00	4,525.00	67,875.00
Control plot (conventional tillage)	52.57	6,046.00	3,577.00	53,655.00

Conclusion

Based on the results obtained in the two-year research on the effects of application of conservation and conventional models of soil tillage HMT in the production of sunflower, commercial maize and wheat, using new types of machines and tools, it can be concluded:

By using the drainage plough and vibrating subsoiler a positive effect in the production of soils HMT can be achieved.

All the soil characteristics have been significantly improved. This tillage system had beneficial effect on soil loosening.

Applied system of tillage has had a positive effect on observed morphological characteristics and productivity of maize and sunflower. As the final result, a very significant increase in grain yield in both crops was obtained.

Conservation tillage compared to conventional tillage system results in higher yields of sunflower and maize in the first year ranging from 8.6 to 9.9%. In the second year of the research, the yield of wheat was increased by 20.9%.

By using conservation tillage system, the realisation of optimal agrotechnical terms, the establishment of a more favourable water-air regime of soil HMT is possible, as well as more efficient use of biological fertility of soil.

High fuel costs are restored already in the first year of use, with higher yield.

The change of tillage system for soil HMT, has resulted in a yield increase in the production of sunflower and commercial maize, and has brought an additional (extra) profit per unit area of 4,000.00 to 6,000.00 RSD per hectare, which is more if we distribute the costs of fuel in the three production years (a prolonged effect of the application of new technologies).

By using conservation tillage systems of soil HMT, water logging is prevented in depressions of experimental plot during the operation, as well as the accompanying negative effects, while in the earlier years it was a common occurrence.

The application of this new tillage technology of soil HMT has even bigger effect in years with more pronounced rainfall, i.e. with hydrologic-climatic extremes, during the growing season of crops.

Investigations do not represent the final results of the application of new tillage technology of soil HMT. It is necessary to extend this research to other significant culture and to extend the existing research for a prolonged effect of the application of new technologies.

Acknowledgements

This research is the part of the Project “Effects of the implementation and optimisation of new technologies, equipment and machinery for cultivation and tillage of soil in crop production”, record number TR 20092, which was funded by the Ministry of Science and Technology, the Republic of Serbia.

References

Antončić, I. (1990): Mehanizacija dubinskih agromelioracionih zahvata. Zbornik radova, Aktuelni zadaci mehanizacije poljoprivrede, Opatija, pp. 280-287.

Bošnjak, Đ., Dragović, S., Hadžić, V., Babović, D., Kostić, N., Burlica, Č, Đorović, M., Pejković, M., Mihajlović, D., Stojanović, S., Vasić, G., Stričević, R., Gajić, B., Popović, V., Šekularac, G., Nešić, Lj., Belić, M., Đorđević, A., Pejić, B., Maksimović, L., Karagić, Đ., Lalić, B., Arsenić, I. (1997): Metode istraživanja i određivanja fizičkih svojstava zemljišta. In: Bošnjak, Đ. (Eds.), Komisija za fiziku zemljišta, Jugoslovensko društvo za proučavanje zemljišta, Novi Sad, pp. 1-278.

Ercegović, Đ., Raičević, D., Vukić, Đ., Oljača, M., Radojević, R., Pajić, M., Gligorević, K. (2008): Tehničko-tehnološki aspekti primene mašina i oruđa za uređenje zemljišta po površini i dubini. Poljoprivredna tehnika 33(2):13-26.

Ercegović, Đ., Pajić, M., Raičević, D., Oljača, M., Gligorević, K., Vukić, Đ., Radojević, R., Dumanović, Z., Dragićević, V. (2009a): Uticaj konzervacijske obrade zemljišta na prinos suncokreta i merkantilnog kukuruza. Poljoprivredna tehnika 34(2):69-82.

Ercegović, Đ., Raičević, D., Vukić, Đ., Radojević, R., Gligorević, K., Pajić, M., Oljača, V. (2009b): Technical-technological aspects of using machines and tools for new technologies in plant production. Journal of Agricultural Sciences 54(3):257-268.

Kovačević, D., Oljača, S., Dolijanović, Ž., Oljača, M. (2008): Uticaj savremenih sistema obrade zemljišta na prinos važnijih ratarskih useva. Poljoprivredna tehnika 33(2):73-80.

Kovačević, D., Dolijanović, Ž., Oljača, M., Oljača, J. (2009a): Uticaj meliorativne obrade na neke fizičke osobine zemljišta. Poljoprivredna tehnika 34(2):35-42.

Kovačević, D., Dolijanović, Ž., Jovanović, Ž., Kolčar, D. (2009b): Uticaj meliorativne obrade zemljišta na razvoj korenovog sistema, zakorovljenost, morfološke i produktivne osobine suncokreta i kukuruza. Poljoprivredna tehnika 34(2):15-26.

Radojević, R., Raičević, D., Oljača, M., Gligorević, K., Pajić, M. (2006): Uticaj jesenje obrade na sabijanje teških zemljišta. Poljoprivredna tehnika 31(2):63-71.

Vasić, G., Milošević, Lj., Tolimir, M. (1991): Pedološka studija zemljišta Instituta za kukuruz O.D. Krnješevci, Krnješevci. Sveska II, Beograd, pp. 1-135.

Received: November 1, 2010
Accepted: January 27, 2011

REZULTATI ISTRAŽIVANJA VIŠEGODIŠNJE PRIMENE NOVE LINIJE MAŠINA I ORUĐA ZA UREĐENJE ZEMLJIŠTA PO POVRŠINI I DUBINI

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R e z i m e

U ovom radu su prikazani dvogodišnji rezultati primene mašina i oruđa za nove tehnologije u biljnoj proizvodnji. Izvršena je uporedna analiza uticaja primene nove tehnologije i nove linije mašina, kao i uticaj konvencionalnog sistema obrade na nekoliko ratarskih kultura (suncokret, merkantilni kukuruz i pšenica). U toku ispitivanja, analizirani su uticaji primene nove linije mašina na: fizičke osobine zemljišta, morfološke osobine gajenih biljaka, utrošak energije i prinos, a takođe su analizirani i ekonomski aspekti primene. Na kontrolnim parcelama je istovremeno bio primenjen konvencionalni sistem obrade, radi uporedne analize prethodno pomenutih faktora. Ogledi su izvedeni na proizvodnim parcelama Instituta za kukuruz "Zemun Polje" u Krnješevcima u periodu od oktobra 2008. godine do jula 2010. godine.

Ključne reči: konzervacijska obrada, linija mašina, nove tehnologije.

Primljeno: 1. novembra 2010.
Odobreno: 27. januara 2011.

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