EFFECTS OF DIFFERENT SOIL TILLAGE SYSTEMS ON YIELD OF MAIZE, WINTER WHEAT AND SOYBEAN ON ALBIC LUVISOL IN NORTH-WEST SLAVONIA

UTJECAJ RAZLIČITIH SUSTAVA OBRADE TLA U PROIZVODNJI KUKURUZA, OZIME PŠENICE I SOJE NA LESIVIRANOM TLU SJEVERO-ZAPADNE SLAVONIJE

***Silvio KOŠUTIĆ[1], Dubravko FILIPOVIĆ[1], Zlatko GOSPODARIĆ[1], Stjepan HUSNJAK[2], Igor KOVAČEV[1], Krešimir ČOPEC[1]**

[1]Faculty of Agriculture, Department of Agricultural Engineering, Zagreb, Croatia, *e-mail: skosutic@agr.hr
[2]Faculty of Agriculture, Dept. of Soil Sciences, Zagreb, Croatia

ABSTRACT

The paper presents comparison of three soil tillage systems in maize, winter wheat and soybean growing on anthropogenic Albic Luvisol in north-west Slavonia, Croatia, during 1996-1999. Tillage systems and implements were: 1. conventional system (CT)-plough, disc-harrow and combined implement, 2. conservation system (RT)-chisel plough and multitiller, 3. no-till system (NT). The aim of testing was comparison of different tillage systems energy requirement and its influence on yield. Results indicate that conventional tillage (CT) system was the greatest energy consumer with 1813.10 MJ ha^{-1}. Comparing to conventional tillage (CT) system, conservation (RT) system with chisel plough and multitiller spent 1133.14 MJ ha^{-1}or 37.5 % less, while no-till (NT) system required even 85.1 % less energy or 270.13 MJ ha^{-1}. In the first season the greatest yield of maize, 7.78 Mg ha^{-1}, achieved conventional tillage (CT) system while next to it was conservation (RT) system with 7.77 Mg ha^{-1}. No-till (NT) system achieved 7.56 Mg ha^{-1}. Second season the greatest yield of winter wheat, 5.89 Mg ha^{-1}, achieved conservation tillage (RT) system. Next to it was conventional (CT) system with 5.75 Mg ha^{-1}, while no-till (NT) achieved 5.73 Mg ha^{-1}. Third season the greatest yield of soybean, 2.71 t ha^{-1}, achieved conservation tillage (RT) system again, while next to it was conventional (CT) system with 2.64 Mg ha^{-1}. No-till (NT) achieved 2.61 Mg ha^{-1}.

KEY WORDS: soil tillage, energy requirement, yield of maize, yield of winter wheat, yield of soybean

SAŽETAK

Rad prikazuje rezultate istraživanja primjene tri (3) različita sustava obrade tla u proizvodnji soje, ozime pšenice i kukuruza na antropogeniziranom lesiviranom tlu zapadne Slavonije, u vremenu 1996-1999. godine. Testirani sustavi obrade su: 1. konvencionalni sustav (CT)-plug, tanjurača i kombinirano oruđe, 2. konzervacijski sustav (RT)-rovilo i multitiller, te 3. nulta obrada (NT)-no-till sijačica. Cilj istraživanja bila je usporedba utroška energije različitih sustava obrade tla i njihov utjecaj na prinos uzgajanih usjeva. Konvencionalni sustav (CT) obrade tla najveći je potrošač energije sa 1813.10 MJ ha^{-1}, dok konzervacijski sustav (RT) iziskuje 37.5 % manje, a nulta obrada (NT) čak 85.1 % manje energije po hektaru. Najveći prinos kukuruza od 7.78 Mg ha^{-1} ostvaren je konvencionalnim sustavom, ali gotovo identičan rezultat s 7.77 Mg ha^{-1} konzervacijskim (RT) sustavom. Nultim (NT) sustavom obrade ostvaren je prinos kukuruza od 7.56 Mg ha^{-1}. U drugoj eksperimentalnoj godini najveći prinos ozime pšenice od 5.89 Mg ha^{-1} ostvario je konzervacijski (RT) sustav obrade. Slijedeći po rezultatu je konvencionalni sustav (CT) s 5.75 Mg ha^{-1}, te nulti (NT) sustav obrade s 5.73 Mg ha^{-1}. U trećoj je godini najveći prinos soje od 2.71 Mg/ha ostvario je konzervacijski (RT) sustav, a slijede konvencionalni (CT) sustav s 2.64 Mg ha^{-1} i nulti (NT) sustav obrade s 2.60 Mg ha^{-1}.

KLJUČNE RIJEČI: obrada tla, potrošnja energije, prinos kukuruza, prinos ozime pšenice, prinos soje

INTRODUCTION

In arable crops growing soil tillage is usually marked as one of the greatest energy and labour consumer. The primary tillage operations require 75% F the total energy spent before the seed-time [19]. Although numerous investigations have proved efficiency of non-conventional soil tillage systems in a manner of saving significant amount of energy and labour, 93.7% of arable growing land in Slavonia and Baranja are still being plouged [26]. Substitution of conventional tillage system by various types of conservation tillage in USA recently reached level of 41% total arable land (45.64 x 10^6 hectars). Within mentioned land area no-till reached even 23% or 24.96 x10^6 hectars [1]. During recent years Europe also noticed mentioned trend of non-conventional tillage followers increase. Therefore, nowadays conservation tillage occupies 1.3% of total agriculture land in Portugal, very significant amount of 14% in Spain, 17% in France, 20% in Germany till fascinating 30% of total agricultural land in United Kingdom [2]. Two basic reasons that initiated mentioned changes could be explained by ecological and economic factors. Conventional tillage is on the one side the most expensive, complicated, organisationally slow system and is significantly great energy and labour consumer, while on the other side it is also ecologically unfavourable way of soil tillage [27]. According to Tebrügge and Düring [23] ecological disadvantages of conventional soil tillage system are as follows: increasing of soil compaction induced by frequent machinery traffic over the same area, continuous decreasing of soil organic matter as aftermath of intensive and frequent soil tillage, greater erosion susceptibility of conventionally tilled soils and finally significant CO_2 emission as a greenhouse gas due to burning of great fossil fuel quantities required for doing that job as well as consequence of stimulation of mineralization of organic matter in soil. On the contrary, non-inversion soil tillage together with harvest residues incorporation, which makes the basic characteristic of conservation tillage system, recovers natural soil fertility being thus counterweight to anthropogenic soil compaction and exposing of soil to erosion [24]. According to Stipesevic et al. [21], application of reduced or conservation soil tillage for arable crops in East Croatia conditions is recommended because of the following reasons: ecological (soil compaction reduction), economic (cost reduction) and organizational (reducing of field operations). The non-conventional tillage systems in Croatian conditions achieved better economic efficiency than conventional tillage system [13]. Different authors [4], [22], [11] and [9] also pointed out to ecological and economic advantages of non-conventional soil tillage systems. Following previously mentioned research interest Agricultural Engineering Department, Faculty of Agriculture in Zagreb performed an experiment with three essential systems of soil tillage and cropping sequence Maize-Winter Wheat-Soybean on silty loam in north-west Slavonia.

MATERIALS AND METHODS

Experiment was performed at agricultural company"Poljoprivreda Suhopolje" in Suhopolje (45° 50' N, 17° 26' E) located 150 km northeast from Zagreb. Experimental field was consisted of nine plots with dimension length 100 m x width 30 m each, organized as randomized blocks with three replications. Implements included in different tillage systems, were as follows:

1. Conventional tillage - plough, disc harrow, seedbed preparation implement (CT)
2. Conservation tillage – chisel plough, multitiller (RT)
3. No-till - no-till drill (NT)

Depth of tillage for mouldboard plough was in average a =32.4 cm, disc harrow a =10.2 cm, seedbed preparation implement a = 6.3 cm. Chisel plough working depth was in average a =33.1 cm and multitiller a =8.4 cm. The tillage with different systems was performed on the Albic Luvisol, according to WRB for Soil Resources (1994), which by its texture, belongs to the silty loam (Table 1.), according to the Soil Survey Staff of the United States Department of Agriculture (1975). According to the basic chemical property data this soil is acid with pH 5.6 (measured in water) and pH 4.9 (measured in M KCl), very rich in physiological nutrients, phosphorus and potassium (determined by Al-method), as well as in nitrogen (determined by Micro-Kjeldahl method). As for the organic matter level of 2.7% (assessed by bichromath Tjurin method), it belongs to a group of soil with good level of organic matter. Schedule of the tillage operations and soil moistures at the moment of tillage are showed in the Table 2.

The first growing season

On the experimental field, previous crop was spring barley. Post harvest residues were chopped at the end of July 1996. Primary tillage for maize with mouldboard and chisel plough was done in the middle of November 1996. Secondary tillage with disc harrow, seedbed preparation implement and multitiller was performed in the second decade of April 1997 and sowing of maize hybrid Bc-592 also during second decade of April 1997. Prior to sowing 60 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 60 kg ha^{-1} K_2O in form of compound fertiliser NPK and 80 kg ha^{-1} of urea was applied. Plant protection was performed first time in the third decade of April with 1.5 l ha^{-1} of

Table 1. Soil particle size distribution and soil type
Tablica 1. Mehanički sastav i teksturna oznaka tla

Depth Dubina (cm)	Particle size distribution (%) Mehanički sastav (%)				Soil type Teksturna oznaka tla
	< 2μm	2-20μm	20-200μm	200-2000 μm	
0-10	22.6	28.0	42.9	6.5	Silty loam Praškasta ilovača
10-20	22.8	27.8	43.3	6.1	Silty loam Praškasta ilovača
20-30	21.4	24.6	48.6	5.4	Silty loam Praškasta ilovača

Table 2. Date of tillage operations and soil moistures at the moment of tillage and at field capacity (FC)
Tablica 2. Datum obavljanja obrade tla s pripadajućim sadržajem vode u tlu i poljskim kapacitetom (FC)

Operation	Soil moisture (%, w/w) Depth (cm)		
	0-10	10-20	20-30
Primary tillage Nov 14, 1996	22.1	19.8	19.1
Secon. tillage Apr 15, 1997	18.4	19.6	20.3
Primary tillage Oct 23, 1997	21.6	20.1	19.7
Secon. tillage Oct 28, 1997	19.9	19.6	19.4
Primary tillage Oct 25 1998	22.3	19.2	19.6
Secon. tillage Apr 15 1999	19.8	21.3	22.5
FC	33.8	34.2	35.0

Dual 960 EC (chloroacetanilide herbicide). Second treatment was performed in the first decade of May with 3.0 l ha^{-1} of Basagran (bentazone) and third treatment in the third decade of May with 1.0 l ha^{-1} of Motivell (pyrimidinylsulfonylurea herbicide) and 0.6 l ha^{-1} of Banvel 480 S (benzoic acid herbicide). Maize harvesting was in the first decade of October 1997. Average air temperatures in 1997 were within thirty years average, except a bit colder April. Total precipitation within growing season in 1997, (Table 2.) were also within thirty years average but during July there were double amount of rain in comparison to 30 years average, while precipitation in September were only 3.3% of 30 years average. Although there were deviation of the air temperature and precipitation, growing period of the maize could be described as more or less as common growing season.

The second growing season

Primary and secondary tillage for winter wheat was performed during the second decade of October 1997. On experimental field winter wheat cultivar"Manda" was sown at the end of October. Prior to wheat sowing, 60 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 60 kg ha^{-1} K_2O in form of compound fertilizer NPK and 200 kg ha^{-1} urea was applied. Plant protection was first time preformed immediately after sowing or at the end of October with 2.0 kg ha^{-1} of Dicuran Forte (phenylurea + triazinylsulfonylurea herbicide). The first top dressing was done at the end of February 1998 with 200 kg ha^{-1} of KAN (Calcium Ammonium Nitrate) and second in the beginning of the second decade of May with the same quantity of KAN. The last plant protection was performed in the first decade of May with 0.8 l ha^{-1} Starane (phyridine herbicide), 0.5 l ha^{-1} Tilt (conazole fungicide), 0.3 l ha^{-1} Bavistin-FL (benzimidazolylcarbamate fungicide) and 0.6 l ha^{-1} Chromorel (pyridine organothiophosphate + pyrethroid ester insecticide). Wheat was harvested at the beginning of July 1998. The average air temperatures during growth season of winter wheat (1997/98) were higher than 30 years average. This means especially for December, January and February, while October was colder than 30 years average. Total precipitation during growth season of winter wheat was within 30 years average, except of July with double amount of rain than average. Thus, growth season 1997/98 could be characterised as a bit warmer and wetter than 30 years average (Table 3.).

The third growing season

Primary soil tillage with mouldboard plough and chisel plough for soybean was done at the end of October 1998. Secondary tillage on CT and RT system plots was performed in the middle of April 1999, while NT plots were treated with Cidokor (organophosphorus herbicide). Soybean cultivar "Gordana" was sown in the beginning of May 1999. Prior to sowing 28 kg ha^{-1} N, 80 kg ha^{-1}

Table 3. Weather conditions in Suhopolje in the years 1997, 1998, 1999 and 30-year average (1965-1994)
Tablica 3. Klimatski uvjeti u Suhopolju u 1997., 1998., 1999. godini i tridesetgodišnji prosjek (1965-1994.)

Month Mjesec	Precipitation Oborine (mm)				Mean air temperature Srednje temperature zraka (^{O}C)			
	1997	1998	1999	1965-1994	1997	1998	1999	1965-1994
January		89.9	32.0	47.5		3.3	0.9	0.1
February		2.5	85.1	45.9		6.0	2.0	1.6
March		57.6	26.6	65.0		5.4	8.6	6.4
April	53.4	77.8	92.8	61.3	7.5	12.7	12.5	112
May	81.5	90.0	86.4	82.1	17.5	15.9	17.5	16.2
June	101.1	62.8	157.9	102.9	20.4	21.5	19.8	19.0
July	144.7	163.8	135.9	61.6	20.1	21.3	21.8	21.8
August	77.6	143.0	83.1	75.0	20.3	21.0	20.9	21.2
September	2.3	115.7	48.8	69.9	16.4	15.4	18.7	17.2
October	79.2	113.3	44.4	68.6	9.1	12.8	11.5	11.2
November	89.7	93.5		62.3	5.8	4.1		5.0
December	97.7	40.2		75.2	2.9	-2.3		1.9
Total	835.2	1068.1	982.2	817.3	10.7	11.4	11.6	11.1

P_2O_5 and 120 K_2O kg ha^{-1} in form compound fertiliser NPK was applied. Plant protection was done in the second decade of May with 3.5 kg ha^{-1} Sencor (triazinone herbicide) and 7.0 L ha^{-1} of Dual Gold (chloroacetanilide herbicide). Soybean harvesting was in the beginning of the third decade of October 1999. The average air temperatures during growth season 1999 were within 30 years average. Although total precipitation during growth season were within 30 years average, June and July had 53% and 120% more rain than average, respectively. The 1999 season could be characterised as a bit wetter than long-term average.

The energy requirement for each tillage system, implement and crop was determined by measuring of the tractor fuel consumption applying volumetric system. Energy equivalent of 38.7 MJ L^{-1} according to Cervinka [7], was taken for energy calculations. A 4WD (Four Wheel Drive) tractor with 92 kW engine power was used in this experiment. The working width of the tillage implements was chosen according to the pulling capacity of the tractor. The labour requirement was determined by measuring the time for finishing single tillage operation at each plot of the known area (3000 m^2). The yields were determined by weighing grain mass of each harvested plot.

The obtained data for each experimental year were analysed applying the analysis of variance (ANOVA). The Duncan's test was used to compare the mean results, after a significant variation had been highlighted by ANOVA. The differences had been considered as significant if $P < 0.05$.

RESULTS AND DISCUSSION

Yield

The greatest maize yield of 7.78 Mg ha^{-1} in the first experimental season achieved conventional tillage system (CT). Conservation tillage system (RT) yielded 7.77 Mg ha^{-1} or only 0.1% less, while no-till system (NT) achieved 7.56 Mg ha^{-1} or 2.8% less maize grain than CT system but differences were not significant (Table 4.). According to Central Bureau of Statistics of the Republic of Croatia [6], average maize yield at legal entities and parts of legal entities in 1997 was 7.49 Mg ha^{-1}, which shows that experimental yields were above average. Yields are often compared through different tillage systems and authors often report of higher yields that can be achieved with conventional tillage in comparison to other non-conventional tillage systems (reduced, conservation and no-till or zero-till). Borin and Sartori [4], reported that among conventional tillage, minimum tillage and no-tillage in maize growing the highest yield had been obtained with the conventional tillage. Maurya [17], also reported of lower maize grain yield achieved with no-till system than with conventional tillage.

In the second season the greatest winter wheat yield of 5.89 Mg ha^{-1} achieved conservation tillage system (RT). Conventional tillage system (CT) achieved 5.75 Mg ha^{-1} or 2.4% less and no-till system (NT) achieved 5.73 Mg ha^{-1} or 2.7% less wheat grain in comparison to conservation tillage system (RT) and only 0.3% less than CT. In spite

Table 4. Average maize, winter wheat and soybean yields
Tablica 4. Prosječni prinosi kukuruza, ozime pšenice i soje

Tillage system Sustav obrade	Maize 1997 Kukuruz Mg ha^{-1}	Wheat 1998 Pšenica Mg ha^{-1}	Soybean 1999 Soja Mg ha^{-1}
Conventional (CT)	7.78a	5.75a	2.64a
Conservation (RT)	7.77a	5.89a	2.71a
No-till (NT)	7.56a	5.73a	2.61a

Data within columns followed by the same letter are not significantly different at the probability level $P < 0.05$

of recorded average yield differences, they were not statistically significant. Yields of winter wheat achieved in the experiment were above average yield of 5.29 Mg ha^{-1} achieved at legal entities and parts of entities in 1998, according to Central Bureau of Statistics of the Republic of Croatia [6]. Lyon et al. [16], determined 8.0% greater winter wheat yield with conventional tillage than with no-till. Lawrence et al. [15], showed in a four years study that no-till had a higher wheat yield than reduced or conventional tillage did. Arshad and Gill [3], comparing conventional, reduced and zero tillage systems found that during three years experiment the greatest average wheat yield had reduced tillage, while conventional tillage had the lowest. Moreno et al. [18], reported of higher winter wheat yield under conservation than traditional tillage but differences were not significant.

In the third season the greatest soybean yield of 2.71 Mg ha^{-1} achieved conservation tillage (RT) system. The conventional tillage (CT) system yielded 2.64 Mg ha^{-1} or 2.6% less and no-till (NT) system achieved 2.61 Mg ha^{-1} or 3.3% less than conservation tillage (RT) system but these average yield differences weren't significant. According to data of the Central Bureau of Statistics of the Republic of Croatia [6], average soybean yield ate the legal entities and parts of legal entities in 1999 was 2.64 Mg ha^{-1}. Thus experimental yields were within average except of the NT that was 1.14% lower. Borin and Sartori [4], reported that conventional tillage system achieved greater soybean plant density, but also greater yield then no-till system. Better soybean yields with no-till in comparison to conventional tillage also achieved Cullum F.R. et al. [8]. On the contrary, Sartori and Peruzzi [20], reported that yield reductions of soybean with minimum tillage and no-tillage are generally around 10% less then with conventional tillage.

Energy requirement

According to data presented in Table 5 it is evident that conventional tillage (CT) system was the greatest fuel and energy consumer. The greatest part of the energy, almost 75% or 1473.36 MJ ha^{-1} spent mouldboard ploughing. Conservation tillage (RT) system that introduced chisel plough instead of mouldborad plough required 1229.76 MJ ha^{-1} enabling thus saving of 37.5%, while no-till (NT) system required only 293.16 MJ ha^{-1} saving thus even 85.1% energy in comparison to conventional tillage (CT) system. Bowers [5], showed a composite of average fuel consumption and energy expended, based on data from eleven states in the U.S.A. and different countries around the world. In comparing these data to other sources, wide variations can be expected due to soil types, field conditions, working depth, etc. For example, according to Bowers [5], average fuel consumption for mouldboard ploughing is 17.49±2.06 L ha^{-1}, for chisel ploughing 10.20±1.50 L ha^{-1}, discharrowing 9.07±3.37 L ha^{-1}, no-till planter in average required 4.02±1.03 L ha^{-1}. On the other hand, Köller [14] reported that the fuel consumption was 49.40 L ha^{-1} for mouldboard ploughing, 31.30 L ha^{-1} for chisel ploughing and 13.40 L ha^{-1} for no-till. Hernanz and Ortiz-Cañavate [10], presented data that coincide between previously mentioned results.

Further comparison of tillage systems was done with respect to energy requirement to obtained yield (Figure1.) In maize growing conventional tillage (CT) system required 233.05 MJ Mg^{-1}. Changing conventional tillage (CT) system with conservation tillage (RT) system enabled saving of 37.4% or 679.96 MJ Mg^{-1}. The greatest energy saving gave no-till (NT) system with energy requirement of only 35.73 MJ Mg^{-1} or 84.7% less energy per Mg of maize grain than CT system.

Data of winter wheat growing showed that conventional tillage (CT) system spent 315.32 MJ Mg^{-1}. Conservation tillage (RT) system with 192.38 MJ Mg^{-1} enabled saving of 39.0%, while no-till (NT) system with only 47.14 MJ Mg^{-1} saved even 85.1% in comparison to CT system.

In soybean growing conventional tillage (CT) system required 686.78 MJ Mg^{-1}. Using of conservation tillage (RT) system required 418.13 MJ Mg^{-1} or 39.2% less energy than CT system. No-till (NT) system required 103.50 MJ Mg^{-1} enabled saving of even 84.9%.

LABOUR REQUIREMENT

Table 5. Energy and labour requirement of different soil tillage methods (three years average)
Tablica 5. Potrošnja energije i rada različitih sustava obrade tla (trogodišnji prosjek)

Tillage Sustav obrade	Fuel consumption Utrošak goriva L ha^{-1}	Energy requirement Utrošak energije MJ ha^{-1}	Work rate Učinak ha h^{-1}	Productivity Produktivnost h Mg^{-1}		
	Conventional tillage (CT)			[1]M	[1]W	[1]S
Plough	35.08	1357.60	0.84	0.15	0.21	0.45
Disc-harrow	7.51	290.64	2.88	0.04	0.06	0.13
Seed-bed impl.	4.26	164.86	6.40	0.02	0.03	0.06
Total	46.85	1813.10		0.21	0.30	0.64
	Conservation tillage (RT)			[1]M	[1]W	[1]S
Chisel	22.43	868.04	1.62	0.08	0.11	0.23
Multitiller	6.85	265.10	3.30	0.04	0.05	0.11
Total	29.28	1133.14		0.12	0.16	0.34
	No-till (NT)			[1]M	[1]W	[1]S
No-till planter	6.98	270.13	2.84	0.05	0.06	0.13

[1] M-maize, W-wheat, S-soybean

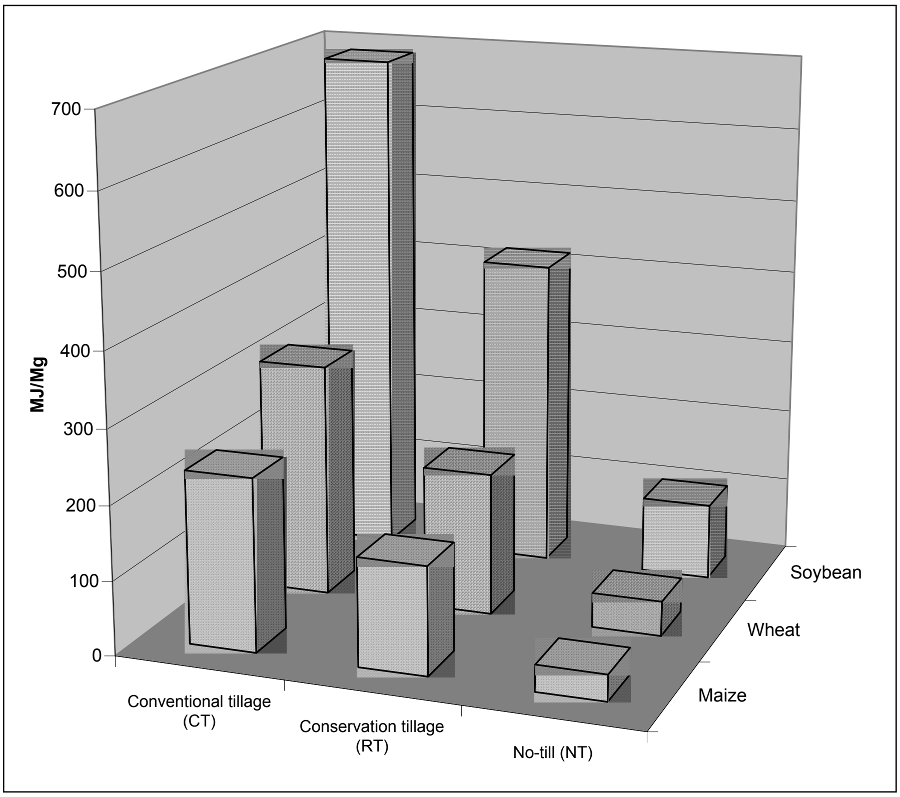

Figure 1. Energy requirement of different soil tillage methods in maize, winter wheat and soybean growing
Slika 1. Utrošak energije različitih sustava obrade tla u proizvodnji kukuruza, pšenice i soje

Comparison of tillage systems according to productivity per Mg of produced grain (Table 5.) showed that conventional tillage (CT) system in maize growing required 0.21 h Mg^{-1}, while conservation tillage (RT) system and no-till (NT) system saved 42.9% and 76.2%, respectively.

Productivity of conventional tillage (CT) system in winter wheat growing was 0.30 h Mg^{-1}. Utilisation of conservation tillage (RT) system saved 46.7%, while no-till (NT) system enabled saving of even 80.0%.

Soybean growing showed that conventional tillage (CT) system required 0.64 h Mg^{-1}, while conservation tillage (RT) system needed 0.34 h Mg^{-1} and no-till (NT) system needed only 0.13 h Mg^{-1}. So, RT and NT system enabled savings of 46.9% and 79.7%, respectively. According to Zimmer et al. [25], the great possibility of labour requirement savings (up to 80%) were possible in soybean growing due to the use of the no-till system. Kanisek et al. [12], reported on the significant possibility of the labour savings (69.6%) and the financial benefits in the winter wheat growing with the use of reduced soil tillage system (rotary cultivator with integrated seed drill) in comparison to conventional tillage system.

CONCLUSIONS

The experiment with three soil tillage systems was performed on an experimental field (silty loam- Albic Luvisol) in north-west Slavonia, Croatia. Test crops were maize (Zea mays L.), winter wheat (Triticum aestivum L.) and soybean [Glycine max. (L.) Merr.] gave opportunity to show following observations:

1. Soil tillage systems greatly differ with respect to energy requirement. No-till (NT) system enabled saving of almost 85% energy, while conservation tillage system (RT) enabled saving of 37-39% energy per hectare and per yield unit in comparison to conventional tillage system (CT)
2. Labour requirement comparison shows that no-till (NT) soil tillage system saved 76-80%, while conservation tillage system (RT) saved 43-46% of labour.
3. Soil tillage systems differ with respect to achieved yields, but differences aren't statistically significant. The greatest maize yield of 7.78 Mg ha^{-1} achieved conventional soil tillage system (CT), while the greatest winter wheat yield of 5.89 Mg ha^{-1} and soybean of 2.71 Mg ha^{-1} achieved conservation tillage system (RT).

The experiment results show real possibilities of energy and labour saving due to utilisation of non-conventional soil tillage systems in arable crops growing. This experience could help farmers in north-west Slavonia to significantly decrease at first their production expenses and at second present greenhouse gas emission in maize, winter wheat and soybean growing. Both facts could be of a great importance during procedure of European Union accommodation and joining.

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