Influence of different tillage systems on soil water availability in the Ap-horizon of an Albic Luvisol and yield in north-west Slavonia, Croatia

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Einfluss verschiedener Bodenbearbeitungssysteme auf die Bodenwasserverfügbarkeit im Ap-horizont eines Albic Luvisol und auf den Ertrag in Nordwest-Slavonien, Kroatien

1. Introduction

One of the limitating factors in the arable crops yield is for sure the soil water content. In a dry farming practice, which is typical for the north-western Slavonia, a successful arable crop production depends on the soil water content at the time of seeding, as well as on the quantity and distribution of precipitation to the end of the growing season and its storage in the soil profile. It is very important to utilize a tillage practice which helps maintain a favourable soil water regime for an optimal crop growth and development. The soil water regime according to RODE (1969) represents periodical changes of the soil water content through the soil depth profile and also a balance among four processes: evaporation, transpiration, infiltration and internal drainage. These processes depend on the soil water retention as well as the soil hydraulic properties. Different soil tillage systems variably affect the mentioned soil properties thus altering the soil water dynamics. No-tillage systems enable soil covering with harvest residues which may reduce the water run off and evaporation and increase infiltration (GAUER et al., 1982; RYDBERG, 1990). Many authors reported greater soil water contents at the no-tillage, the reduced tillage and the conservation tillage systems in comparison to the conventional tillage system. GREVERS et al. (1986) found that the no tillage system in comparison .to the conventional tillage enables better water storage. KLADIVKO et al. (1986) also determined a greater soil water content at the conservation tillage system than at other tillage systems. HEER and KRENZER (1989) reported that the no tillage system enables more successful crop production than the conventional tillage system, especially in arid climate or in drier years.

Zusammenfassung

In der Zeit von 1997 bis 2000 wurden im Nordwesten Slavoniens Experimente mit fünf verschiedenen Bodenbearbeitungssystemen durchgeführt, um deren Einfluss auf die Bodenwasserverfügbarkeit im Ap-horizont (schluffiger Lehm – Albic Luvisol) zu ermitteln. Die verglichenen Bodenbearbeitungssysteme waren: 1. konventionelle Bodenbearbeitung (CT), 2. reduzierte Bodenbearbeitung (RT), 3. konservierende Bodenbearbeitung I (CP), 4. konservierende Bodenbearbeitung II (CM), 5. keine Bodenbearbeitung – Direktsaat (NT). Die Fruchtfolge war: Winterweizen (*Triticum aestivum* L.) – Sojabohne (*Glycine max* L.) – Winterweizen. Der gravimetrische Bodenwassergehalt wurde in Schichten von 0–5 cm, 15–20 cm und 30–35 cm gemessen und die nutzbare Wasserkapazität bis 40 cm errechnet. Sowohl der gravimetrische Bodenwassergehalt in allen drei Schichten als auch das pflanzenverfügbare Wasser waren in allen Versuchszeiträumen bei dem NT-System am größten und bei dem CT-System am kleinsten. Der am häufigsten aufgetretene Trend beim gravimetrischen Bodenwassergehalt und beim verfügbares Bodenwasser war NT > CM > CP > RT > CT. Der höchste Ertrag wurde in allen Versuchjahren beim CM-System erreicht und der geringste Ertrag beim RT-System.

Schlagworte: Bodenwasser, konventionelle Bodenbearbeitung, nichtkonventionelle Bodenbearbeitung, Winterweizen, Sojabohne.

Summary

An experiment with five different tillage systems and their influence on soil water availability in the Ap-horizon (silty loam – Albic Luvisol) was carried out in the period of 1997–2000 in north-west Slavonia. The compared tillage systems were: 1. conventional tillage (CT), 2. reduced tillage (RT), 3. conservation tillage I (CP), 4. conservation tillage II (CM), 5. no-tillage system (NT). The crop rotation was winter wheat (*Triticum aestivum* L.) – soybean (*Glycine max* L.) – winter wheat. The gravimetric soil water content was measured at 0–5 cm, 15–20 cm and 30–35 cm layers and the percentage of avilable water capacity was calculated. The gravimetric soil water content at all three monitored layers so as the available soil water during all experimental seasons were the greatest under the NT system and the lowest under the CT system. The most frequent trend of the gravimetric soil water content and the available soil water was NT > CM > CP > RT > CT. The highest yield in all the experimental years was achieved under the CM tillage system, while the lowest yield was achieved under the RT system.

Key words: soil water, conventional tillage, unconventional tillage systems, winter wheat, soybean.

LYON et al. (1998) found that the no tillage system stored the maximum quantity of water, while the conventional tillage stored a minimum amount. MORENO et al. (1997) also found that the no tillage system stored greater amount of water in comparison to the conventional tillage system and the difference was more obvious during the drier period of the year. On the basis of several year experiment LARNEY and LINDWALL (1995) determined that the no tillage systems played a significant role in the soil water content increasing. PHILLIPS (1984) on silty loam determined 2.4 greater evaporation under the conventional tillage system in comparison to the no tillage system. There are no recorded data or experiences of different tillage systems influence on the soil water dynamics in agroclimatic conditions of Slavonia. The aim of the investigations was to determine the influence of five different tillage systems on the dynamics of the soil water availability in silty loam (Albic Luvisol) and whether the soil water supply during the growing season influences crop yield.

2. Material and methods

2.1 Experimental site and soil

The experiment was performed at a location belonging to agricultural firm "Poljoprivreda Suhopolje" located 150 km north-east from Zagreb (45° 50' N, 17° 26' E). The experimental field consisted of 15 plots 100 m length x 28 m width each, organized as randomized blocks with three replications. During 1996 the field was at a resting stage. The previous crop in the season of 1994–1995 was winter barley, and the tillage was conventional. The experiment with different soil tillage systems started in the autumn of 1996 and monitoring of soil water started in the autumn of 1997. The soil of the experimental field was Albic Luvisol, according to FAO Classification (1998), and by its texture within monitored layer (0–40 cm) it belongs to the silty loam soils (Table 1). Basic physical properties of soil are shown in the Table 2. The water retention at 1.5 MPa (wilting point) was determined by pressure membrane apparatus, while at 0.03 MPa (field capacity) was determined by pressure plate apparatus. According to the basic chemical properties (Table 3) this soil within 0–40 cm layer is acid, very rich in physiological nutrients phosphorus and potassium (determined by Al-method). As for the organic matter level, within monitored Ap-horizon (assessed by bichromath Tjurin method), it belongs to soils with medium level of organic matter.

Table 1: Soil particle size distribution
Tabelle 1: Korngrößenverteilung des untersuchten Bodens

Depth cm	Particles size distribution (%) < 0.002 mm	0.05–0.002 mm	0.05–2.0 mm	Texture
0–40	22	69	9	Silty loam
0–70	31	62	7	Silty clay loam
70–100	20	70	10	Silty loam

Table 2: Soil physical properties
Tabelle 2: Bodenphysikalische Eigenschaften am Untersuchungsstandort

Depth cm	Water retention at 1.5 MPa	0.03 MPa	Bulk density g cm^{-3}
0–40	8.9	27.8	1.34
40–70	9.7	29.2	1.41
70–100	8.3	27.2	1.37

Table 3: Soil chemical properties
Tabelle 3: Bodenchemische Eigenschaften am Untersuchungsstandort

Depth	pH		Organic	P_2O_5	K_2O
cm	Water	1M KCl	matter %	mg $100g^{-1}$	mg $100g^{-1}$
0–40	5.6	4.9	2.7	28	33
40–70	6.0	5.2	4	4	8
70–100	5.9	5.1	–	–	–

2.2 Tillage treatments

Five tillage systems and implements included in a system are as follows:

1. Conventional tillage – plough, discharrow, seed bed implement (CT)
2. Reduced conventional tillage – plough, seed bed implement (RT)
3. Conservation tillage I – chisel plough, power harrow (CP)
4. Conservation tillage II – chisel plough, multitiller (CM)
5. No-tillage system – no-till planter (NT)

In the first year of this experiment a primary tillage with a mouldboard plough and a chisel plough was done on October 23, 1997. A secondary tillage with a discharrow, a combined implement, a power harrow and a multitiller was done on October 28, 1997. The field was seeded with winter wheat (*Triticum aestivum* L.) cultivar "Manda" on October 30, 1997. Fertilizing and crop protection were uniform for whole experimental field. Prior to seeding 60 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 60 kg ha^{-1} K_2O in a form of compound NPK fertilizer was applied. The urea was also applied prior to seeding in dose of 200 kg ha^{-1}. The weed control was first time performed after seeding on October 31, 1997 with 2.0 kg ha^{-1} of Dicuran Forte (herbicide). The first top dressing was performed on February 26, 1998 with 200 kg ha^{-1} Calcium Ammonium Nitrate (commercial name KAN) and the second treatment on May 16, 1998 with the same rate of KAN. The final crop protection was performed on May 09, 1998 with 0.8 l ha^{-1} Starane (herbicide), 0.5 l ha^{-1} Tilt (fungicide), 0.3 l ha^{-1} Bavistin-FL (fungicide) and 0.6 l ha^{-1} Chromorel (insecticide). The winter wheat was harvested on July 07, 1998.

In the second year a primary tillage was performed on October 25, 1998 and a secondary tillage on April 15, 1999. The soybean (*Glycine max* L.) cultivar "Gordana" was sown on May 02, 1999. Prior to sowing 28 kg ha^{-1} N, 80 kg ha^{-1} P_2O_5 and 120 kg ha^{-1} K_2O in a form of compound NPK fertilizer was applied. The weed control was performed on May 12, 1999 with 3.5 kg ha^{-1} of Senkor and 7 kg ha^{-1} of Dual Gold (both herbicides). The soybean was harvested on October 21, 1999.

In the third year a primary tillage for the winter wheat was done on October 23, 1999 and a secondary tillage on October 25, 1999. The winter wheat cultivar "Manda" was seeded on October 26, 1999. The weed control was the first time performed after seeding on October 26, 1999 with 2.0 kg ha^{-1} of Dicuran Forte (herbicide). Prior to the seeding 50 kg ha^{-1} N, 140 kg ha^{-1} P_2O_5 and 210 kg ha^{-1} K_2O in a form of compound NPK fertilizer was applied. The urea was also applied prior to seeding in dose of 200 kg ha^{-1}. The first top dressing was performed on March 30, 2000 with 200 kg ha^{-1} Calcium Ammonium Nitrate (commercial name KAN) and the second treatment on May 17, 2000 with 120 kg ha^{-1} of KAN. The final crop protection was performed on May 23, 2000 with 1.0 l ha^{-1} Duett (fungicide) and 0.2 l ha^{-1} Fastac (insecticide). Winter wheat was harvested on July 03, 2000.

2.3 Soil water measurement

The gravimetric soil water content (% of d.b. weight) was measured by a gravimetric analysis, two times a month at 0–5 cm, 15–20 cm and 30–35 cm layers at each tillage treatment during three experimental years . The available water capacity (AWC) was calculated as difference of the soil water content at the field capacity (FC) and the soil water content at the wilting point (WP). The water availability to the plants was expressed as percents of AWC.

2.4 Precipitations and air temperatures during growing seasons

The climate is semihumid with average annual precipitation of 817 mm and average annual temperature of 11.1 °C (30 year average 1965–1994). The total precipitation of 568 mm during growing season of winter wheat 1997/98 (November-June) was 4.8% higher than the 30 year average (Table 4). The air temperature average of 9.2 °C during the winter wheat growing season 1997/98 was 1.5 °C higher than 30 years average. In 1999 during the soybean growing season (May–October), the total precipitation of 556.5 mm was 22.9% greater than the 30 year average, and the average air temperature was 18.3 °C which was 0.5 °C higher than 30 years average. The total precipitation of

Table 4: Precipitations and air temperatures during growing season of winter wheat (1997/98 and 1999/2000) and soybean (1999) and thirty-years average (1965–1994)

Tabelle 4: Niederschläge und Lufttemperaturen während der Vegetationsperioden für Winterweizen (1997/98 sowie 1999/2000) und Sojabohne (1999) sowie die 30-jährigen Durchschnittswerte (1965–1994)

Month	Precipitation, mm					Air temperature, °C				
	1997	1998	1999	2000	1965–1994	1997	1998	1999	2000	1965–1994
January		89.9	32.0	5.0	47.5		3.3	0.9	– 0.7	0.1
February		2.5	85.1	20.3	45.9		6.0	2.0	5.0	1.6
March		57.6	26.6	43.8	65.0		5.4	8.6	7.6	6.4
April		77.8	92.8	52.4	61.3		12.7	12.5	14.5	11.2
May		90.0	86.4	55.9	82.1		15.9	17.1	17.8	16.2
June		62.8	157.9	40.8	102.9		21.5	19.8	18.8	19.0
July		163.8	135.9		61.6		21.3	21.8		21.8
August		143.0	83.1		75.0		21.0	20.9		21.2
September		115.7	48.8		69.9		15.4	18.7		17.2
October	79.2	131.3	44.4		68.6	9.1	12.8	11.5		11.2
November	89.7	93.5	132.3		62.3	5.8	4.1	3.7		5.0
December	97.7	40.2	56.9		75.2	2.9	– 2.3	1.7		1.9

407.4 mm during the winter wheat growing season 1999/2000 was 24.9 % less then the 30 year average, while the average air temperature of 8.6 °C was recorded which was 0.9 °C above average.

2.5 Statistical analyses

The data were analysed using analysis of variance (ANOVA). A Duncan's test was used to compare the mean values when a significant variation was highlighted by ANOVA. The differences were accepted as significant if $P < 0.05$.

3. Results and discussion

In the first year of the experiment, during the winter wheat growing season in the most measurements the greatest soil water content was recorded under the NT system. On the contrary, the lowest soil water content was recorded under the CT system (Figure 1–3). Maximal value of the AWC (100%) at 0–5 cm layer was recorded at all tillage treatments 87 days after the seeding. At the tillage systems CP, CM and NT maximal value of the AWC was still recorded twice (14 and 22 days after the seeding). At the soil layer 15–20 cm maximal value of the AWC was recorded once and only at the NT tillage system 29 days after the seeding. At the soil layer 30–35 cm maximal value of the AWC wasn't recorded at any tillage system. It must be pointed that maximal values of the AWC were recorded during the wet period of the winter wheat growing season when recorded

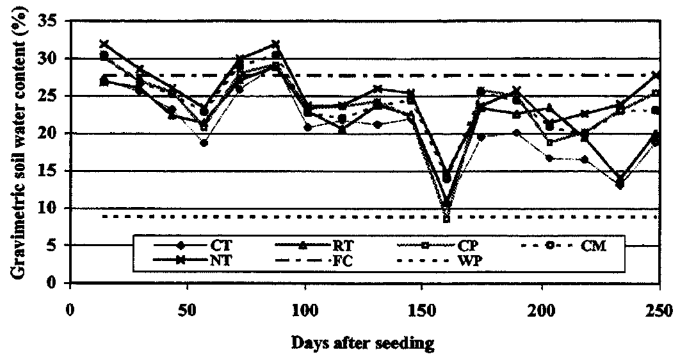

Figure 1: Gravimetric soil water content at 0–5 cm layer during winter wheat growing season 1997/98

Abbildung 1: Gravimetrisch bestimmter Bodenwassergehalt in der 0–5 cm Schicht während der Vegetationsperiode des Winterweizens 1997/98

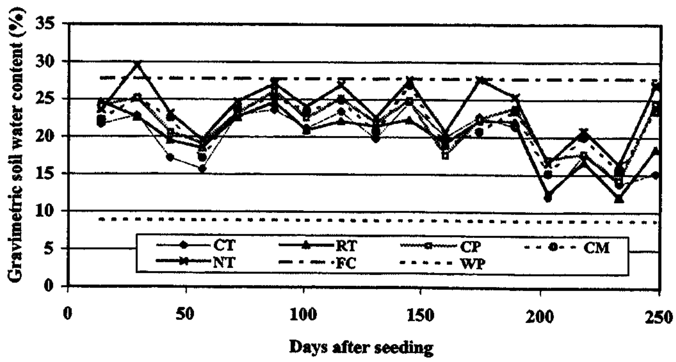

Figure 2: Gravimetric soil water content at 15–20 cm layer during winter wheat growing season 1997/98

Abbildung 2: Gravimetrisch bestimmter Bodenwassergehalt in der 15–20 cm Schicht während der Vegetationsperiode des Winterweizens 1997/98

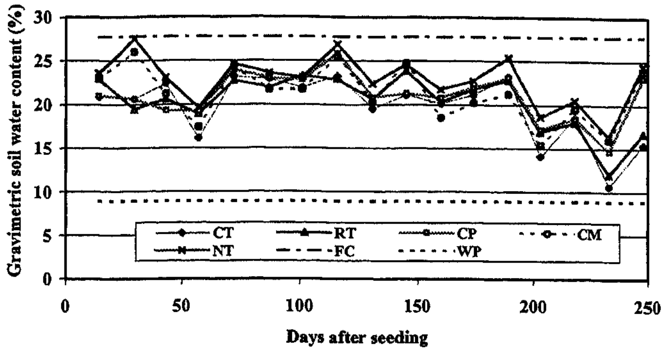

Figure 3: Gravimetric soil water content at 30–35 cm layer during winter wheat growing season 1997/98

Abbildung 3: Gravimetrisch bestimmter Bodenwassergehalt in der 30–35 cm Schicht während der Vegetationsperiode des Winterweizens 1997/98

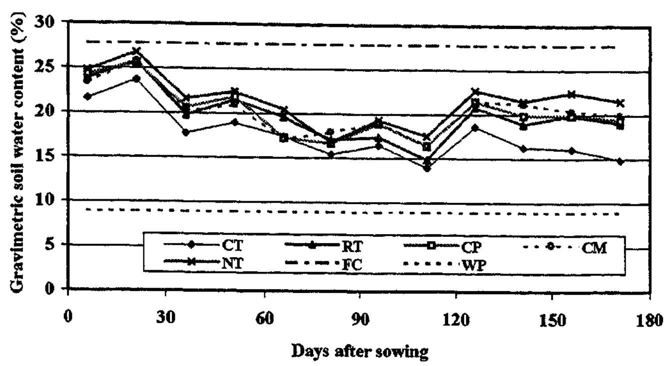

Figure 5: Gravimetric soil water content at 15–20 cm layer during soybean growing season 1999

Abbildung 5: Gravimetrisch bestimmter Bodenwassergehalt in der 15–20 cm Schicht während der Vegetationszeit der Sojabohne 1999

precipitations were above 30 years average. The soil water content below the wilting point during the winter wheat growing season 1997/98 was recorded only one time (160 days after seeding) under the CP system at 0–5 cm layer, while at the other tillage systems and depths was not recorded. The greatest difference of the AWC percentage was recorded between the NT and CT systems at the soil layer 0–5 cm 233 days and at the other soil layers 248 days after the seeding.

In the second year during the soybean growing season the NT system again achieved the greatest, while the CT system achieved the lowest soil water content (Figure 4–6). The maximum AWC at the soil layer 0–5 cm was recorded 126 days after the sowing only at the NT system. In the mentioned soil layer the greatest percent of AWC was recorded at all other tillage systems also 126 days after the

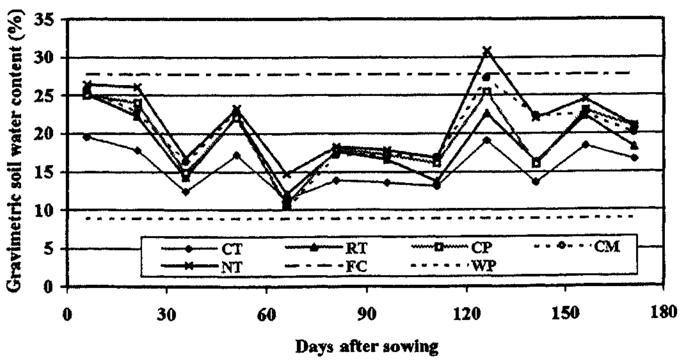

Figure 4: Gravimetric soil water content at 0–5 cm layer during soybean growing season 1999

Abbildung 4: Gravimetrisch bestimmter Bodenwassergehalt in der 0–5 cm Schicht während der Vegetationszeit der Sojabohne 1999

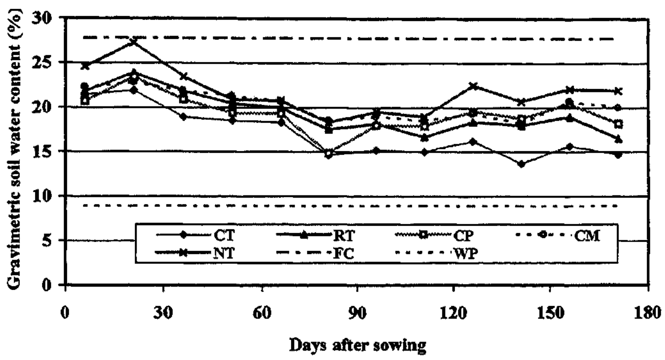

Figure 6: Gravimetric soil water content at 30–35 cm layer during soybean growing season 1999

Abbildung 6: Gravimetrisch bestimmter Bodenwassergehalt in der 30–35 cm Schicht während der Vegetationszeit der Sojabohne 1999

sowing, which was aftermath of unusual precipitation (twice above 30 years average) that occured during July. At the soil layers 15–20 cm and 30–35 cm the greatest percentage of AWC was recorded 21 days after the sowing at all tillage systems. The soil water content below the wilting point was not recorded neither at any tillage system nor at any soil layer. The greatest difference of the AWC percentage was recorded again between the NT and CT systems, at the soil layer 0–5 cm 126 days and at the other soil layers 171 days after the sowing.

In the third year during the winter wheat growing season 1999/2000 the maximum AWC at 0–5 cm layer was recorded five times under the RT, CP, CM and NT systems (33, 47, 62, 76 and 90 days after seeding) and twice under the CT system (62 and 76 days after seeding) (Figure 7). At 15–20 cm layer, the maximum AWC was recorded only

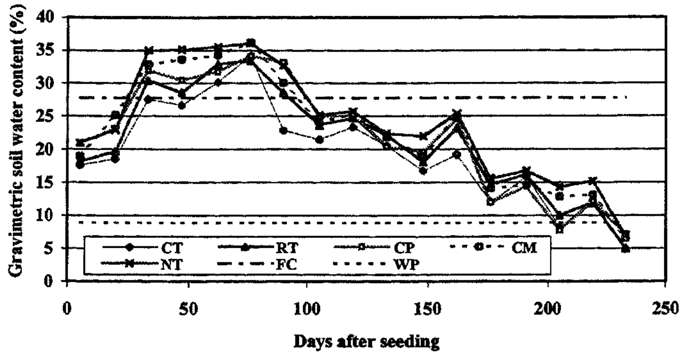

Figure 7: Gravimetric soil water content at 0–5 cm layer during winter wheat growing season 1999/2000
Abbildung 7: Gravimetrisch bestimmter Bodenwassergehalt in der 0–5 cm Schicht während der Vegetationszeit des Winterweizens 1999/2000

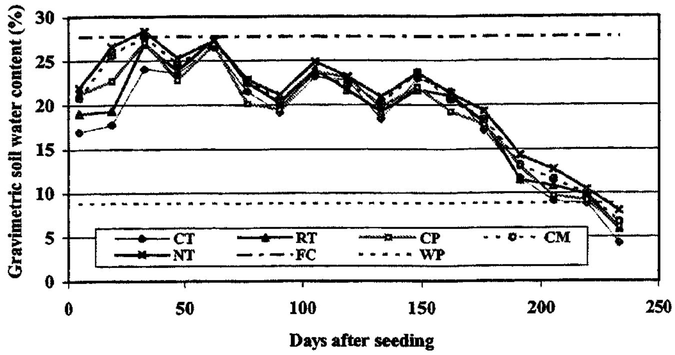

Figure 8: Gravimetric soil water content at 15–20 cm layer during winter wheat growing season 1999/2000
Abbildung 8: Gravimetrisch bestimmter Bodenwassergehalt in der 15–20 cm Schicht während der Vegetationszeit des Winterweizens 1999/2000

once under the NT system (33 days after seeding), while at 30–35 cm was not recorded at any tillage system (Figures 8 and 9). The soil water content below the wilting point was recorded at all tillage systems which could be influenced by 24.9% lower precipitation in comparison to the 30 years average. So, the soil water content below the wilting point was recorded at 0–5 cm layer two times under the CT and CP systems (205 and 233 days after seeding) and once under other systems (233 days after seeding). At 15–20 cm layer the soil water content below the wilting point was recorded twice under the CT system (219 and 233 days after seeding) and once under other systems (233 days after seeding). At 30–35 cm layer the soil water content below the wilting point was recorded once under all tillage systems (233 days after seeding) except the NT system. The greatest

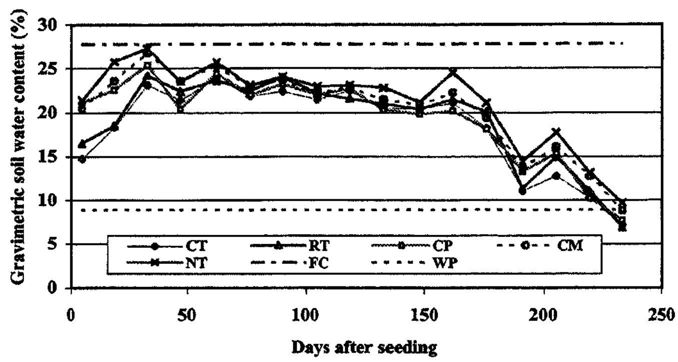

Figure 9: Gravimetric soil water content at 30–35 cm layer during winter wheat growing season 1999/2000
Abbildung 9: Gravimetrisch bestimmter Bodenwassergehalt in der 30–35 cm Schicht während der Vegetationsperiode des Winterweizens 1999/2000

Table 5: Average percent of available water capacity (%)
Tabelle 5: Durchschnittsanteile der verfügbaren Wasserkapazität

Tillage system	Winter wheat 1997/98			Soybean 1999			Winter wheat 1999/2000		
	Layer, cm			Layer, cm			Layer, cm		
	0–5	15–20	30–35	0–5	15–20	30–35	0–5	15–20	30–35
CT	61,69 a	57,39 a	57,17 a	35,19 a	45,99 a	42,90 a	55,15 a	50,64 a	50,23 a
RT	69,72 a	59,42 a	60,44 a	51,41 b	58,11 b	55,34 b	62,00 a	54,31 a	53,94 a
CP	76,56 ab	68,13 a	64,05 a	55,78 b	59,70 b	54,98 b	63,15 ab	54,53 a	55,59 a
CM	78,15 ab	67,94 a	65,14 a	59,30b	60,32 b	60,14 b	65,64 ab	59,10 ab	60,91 ab
NT	83,41 b	77,87 ab	73,95 ab	65,56 bc	66,58 c	67,99 c	69,50 ab	62,59 ab	65,42 ab

[a] Means followed by the different letters in the same column are significantly different at the 5% level

difference of the AWC percentage was recorded between the CM and CT systems at the soil layer 0–5 cm 19 days after the seeding and at the other soil layers between the NT and CT also 19 days after the seeding.

Statistical analysis showed that the percent of AWC under the CT system was significantly lower than under the RT system at all three soil layers but only during the soybean growing season (Table 5). Comparison of the AWC percentage differences under the CT system and the CP system showed that the CT system had a significantly lower AWC percentage during the soybean growing season for all three soil layers, while during both winter wheat growing seasons the CT system had significantly lower AWC percentage than the CP system, but only at the 0–5 cm soil layer. The AWC percentage under the CT system was significantly lower than under the CM system only at 0–5 cm soil layer during the winter wheat growing season 1997/98, while during the soybean and winter wheat 1999/2000 growing seasons the CM system had a significantly greater AWC percentage at all three soil layers. The AWC percentage under the CT system was a significantly lower than under the NT system for all three soil layers and for all three growing seasons.

Many authors reported greater soil water contents under the no-till or zero tillage than under the conventional tillage (e.g., BLEVINS et al., 1971; GAUER et al., 1982; GREVERS et al., 1986; BALL-COELHO et al., 1998) which corresponds to the results presented in this paper. LARNEY and LINDWALL (1995) found that the available water in the 0–15 cm depth interval in the spring under the winter wheat was greater with the zero tillage than the conventional and minimum tillage. ARSHAD and GILL (1997) reported on a significantly higher soil moisture content under the zero tillage than under the conventional tillage on clay soil in the semiarid climate. MORENO et al. (1997) reported that the soil water content on sandy clay loam was higher under the conservation tillage than the conventional tillage. On the other hand, HUSSAIN et al. (1999) found non-significant differences of the soil water content on silty loam (Albic Luvisol) among the conventional tillage, conservation tillage and no-till systems. According to SINGH et al. (1998), the tillage management may regulate the soil water in two ways: through their alteration of the soil characteristics or their effect on the hydrologic processes that alter soil water. The relativ importance of each may vary depending on the inherent soil characteristic.

3.3 Yield

Although it is known that the available soil water is one of the most important factors in successful plant production, achieved yields haven't clearly proved the fact because the highest yield in all experimental years hasn't been connected with the tillage system with the greatest available soil water. The lowest yield also wasn't determined under the tillage system with the lowest available soil water. The highest yield in all experimental years was achieved under the CM tillage system and the lowest yield was achieved under the RT system (Table 6). According to the fact that the second rank soil water content was recorded under the CM system and the fourth rank under the RT system, the influence of the soil water conservation ability on the achieved yield couldn't be neglected. In all three growing seasons only in the first year the yield difference between the CM and RT was significant. During the winter wheat growing season 1997/98 and the soybean growing season 1999, the yield trend was CM > CT > NT > CP > RT, while during the winter wheat growing season 1999/2000 the yield trend was CM > NT > CP > CT > RT. During the third experimental year the yields under the NT and CP recorded an increase, while under the CT system it decreased. It must be emphasized that the growing season 1999/2000 was characterised by the 24.9% less precipitation than 30-years-average, but the precipitation distribution wasn't so unfavourable as to reduce yields significantly. It seems that the conservation and no till system showed the influence of their better soil water conservation ability on the crop yield more obviously during the growing seasons with the precipitation below average.

Table 6: Average yields of winter wheat and soybean (Mg ha^{-1})
Tabelle 6: Durchschnittserträge von Winterweizen und Sojabohne

Tillage system	Winter wheat 1997/98	Soybean 1999	Winter wheat 1999/2000
CT	5.75 a[a]	2.64 a	5.42 a
RT	5.27 ab	2.49 a	5.22 a
CP	5.51 a	2.57 a	5.49 a
CM	5.89 a	2.71 a	5.73 a
NT	5.73 a	2.60 a	5.62 a

[a]Means followed by the different letters in the same column are significantly different at the 5% level

LYON et al. (1998) determined a 8.0% greater winter wheat yield under the conventional tillage than under the no till system. MORENO et al. (1997) reported on a higher winter wheat yield under the conservation than under the traditional tillage but the differences weren't significant. Comparing conventional, reduced and zero tillage systems ARSHAD and GILL (1997) found that during a three years experiment the reduced tillage had the greatest average yield and the conventional tillage had the lowest one. RASMUSSEN (1999) reported that the winter wheat in a cereal monoculture crop rotation is the only crop with similar yields with the direct drilling and ploughing.

According to SARTORI and PERUZZI (1994) the yield reduction in the soybean production with the minimum tillage and no-tillage was generally around 10 % less than with the conventional tillage. The previous thesis was proved by BORIN and SARTORI (1995). On the contrary, HUSSAIN et al. (1999) reported that a four year average yield of soybean under no-till was 15 % higher than under the conventional tillage.

According to STIPESEVIC et al. (1997), application of the reduced or conservation soil tillage for the 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).

4. Conclusions

The experiment showed that the differences of the available soil water are significantly influenced by the applied soil tillage systems. The available soil water at all three monitored layers (0–5, 15–20 and 30–35 cm) and all three experimental years was greatest under the NT system, while the lowest one was under the CT system. The most frequent trend of the available soil water was NT > CM > CP > RT > CT. The available soil water content differences between the NT and CT tillage systems at all observed layers and during all experimental years were significant. The greatest differences of the available soil water content influenced by the tillage treatment were recorded at 0–5 cm soil layer. The highest yield in all experimental years was achieved under the CM tillage system and the lowest one was achieved under the RT system.

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