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THE EFFECT OF COVER CROPS ON SOIL WATER BALANCE IN RAIN-FED CONDITIONS

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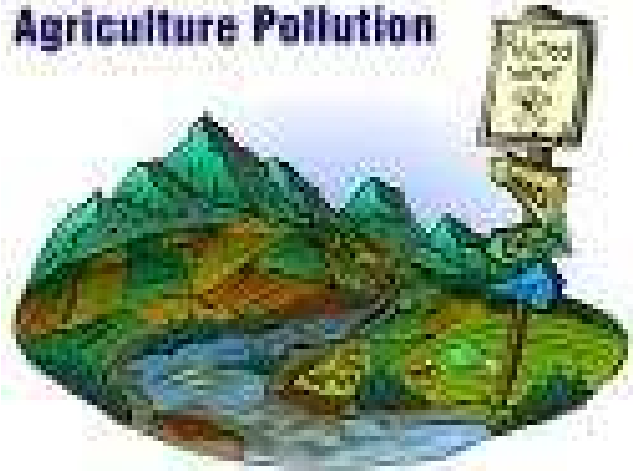
- The intensification of agricultural practice during the second half of the XXth century, with more inputs (nitrogen, pesticides, irrigation) allowed significant yield improvement in most arable crops

- However, at the same time, these types of farming systems, together with other human activities, have contributed to many negative environmental impacts leading to several risks or damages:

- greenhouse gas emissions,
- a consumption of fossil energy (fertilizer production),
- the high use of pesticides
- increasing amounts of water for irrigation which contributes to the depletion of underground water etc.



- The practice of cover cropping in some regions has gained importance in view of the decline of livestock unit per hectar and the related reduced availability of organic fertilizers.

- In the Vojvodina province, Serbia, fertile soils such as chernozem have suffered a significant reduction in humus content, in some cases as much as 50%, which justifies the introduction of cover cropping in commercial production

- Cover crops-definition/main properties
- growing of pure stand or mixtures (companion/intercropping) between cash crop-grain harvest-economical effect
- Cover crops-short growing season
- Sowing date-winter, spring, second crops

- Forage crops-cutting regime (Green forage relay)
- Green manure-mulching regime

Benefits of cover crops

Reducing greenhouse effect

↓

Cutting of fertilizer costs/omit fertilizers

Conserve of soil moisture and prevent nutrient leaching

Improving soil properties/enhancing soil health

Prevent soil erosion

Reduce the need for pesticides
(prevention diseases, pests, nematodes and weeds)

Protect water quality

Improve rotations for management efficiency and biodiversity

Water use efficiency

↓

Help safeguard personal health

Benefits-vary by agro ecological conditions
Two or three occur in any c.c.

THE AIM

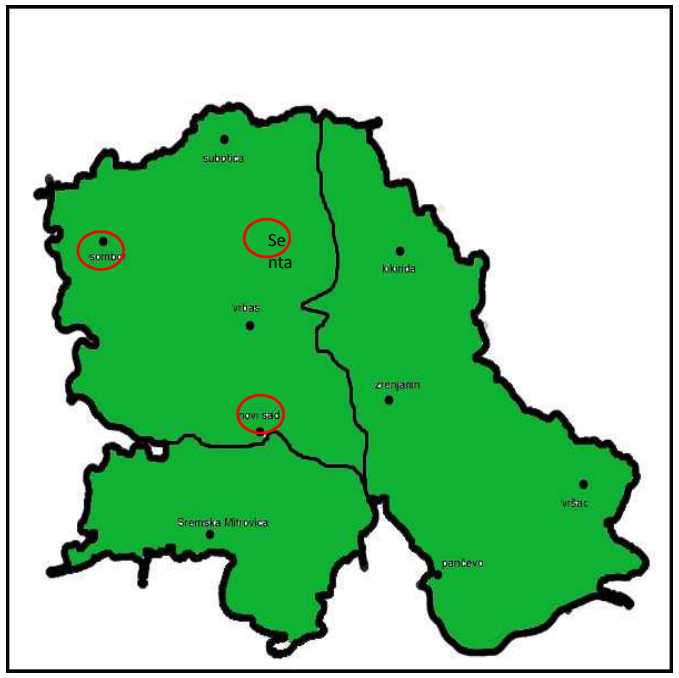
- Having in mind that the effect of cover crops depend on the weather conditions of a region the aim of this study was to analyze effect of winter cover crops on the soil water balance in agro-ecological conditions of Vojvodina.
- The aim was also to investigate whether cover crops reduces water availability for the main/cash crop and to compare it with a bare soil as usual practice of a maize-based cropping system.

Material and methods

Cover crop

2011/2012 **2012/2013**

Main crop-Cash crop



three locations:

Novi Sad-Rimski Šančevi, (45°19´ N, 19°50´ E, 80 m a.s.l.)

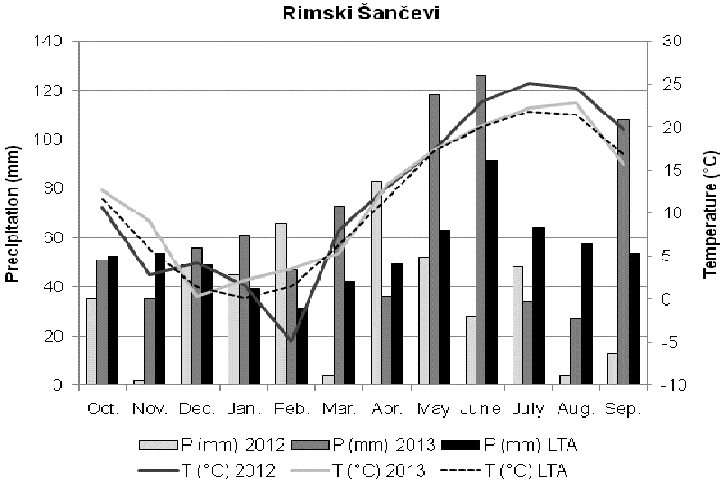
Sombor (45°44´ N, 19°08´ E, 84 m a.s.l.)

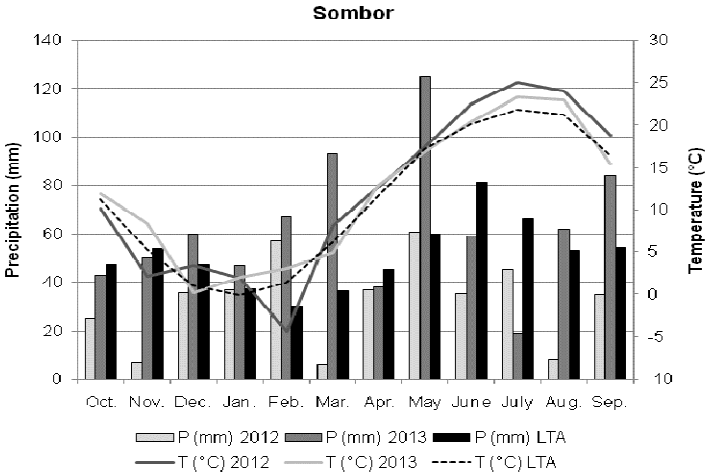
Senta (45°54´ N, 20°05´ E, 77 m a.s.l.)

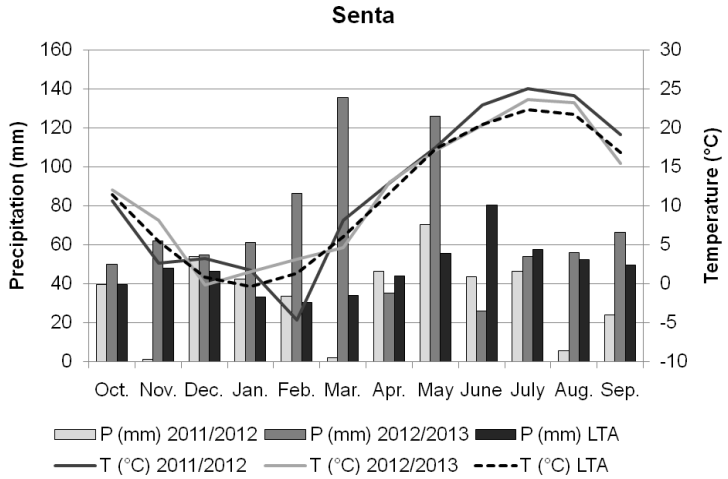
•Cover crop – silage corn (2012-2013 / 3 loc.)

Photo-end of May (2012)

Long term average (LTA), the mean monthly temperature and total monthly precipitation for hydrological years 2011/2012 and 2012/2013.







The chemical characteristics of the soil for
Rimski Šančevi, Sombor, and Senta in 2011 and 2012.

Location	Year	pH		$CaCO_3$ %	Organic matter %	P_2O_5	K_2O
		in H_2O	in KCl			mg 100 g^{-1} soil	
Rimski Šančevi	2011	7.77	8.56	8.01	2.07	34.74	26.96
	2012	7.60	8.61	5.48	2.49	46.04	24.13
Sombor	2011	7.60	7.36	6.80	3.08	22.50	22.05
	2012	7.50	7.25	7.40	3.12	21.80	21.10
Senta	2011	7.29	8.18	13.81	3.95	18.31	26.20
	2012	7.31	8.26	12.41	3.48	19.57	24.32

Field operations at Novi Sad-Rimski Šančevi, Sombor and Senta for each year of study during the season 2011/2012 and 2012/2013

	Location					
	Rimski Šančevi		Sombor		Senta	
	Date of field operations					
Cover crop sowing	26.10.2011	22.10.2012	27.10.2011	24.10.2012	24.10.2011	14.10.2012
Cover crops ploughing-in and application of N mineral fertilizers	29.05.2012	16.05.2013	23.05.2012	30.05.2013	26.05.2012	25.05.2013
Silage corn sowing	30.05.2012	20.05.2013	26.05.2012	02.05.2013	28.05.2012	30.05.2013
Silage corn harvest	11.05.2012	02.05.2013	13.05.2012	05.05.2013	12.05.2012	16.05.2013
Soil sampling						
I term	10.03.2012.	08.03.2013.	06.03.2012.	04.03.2013.	02.03.2012.	09.03.2012.
II term	30.05.2012	17.05.2013	27.05.2012	30.05.2013	27.05.2012	30.05.2013
III term	12.09.2012	08.09.2013	15.09.2012	06.09.2013	14.09.2012	18.09.2013.

The soil moisture content was determined by thermo-gravimetric technique in which soil samples were dried to a constant weight at 105 °C for 24 h

$$\theta_i = W \times 10 \times d \times \rho \quad (1)$$

θ_i - a soil water content for a given depth of soil (mm)

W - soil moisture content for a given soil depth (%)

d - a soil depth (cm)

ρ - is the bulk density of the soil for the calculated soil depth (g cm^{-3}).

The water content of the soil profile (P)

$$P = \sum_{0}^{120} \theta_i \qquad (2)$$

Soil water balance (Δ)

$$\Delta = W_B - W_E + P_{B+E} \qquad (3)$$

W_B is a soil water content at the beginning of the examined period

W_E is a soil water content at the end of the examined period

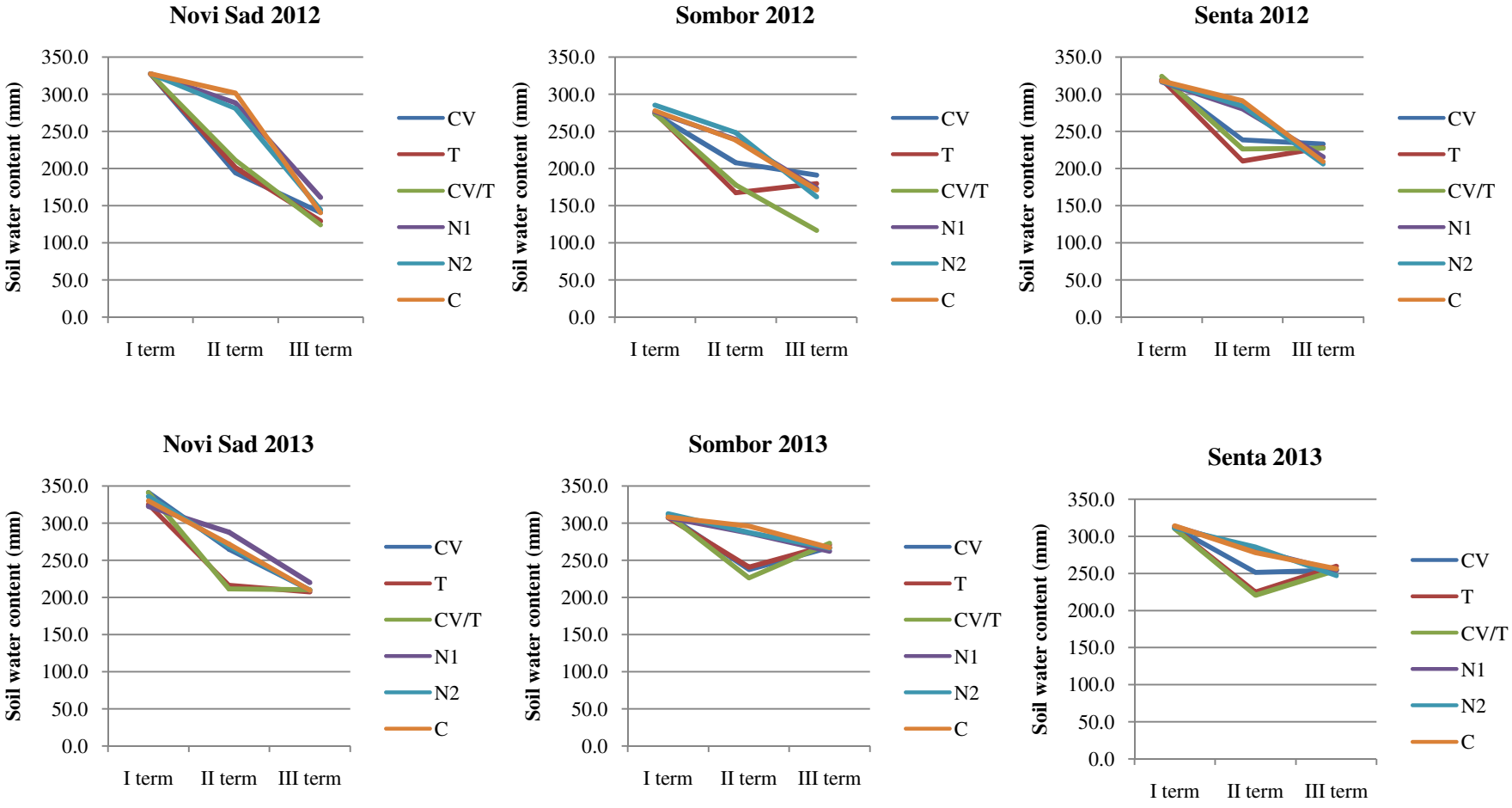
P_{B+E} is a sum of precipitation of the period.

Modified drought classification of Standardized precipation index (SPI) for Vojvodina province

Abbr.	Drought/moisture conditions	Value
EcD	Exceptional drought	SPI ≤ -2.326
EtD	Extreme drought	-2.326 < SPI ≤ -1.645
SD	Severe drought	-1.645 < SPI ≤ -1.282
MoD	Moderate drought	-1.282 < SPI ≤ -0.935
MiD	Minor drought	-0.935 < SPI ≤ -0.524
N	Near normal	-0.524 < SPI < +0.524
SM	Slightly increased moisture	+0.524 ≤ SPI < +0.935
MM	Moderately increased moisture	+0.935 ≤ SPI < +1.282
CM	Considerably increased moisture	+1.282 ≤ SPI < +1.645
EtW	Extremely wet	+1.645 ≤ SPI < +2.326
EcW	Exceptionally wet	SPI ≥ +2.326

Results and Discussion

The effect of different cover crops and nitrogen fertilization **on soil water content** in the soil profile P from 0 to 120 cm at the locality Novi Sad-Rimski Šančevi, Sombor and Senta in 2012 and 2013;



CV - common vetch sole crop; T - triticale sole crop; CV/T - mixture of common vetch and triticale; N_1 - 80 kg N ha^{-1}; N_2 - 160 kg N ha^{-1}, C - control

The effect of different cover crops and fertilization rate **on soil water balance** for period March-May and June-September/October in 2012 and 2013.

			Treatments					
Period	Locality	Year	CV	T	CV/T	N_1	N_2	C
March-May	Novi Sad	2012	252.2	245.1	235.0	157.9	165.2	144.5
		2013	410.0	438.8	449.7	396.1	309.9	293.7
Cover crop	Sombor	2012	168.9	211.0	199.8	140.7	140.2	142.7
		2013	327.3	329.9	328.9	260.2	230.7	210.7
	Senta	2012	200.2	228.6	216.4	154.9	152.1	145.1
		2013	359.4	366.0	377.9	324.8	272.1	262.4
June-September /October	Novi Sad	2012	172.7	191.2	206.6	246.8	256.0	280.7
		2013	314.4	346.2	347.0	385.0	411.9	416.9
	Sombor	2012	140.0	110.8	184.2	188.8	209.6	190.3
Maize		2013	334.3	394.6	392.2	457.7	489.4	499.8
	Senta	2012	124.8	101.2	118.3	184.1	197.5	201.6
		2013	336.2	416.1	410.1	440.4	460.0	458.6

Table . The SPI values for 1, 3 and 9 months for 2011/2012 and 2012/2013 for the locality of Novi Sad-Rimski Šančevi, Sombor and Senta

		Value			Abbreviation		
Year	Month	SPI1	SPI3	SPI9	SPI1	SPI3	SPI9
2011/2012	10	-0.07	-1.67	-1.51	N	EtD	SD
	11	-3.31	-1.61	-1.92	EtD	SD	EtD
	12	0.3	-1.07	-1.75	N	MD	EtD
	1	0.44	-0.85	-1.53	N	MiD	SD
	2	1.17	0.8	-1.29	MM	MM	SD
	3	-2.18	0.2	-1.38	EtD	N	SD
	4	1.27	0.76	-1.17	MM	MM	MD
	5	-0.14	-0.02	-0.55	N	N	MiD
	6	-1.95	-0.42	-0.87	EtD	N	MiD
	7	-0.28	-1.33	-0.82	N	SD	MiD
	8	-1.92	-1.98	-0.75	EtD	EtD	MiD
	9	-1.3	-1.71	-1.02	SD	EtD	MD
2012/2013	10	0.36	-1.49	-1.11	N	SD	MD
	11	-0.3	-0.68	-1.47	N	MiD	SD
	12	0.49	0.09	-1.05	N	N	MD
	1	0.98	0.42	-1.24	MM	N	MD
	2	0.67	0.85	-1.09	MM	MM	MD
	3	1.26	1.34	-0.32	MM	CM	N
	4	-0.29	0.81	-0.33	N	MM	N
	5	1.57	1.33	0.9	CM	CM	MM
	6	0.92	1.14	1.33	MM	MM	CM
	7	-0,73	0,86	0,94	MiD	MM	MM
	8	-0,49	-0,2	0,74	N	N	MM
	9	1,6	0,11	1,05	CM	N	MM

Abbr.	Drought/moisture conditions
EcD	Exceptional drought
EtD	Extreme drought
SD	Severe drought
MoD	Moderate drought
MiD	Minor drought
N	Near normal
SM	Slightly increased moisture
MM	Moderately increased moisture
CM	Considerably increased moisture
EtW	Extremely wet
EcW	Exceptionally wet

2012

without cc
(control or N)

cover crop

15 mm-after sowing

July-Sept.-15 mm in total
Aver. daily temp.-above 30

without cc
(control or N)

cover crop

2013

2012

2013

2012

Conclusion

•The cover crop had a high impact on the soil water content in both years.

•In optimal and wet years, summer precipitation cover the lack of water, which were used by cover crops.

•Cover crops have had a negative short-term effect on soil water content.

•In long term, they rise organic mater, improve soil quality and soil water capacity.

• On farms where are no other source of organic fertilisers, the cultivation of cover crop for green manure/sideration need to be regular measure.