Changes in soil water storages under cover crops

Ksenija Mačkić[1]*, Borivoj Pejić[1], Vera Popović[2], Đorđe Krstić[1], Svetlana Vujić[1], Branko Ćupina[1]

[1]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, Novi Sad, Republic of Serbia

[2]Institute of Field and Vegetable Crops, Institute of National Importance for the Republic of Serbia, Maksima Gorkog 30, Novi Sad, Republic of Serbia

Correspondence: ksenija@polj.uns.ac.rs

INTRODUCTION

Soil water availability in the root zone is one of the crucial factors in agriculture production especially in semiarid and arid conditions, but also in regions with variable rainfall. It is site-specific and mainly determined by the soil water balance. Optimum soil moisture ranges from field water capacity to lentocapilary moisture, with no significant decrease in crop productivity. Soil moisture below permanent wilting point, is not available to the plants.

Cover crops provide a wide range of ecosystem services, but their impacts on available water levels in the soil depend mainly on weather conditions, soil and farm practices. Cover crops are grown during the winter fallow period between two main cash crops. In spring, their residues are incorporated or left on the soil surface as a mulch. Benefits that cover crops provide to agricultural production, and beyond to ecosystem, are highly weather and site-specific, especially in the Vojvodina region with variable rainfall. The use of winter cover crops is still disputable in this region giving rise to justification of changing the farming system. Therefore, the aim of this paper was to determine the effect of annual winter cover crops from the standpoint of soil water storage.

MATERIAL AND METHODS

The experiment was conducted in northern Serbia, in the Vojvodina province, at locality Rimski Šančevi, (45°19´ N, 19°50´ E, 80 m a.s.l.). The experiment was set up as a random block design with plot size 25m^2. It included six treatments in rain-fed production, three of which were winter cover crop treatments with common vetch (*Vicia sativa* L.., cv. Neoplanta) (CV), triticale (*Triticosecale* Wittm. ex A. Camus, cv. Odisej) (TS) and their mixture (CV/TS). The fallow control plot was plowed in autumn and left as a bare soil until the maize sowing, without N fertilization. The early maturity silage maize was sown after the cover crops termination. The experiment was initiated in late October in both study periods with winter cover crops seeded at 120 kg ha^{-1} for vetch, 220 kg ha^{-1} for triticale and 90 kg ha^{-1} of vetch and 30 kg ha^{-1} of triticale for the mixture. The winter cover crops were incorporated in the soil in May by ploughing-in. In order to determine the soil moisture with thermogravimetric method, soil samples were taken per 30 cm soil layers to the depth of 120 cm. Soil water storage (SWS) was calculated for the 120 cm soil depth, as a sum of water contents of each soil layer. Soil water content at field water capacity (FWC), lentocapilary moisture (LCM) and wilting point (WP) were calculated using the measured values of soil moisture at soil matric potential of -33 kPa , -625 kPa and -1500 kPa.

Soil water storage (mm) by 30 cm soil layers in 2012

Soil depth (cm)	Month	Treatment				
		CV	TS	CV/TS	Control	Average
0-30	March	80.58aA	80.98aA	79.4aA	79.05aA	80.01a
	May	48.22bA	42.20bA	42.12bA	70.13aB	50.67b
	October	33.60cA	31.44cA	31.40cA	33.87bA	32.58c
30-60	March	90.86aA	91.31aA	89.59aA	89.13aA	90.22a
	May	50.87bA	50.97bA	50.79bA	79.91aB	58.14b
	October	40.90cA	36.45cA	34.63cA	43.14bA	38.78c
60-90	March	79.21aA	79.61aA	78.10aA	77.71aA	78.66a
	May	46.90bA	52.81bA	57.98bA	74.97aB	58.17b
	October	33.60cA	31.88cAB	29.55cB	32.45bA	31.87c
90-120	March	96.16aA	96.64aA	94.82aA	94.33aA	95.49a
	May	60.04bA	68.92bAB	75.41bB	95.83abC	75.05b
	October	40.75cA	36.89cBC	35.60cC	38.69bAB	37.98c

Soil water storage (mm) by 30 cm soil layers in 2013

Soil depth (cm)	Month	Treatment				
		CV	TS	CV/TS	Control	Average
0-30	March	85.74aAB	84.35aAB	90.07aB	80.59aA	85.19a
	May	66.19bA	57.52bA	58.67bA	64.93bA	61.83b
	October	67.82bA	63.14bA	65.80bA	65.42bA	65.54b
30-60	March	96.78aA	87.02aB	93.10aAB	91.28aAB	92.04a
	May	71.65bA	56.66bB	55.14bB	73.90bC	64.34b
	October	54.75cA	53.15bA	58.97bA	57.22cA	56.02c
60-90	March	80.60aA	77.31aA	78.38aA	81.26aA	79.39a
	May	62.47bA	49.56bB	48.08bB	64.64bC	56.19b
	October	44.55cA	46.74bA	43.92cA	44.73cA	44.98c
90-120	March	97.94aA	95.84aA	99.65aA	96.46aA	97.47a
	May	80.53bA	65.73bB	61.99bB	85.81bC	73.52b
	October	53.64cA	55.68cA	52.08cA	52.74cA	53.54c

Different lower case letter denote significant difference for sampling dates within one treatment, and different upper case letter denote significant difference for treatments within single sampling date.
Highlighted text: without highlight – SWS above LCM, lighter green– between LCM and WP, darker green– below WP

RESULTS AND DISCUSSION

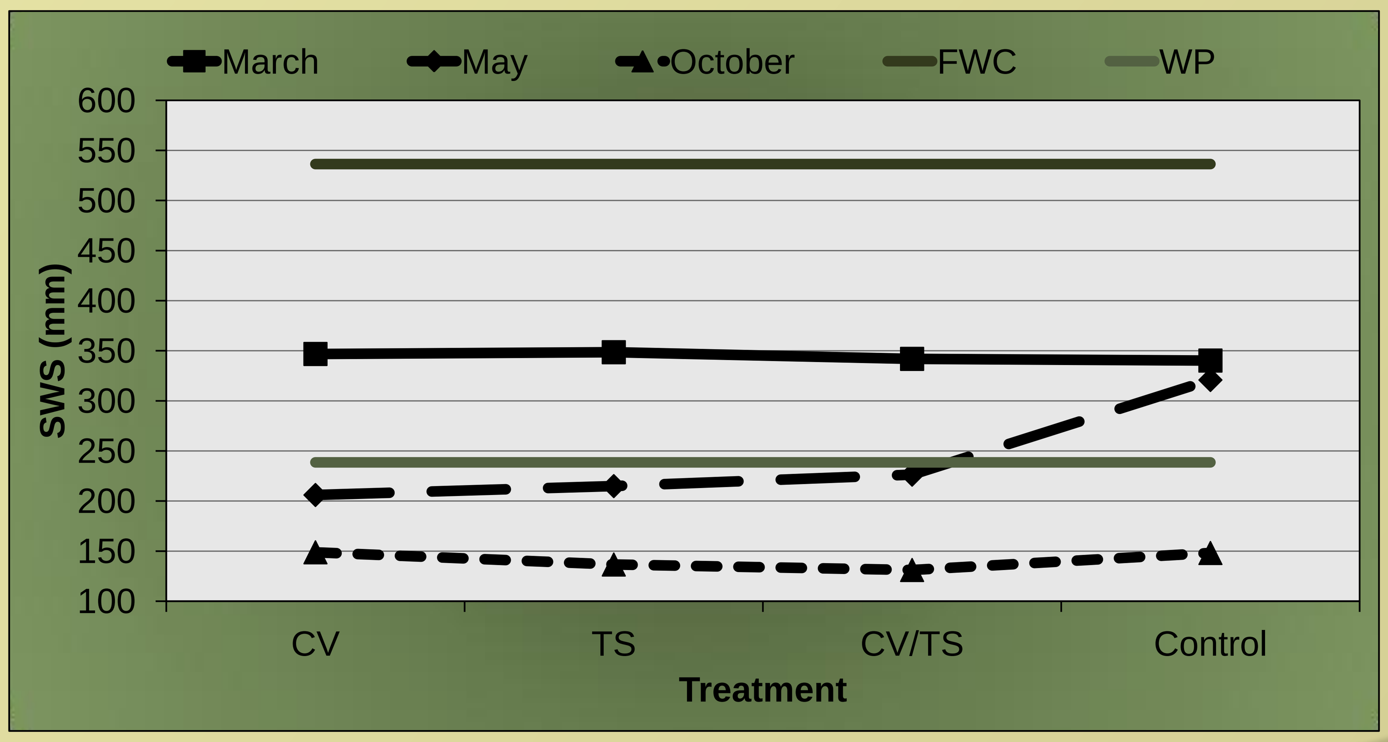
Cover crops were supplied with a sufficient amount of readily available water at the end of winter due to sufficient amounts of winter precipitation in both investigated years. After termination of cover crops, SWS was reduced on all cover crop treatments, to the content below wilting point in layer up to 60cm. In the dry year, after the maize harvest, all available water was depleted from the 120 cm soil layer, and in relatively favorable year sufficient quantities of readily available water remained in the deeper soil layers.

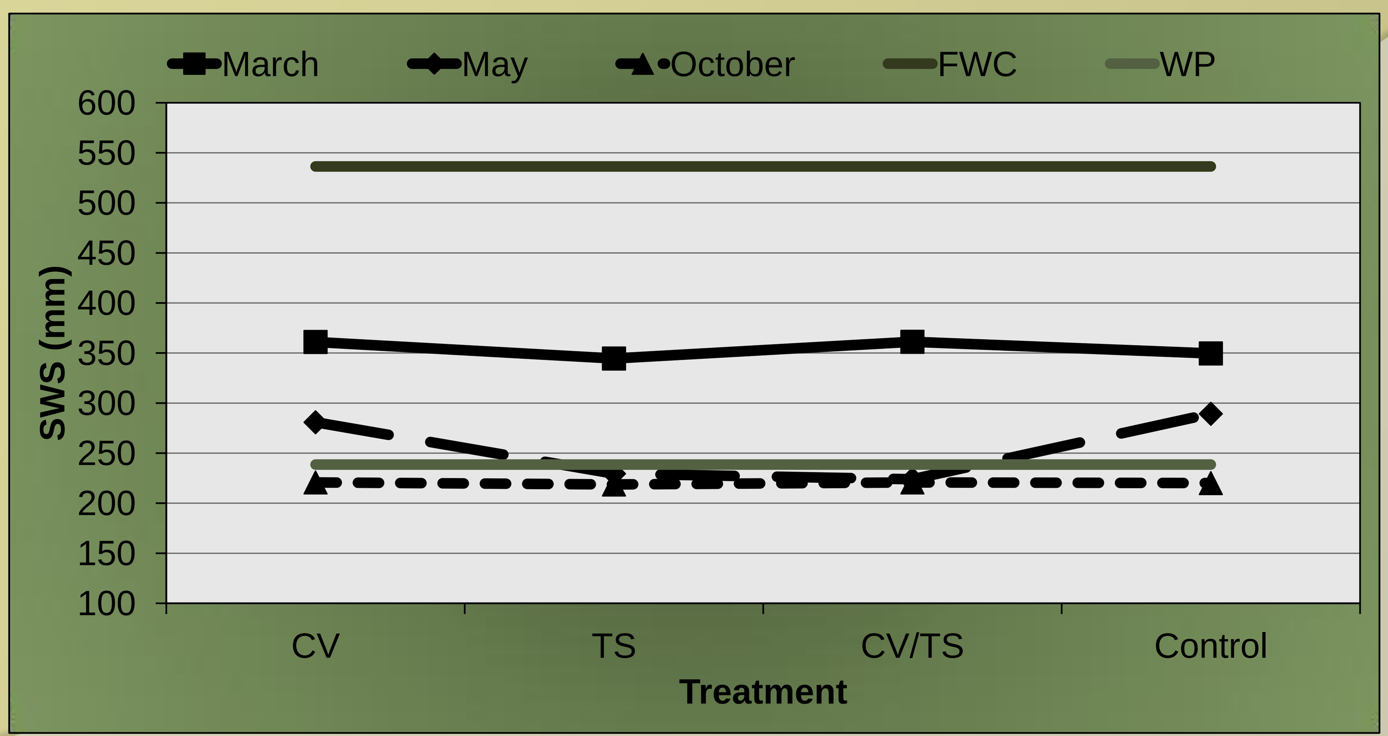
In March for both investigated years cover crops were supplied with a sufficient amount of easily available water. Due to sufficient amounts of winter precipitation, soil up to 120 cm has been wetted. However, SWS was far below the FWC, but still above the lower limit for optimum soil water content. In this sampling term no significant difference was found between the treatments in 2012. In 2013 different SWS values were determined in 0-30 cm and 30-60 cm layer, with no regularity found, and no influence on water consumption in following period. In this region winter precipitation can replenished the pre-vegetation soil reserve, but they are insufficient to produce high yields, especially with scant rainfall during the growing season.

In May, after cover crop termination, plants extracted the remaining available water mostly up to 60 cm layer. In order to interpret the dynamics of water in the soil, it is necessary to know the amount of precipitation and more important their distribution. Small and frequent amount of rain in this period were not sufficient to wet the surface layer of soil, and considering the consumption of water by the plants, it caused the reduction of SWS below the WP. However, layers below 60 cm in 2012 and below 90 cm in 2013 were supplied with sufficient amounts of available water due to winter reserves and consumption from the shallow layers. The SWS on control corresponded to water levels above LCM in 2012 in all layers, but in 2013 only below 60 cm.

By the end of maize vegetation, water content in most cases declined to the level below WP.

Soil water storage for 120 cm soil depth in 2012 and 2013





CONCLUSION

In water-limited years winter cover crops reduce water level from available to hardly available water level. Deeper soil layers, below 60 cm, were within limits of available soil water. No greater effect of the mixture over single crop use was recorded. The cover crops limit water for the next crop, and if the water is not replenished their use may not be justified in all years in a moderate continental climate from the water consumption point of view.

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