2-years effect on the soil nutrient supply after wastewater irrigation

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Introduction

Renewed interest in the reuse of wastewater is due to a combination of factors such as water scarcity, water supply demands, prolonged drought, climate variability, laws preventing direct discharge of wastewater into surface waters and the need to conserve freshwater (Ganjegunte et al. 2018, Roccaro and Verlicchi 2018). According to Abd-Elwahed (2018) the long-term application of wastewater offered water, nutrients and total organic matter to the soils but to avoid unwanted harmful effects from the wastewater applied to soil, regular assessment of soil quality is crucial. Aim of our study was to determine the impacts of the irrigated wastewater (originated from an intensive catfish farm with high nutrient and salt content due to the technology and geothermal origin) on the soil nutrient supply (NPK).

Materials and methods

The experiment was set up in Szarvas, Hungary, NAIK ÖVKI Lysimeter Station. For irrigation, in order to reduce the negative effects of geothermal origin for soil, wastewater of a fish farm was used in three treatments: untreated wastewater (UW), wastewater with calcium-sulphate amendment (WA), and diluted wastewater with amendment (DWA). Wastewater had high inorganic N content (*Table 1*). Irrigation water amount was 335 mm and 575 mm in 2016 and 2017, respectively. Control treatment was non-irrigated (RF as rainfed, in 2016 189.5 mm and Körös River (KR) water irrigated in 2017). The experiment was conducted in 16 lysimeters (1 m^3), each treatment with 4 replications. Irrigated plants were sorghum (2016) and rice (2017). The soil samples (∑128) were collected before and after the irrigation periods. All water and soil analyses were made by the relevant Hungarian standards. The statistical calculation was performed in SPSS 22.0 Statistics Software. Paired Sample T-test was used to determine the significant changes in the nutrient concentrations between treatments.

Table 1: Chemical composition of the different wastewaters in the experiment

	UW	WA	DWA	KR
Ammonium-N (mg/dm^3)	24.4	24.4	10.8	0.37
Total phosphorous (mg/dm^3)	2.16	1.82	0.918	0.15
Potassium (mg/dm^3)	6.25	6.34	5.40	3.71

Results and discussion

According to our results in 2016 the N content of the soil was higher after the irrigation period in all treatments. In case of UW and WA treatment the differences between the concentrations are significant (*Table 2*) due to the ammonium-N concentration of the irrigation water. In 2017, the highest N contents were measured again in the same treatments. Decrease of the soil N in 2017 could be because of more precipitation and rainwater amount which could leach the nitrate or more plant uptake. The phosphorous

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content of the soil did not show any alteration due to the wastewater irrigation excepting in 2016 in UW treatment. The available potassium level also did not change due to the wastewater treatments but the increase occurred because of natural soil formation.

Table 2: Nutrient supply of the soil (0-90 cm) in the wastewater irrigation experiment in 2016 and 2017

Nitrogen mean (mg/kg)	**2016 spring**	**2016 autumn**	**2017 spring**	**2017 autumn**
RF(irrigated KR in 2017)	6.80	10.54	11.03	5.31**
UW	6.73	14.12**	12.40	9.77
WA	6.72	12.50**	11.62	10.02
DWA	7.07	7.99	10.62	5.89**
Phosphorous mean (mg/kg)	**2016 spring**	**2016 autumn**	**2017 spring**	**2017 autumn**
RF (irrigated KR in 2017)	638	646	729	638
UW	372	467*	381	385
WA	534	653	540	414
DWA	540	680	648	452*
Potassium mean (mg/kg)	**2016 spring**	**2016 autumn**	**2017 spring**	**2017 autumn**
RF (irrigated KR in 2017)	343	396*	372	467***
UW	328	394***	341	439**
WA	328	390**	349	446**
DWA	337	386**	354	429***

Note: Nitrogen: KCl-NO_2^-+NO_3^--N, Phosphorous: AL-P_2O_5, Potassium: AL-K_2O.
(:$p<0.05$, **: $p<0.01$, ***: $p<0.001$, $n=8$)*

Conclusions

Overall, the applied wastewater had been suitable to enhance available N level of the soil. In case of P and K the original soil supplies were abundant – this type of wastewater could not enhance it. Increasing available potassium level is assumed to occur because of the natural mineralization of mica clay minerals. In the future, further investigation is needed to analyze the impact of the wastewater treatment on the nitrate leaching and plant nutrient uptake for this the plant analyzes and the chemical analyzes of the leaching water in progress.

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