EFFECT OF WASTEWATER RECLAIMED WITH MICROALGAE ON AGRICULTURAL SOIL CULTIVATED WITH *Scindapsus aureus.*

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ABSTRACT.

Impact of reclaimed wastewater reuse in agricultural soil with ornamental plant *Scindapsus aureus* in pots is studied. Wastewater regeneration is verified in a biological photoreactors system in continuous operation, Modified Natural Technology (M.N.T.)

The aim of this study is to compare the behaviour of well water, secondary urban waste water and water from biological reactor on soil and plant, as well as to validate the M.N.T. as a method for removing pathogens from wastewater.

Results suggested that reclaimed water and well water are entirely suitable for use in agricultural irrigation. Reclaimed water supplied more nutrients to the plant than the others. Soil acted as a wastewater treatment system.

Keywords: wastewater reclamation, reuse in irrigation, biological photobioreactor.

INTRODUCTIÓN.

Treatment and disinfection of urban wastewater can be achieved by means of M.N.T. Quality requirements of R.D. *1620/2007, de 7 de diciembre, por el que se establece el régimen jurídico de la reutilización de las aguas depuradas para su uso en riego agrícola* may be reach with a sealed photoreactors system, the presence of microalgae, and solar radiation, with the consequent over oxygenation in the reactor.

MÉTHODS

Weekly irrigation of three blocks of pots were performed with three types of water: well water (control), Secondary treatment water (SW) and regenerated with photoreactor water (RW), tracking irrigation and drainage water quality, soil and plants. The following parameters were measured:

-On water samples. Chemicals: DBO_5, DQO, pH, electrical conductivity, turbidity, suspended solids, nitrogen (organic and nitrate), phosphorus, sodium, potassium, calcium, magnesium. Microbiological: total and faecal coliformes.

-On soil samples. Physicals: Texture. Chemicals: pH in water and KCl, E.C., total nitrogen, phosphorus, sodium, potasium, carbonates, organic matter. Microbiological: Coliformes.

-On plant samples. Chemicals: total nitrogen, phosphorus, sodium, potassium, calcium, magnesium.

The experiment was carried out from 11/11/09 to 24/03/10 (134 days). Water samples were taken and analysed on irrigation days. Soil samples were taken on days 1, 36, 71 and 134. Plant samples were taken and analysed at the end of the experiment

RESULTS AND DISCUSSION.

Comparison of irrigation water

In Fig.1, 2 y 3 evolution of oH, COD (mg/L) and BOD_5 (mg/L) is compared, for well water (C), secondary treated water (SW) and reclaimed water (RW), throughout the experience.

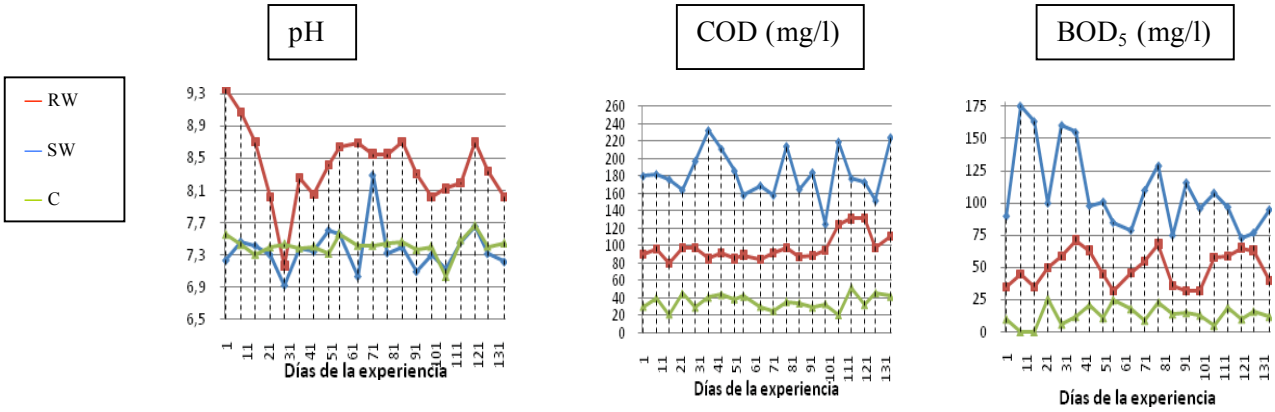

Fig.1 Fig.2

Fig.3

Photosynthesis of microalgae developed within the photoreactors causes a decrease in CO_2 and consequently the pH increased. The reclaimed water contains less organic matter (COD y de BOD_5) than the secondary treated, and can be considered as contamination free according to normative.

Secondary treated water has a higher concentration of dissolved salts, and high levels of turbidity and suspended solids, progressively increasing as a result of algae proliferation in the photoreactors system. The reclaimed water contains higher concentration of organic nitrogen and nitrate, mainly because of the high population of algae.

There are no significant differences between Na^+, K^+, Ca^{2+} and Mg^{2+} in irrigation waters. All waters show high risk of salinization and low of alkalinization.

The absence of total and faecal coliformes indicates that both, the reclaimed and the well water are bacteriologically safe. The secondary treated water exceeds the limit admitted of 10000 UFC/100ml (R.D. 1620/2007)

Comparison of soils.

	INITIAL	TREATED WATER			RECLAIMED WATER			WELL WATER		
		MEDIA		SD	MEDIA		SD	MEDIA		SD
pH water	8,66	8,25	a	0,16	8,63	b	0,09	8,39	b	0,03
pH (KCl)	7,44	8,04	a	0,07	8,49	b	0,04	8,11	a	0,06
C.E.	97,07	97,67	a	0,44	97,11	a	0,01	97,14	a	0,06
% OM.	1,82	0,52	a	0,09	0,80	ab	0,22	1,10	b	0,21
%N	0,17	0,03	a	0,00	0,04	ab	0,01	0,06	b	0,01
C/N	10,41	10,50	a	0,03	11,25	b	0,30	10,74	a	0,32
P	0,55	1,01	a	0,13	0,89	a	0,10	0,88	a	0,14
Na	161	0,84	a	0,12	1,07	a	0,20	0,78	a	0,09
K	6,6	6,62	a	0,04	6,64	a	0,06	6,60	a	0,02
Ca	5250,0	6316,7	a	202,1	6466,7	a	125,8	6216,7	a	256,6
Mg	200,0	291,7	a	38,2	275,0	a	25,0	250,0	a	0,0
%Carbonates	18,4	18,91	b	0,16	17,80	a	0,24	18,59	b	0,13

Textural analysis shows a loamy soil. Table 1 shows that soil irrigated with reclaimed water presents a higher pH and exchangeable sodium. Soil irrigated with treated water presents the highest salinity and exchangeable magnesium.

Only the treated water contributes to soil coliformes (total coliformes 30.500.000 UFC/kg ± 155.000, and faecal coliformes 14.800.000 UFC/kg ± 99.500).

Study of drained water.

	TREATED W.			RECLAIMED W.			WELL W.		
	AVER.		SD	AVER.		SD	AVER.		SD
pH	7,62	a	0,33	8,45	b	0,36	7,71	a	0,27
C.E.	1263,95	b	115,52	1083,62	a	110,37	1037,28	a	67,86
COD	170,45	c	22,31	90,50	b	12,10	32,73	a	7,87
BOD5	127,37	c	30,46	51,03	b	16,64	11,37	a	9,61
P	1,049	c	0,651	0,062	b	0,067	0,026	a	0,017
NO3-	92,3	c	19,6	78,9	b	16,8	55,9	a	9,1
TC	496 391		128 718	0			0		
FC	52 258		14 313	0			0		

Soils irrigated with treated water induced a descent of 95 % and 88 % respectively in FC and TC of water. This means that soils act as a biological filter for both coliform and organic matter.

Comparison of plants

	PLANTS – TREATED WATER			PLANTS – RECLAIMED WATER			PLANTS – WELL WATER		
	AVER.		SD	AVER.		SD	AVER.		SD
N	17 444,9	a	7 450,8	20 454,4	a	6 920,2	20 270,8	a	2 201,6
P	7 414,7	a	2 465,0	8 444,7	a	528,2	7 791,8	a	667,6
Na	4 652,6	a	2 776,5	4 848,6	a	3 328,4	1 728,6	a	1 043,8
K	24 244,2	a	6 897,3	28 010,6	a	3 130,4	24 750,3	a	1 159,7
Ca	16 025,7	a	2 964,1	23 352,0	a	4 686,3	19 271,0	a	3 339,5
Mg	2 872,3	a	545,0	4 778,6	a	1 091,3	3 058,8	a	451,2

The plants in pots that were irrigated with reclaimed water contained higher concentrations in all macronutrients, compared to plants irrigated with treated and well water. N and K levels measured in plants were deficient in all cases.

CONCLUSIONS

- The reclaimed and well water used in this paper are entirely suitable for use in agricultural irrigation. This conclusion is supported by the results of the parameters COD, BOD_5, phosphorus, fecal coliformes and total coliformes, which ranks reclaimed water as free from organic and microbiological contamination. The secondary treated water does not reach the quality requirements for irrigation water according to the FAO, or standards imposed by R.D.*1620/2007.*

- The effects of re-using reclaimed water on soil and plants are:

Organic compounds: The addition of organic compounds (COD, BOD_5 and suspended microalgae) improves soil fertility by increasing the C/N, resulting in the rapid decomposition and mineralization of organic matter.

Nutrients and disposable cations: Irrigation with reclaimed water provides plant more nutrients (N, P, Na, K, Ca y Mg) than treated and well water. The highest content of organic nitrogen confers more vigot to the plants irrigated with reclaimed water. Only the treated water has a phosphorous content high enough to change its content in the soil.

Physicochemical parameters: Concerning the effect on physical and chemical parameters studied in the soil, reclaimed water and well water effects are similar.

Microbiological parameters: The biological photoreactors system (M.N.T.) for water regeneration guarantees the absence of coliform in it, and in the soil in which it applies.

- Soil acts as a treatment wastewater system.

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