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RESEARCH ARTICLE

CHANGES CHEMICAL ORGANIC SUBSTRATE SUBMITTED TO REPLACEMENT WATER LEVELS IN PEPPER PLANTS

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ABSTRACT

In regions water scarcity the water reuse in irrigation is alternative for farmers. In this context, the study was conducted in order to changes the chemical attributes of organic substrates subjected to water replacement levels with different water qualities in pepper cultivation. The experimental design was randomized blocks in factorial design 2x5x2, being represented by two types of water (water supply and wastewater), 5 water levels based on water requirement (WR) culture [100% WR (L5), 80% WR (L4), 60% WR (L3), 40% WR (L2) and 20% WR (L1)] and second substrates (cattle and goats). Were evaluated the Ec, pH and sodium Adsorption Ratio (SAR). Increasing water levels influence in the of Ec and pH. The pH was higher than 7 exchangeable and total acidity was zero, with no changes to these attributes. According the data obtained was found that there were changes in chemical properties of the substrate elevating the levels of the elements, necessitating leaching blades to reduce concentrations in substrates.

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INTRODUCTION

Irrigation with wastewater in crops has been used as effective strategy in association with scarcity of water resources in arid and semi-arid regions (Azevedo *et al.,* 2013). Santos Júnior *et al*. (2014) claim that water reuse provides production systems of these regions water availability for expansion crops and reduce the costs of fertilizer. Treated water reuse in irrigation, as affirmed Costa *et al*. (2014) are alternative sources of water and fertilizer for agriculture, however, there chemical, physical and biological limitations on its use, so the relevance studies techniques that enable use, taking into consideration the environment and rural development. These same authors also reports that application of wastewater when used for long periods can influence the chemical composition of the soil, due to the physical and chemical properties that are in addition to the climatic conditions and soil type. The benefits of domestic wastewater in agriculture are many, because have in composition water and nutrients, promotes the possibility of partial replacement of chemical fertilizers, with reduced environmental impact, due the reduction of pollution of water bodies; significant increase in production, both qualitative and quantitative; saving the amount of water directed to irrigation, can be used for more noble purposes, such as public supply; and promote improvement physical conditions in soil by adding organic matter, while solves the problem of final disposal (Fonseca *et al*., 2007, Azevedo *et al*., 2013). The interaction in organic substrate and reuse of wastewater in the agricultural activities, according Silva *et al*. (2013) introduce benefits crops, increasing the growth and production. The use organic substrates in pepper crop has be taken in consideration ease acquisition, as stalls of the producers themselves, become way of providing nutrients to plants, improve the soil quality physical piece as chemical, giving conditions proper development the plant. The organic substrates with properties appropriate for species be cultivated, allows reduction of cultivation time and consumption of inputs such as chemical fertilizers, pesticides and labor-intensive (Fermino and Kampf, 2003). Pepper plants cultivation irrigated with secondary water and organic substrates be investigated, because in commercial value of pepper Capsicum have been the most consumed vegetable crop and marketed worldwide

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(Silva *et al*., 2015), about a quarter the world's population consume pepper, are as fresh, liquid or pasty sauces, canned or dried. Resulting product the value added there peppers production increase (Caixeta *et al*., 2014), and pepper market, according Domenico *et al*. (2012), is segment with large potential for development all continents, for both fresh consumption and processing. The research was conducted aiming to evaluate the changes in chemical attributes of organic substrates subjected to irrigation replacement levels with different water qualities in pepper plants cultivation.

MATERIALS AND METHODS

Site description

Experiment were conducted in greenhouse with area 72 m^2 at the Federal University of Campina Grande, Paraíba, Brazil, is located at an altitude of 550 m above mean sea level and it is 7º15'18" latitude and 35º52'28" longitude (Oliveira *et al*., 2013). The climate is classified as Bswh according to the Köppen classification system, with an average annual temperature of 26.8°C and average annual rainfall of 360 mm (Medeiros *et al*., 2011).

Cultivation

The species used on experiment was cultivate pepper BRS Moema (Capsicum chinense), developed by ISLA seeds company, according Ribeiro *et al*. (2016), selected genetic material and developed by EMBRAPA from CNPH 3870 population have the habit of intermediate growth, approximately of 60 cm high, is resistant to nematode-of-galls (Meloidogyne javanica) and can used as ornamental pepper plant because beauty and degree of uniformity of the plant. Cultivar BRS Moema pepper (*Capsicum chinense*), seeds were planted in organic substrate according company ISLA Seeds.

For propagation, seeds were planted directly in the cultivation site, in 0.5 cm deep holes, as recommended by company. For drainage were performed 6 holes with 5 mm diameter on the base, to allow drainage and below them there was container of 500 mL capacity to collect drainage water, will not allow the loss of water and estimated the water consumption by plant difference between the average volume applied and average volume drained, collected, by drainage lysimeter method, according to the authors, Andrade *et al.* (2012) and Lima *et al*. (2015).

Irrigation of the lysimeters were carried out day before irrigation at 17 hrs. The hydric need was calculated through the difference between the volume put and drained

Treatments

The soil was Gray Argisol Eutrophic mixed with manure in proportion of 7: 3 (soil: manure), 30% of the total volume for composition of the organic substrate. The experiment was laid out in randomized block design, in 2x5x2 factorial, composed of two types of water, supply water (A1) and wastewater (A2), five water levels based on crop water requirement and two types of substrate, cattle manure (S1) and goats manure(S2). The five irrigation levels (L) using supply water and wastewater treated by upflow anaerobic sludge blanket reactor (UASB+WETLAND), based on crop water requirement (WR): 100 % of WR (L5), 80% of WR (L4), 60 % of WR (L3), 40 % of WR (L2) and 20 % of WR (L1). The chemical characteristics of cattle substrate (S1) were: pH (7,84), Ec (1,95 dS/m), Ca (3,3 $cmol_c/dm^3$), Mg (4,30 $cmol_c/dm^3$), Na (3,39 $cmol_c/dm^3$), K (3,0 $cmol_c/dm^3$), SB (13,92 $cmol_c/dm^3$), Al (0,0), H (0,0), P (3,8 $mmol_c/dm^3$), SAR (1,74 $cmol_c/dm^3$) and ESp (24%). Chemical characteristics of goat substrate (S2) were: pH (7,35), Ec (2,1 dS/m), Ca (4,9 $cmol_c/dm^3$), Mg (5,94 $cmol_c/dm^3$), Na (0,75 $cmol_c/dm^3$), K (4,58 $cmol_c/dm^3$), SB (16,17 $cmol_c/dm^3$), Al (0,0), H (0,0), P (3,68 $mmol_c/dm^3$), SAR (0,32 $cmol_c/dm^3$) and ESP (4,63%). Chemical analysis of the substrates were held in Irrigation and Salinity Laboratory Federal University of Campina Grande – LIS (EMBRAPA, 2011). The chemical characteristics of substrate after cultivation evaluated were: pH; Ec and sodium adsorption ratio (SAR); carried out in National Institute for Semi-Arid - INSA, following the methodology of EMBRAPA (2011). The statistical analysis was based on analysis of variance, correlation analysis, and a Tukey's test ($p < 0.05$), using the System Computer Program for Analysis of Variance - SISVAR 2.5 (Ferreira, 2014).

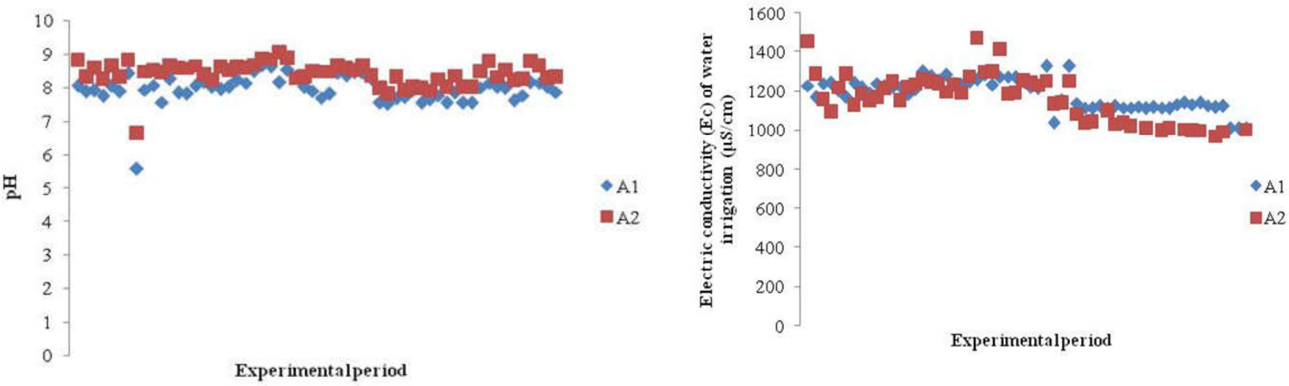
RESULTS AND DISCUSSION

The electrical conductivity of the water supply used for irrigation ranged from 1.0 to 1.3 dS m^{-1} while the waste water ranged from 1.0 to 1.5 dS m^{-1}(Figure 1A). According to Ayers and Westcot (1999), use of such water for irrigation fits in relation electrical conductivity on degree of slight to moderate use restriction (0.7 dS m^{-1} < Ec < 3.0 dS m^{-1}). Andrade *et al*. (2012) working with treated wastewater and supply of same source in the irrigation verified Ec of 1.06 to 1.3 dS m^{-1} and the pH of wastewater by 7.6 to 7.9 and 7.2 supply during the period. In pH monitoring the supply water varies of 5.57 to 8.64 of acid to the basic, averaging 7.9 and wastewater pH of 6.63 to 9.05, almost neutral to basic, averaging 8.4 (Figure 1B). Ayres and Westcot (1991) affirm that normal pH range for irrigation water is of 6.5 to 8.4, being this average of the pH of water irrigated obtained. For type substrates and irrigation levels all variables were statistically significant ($p <0.01$). Note that electrical conductivity was higher for wastewater (3.25 dS/m) and goat substrate (3.65 dS /m), there was increase of Ec when compared with baseline values before treatment (Table 1). In goat substrate was increased by 1.55 dS /m, while in cattle substrate was by 0.41 dS/m for substrates irrigated with wastewater the increase of Ec to 3.25 dS /m and 2.7 dS/m with water supply (Table 1). Pessoa *et al*. (2010) and Gonçalves *et al*. (2011) studied chemical changes in Neossolos on semiarid region of Pernambuco, no significant changes in terms of irrigation water. The used wastewater in irrigation resulted in chemical parameters in substrates with highest average in relation with the water supply applied. Regarding the type of organic substrate used the compost with cattle manure had higher averages to Ec, pH and SAR. It is observed that use these waters raised the chemical parameters of organic substrates (Table 1).

Table 1. Mean on the chemical properties of organic substrates after pepper BRS Moema cultivation underwent irrigation levels in water quality

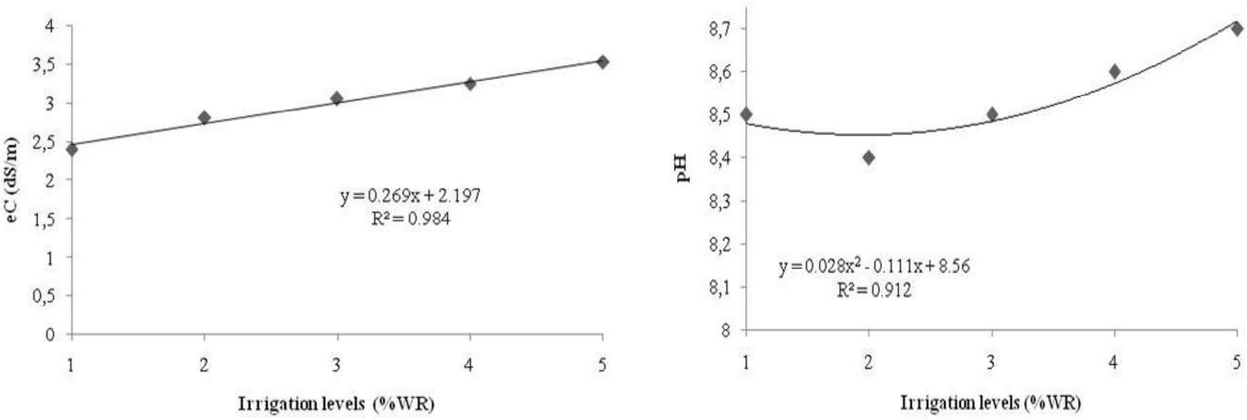
Mean Square				
Source of Variation	**DF**	**Ec**	**pH**	**SAR**
Type of water (A)	1	3.6**	0.35**	0.04**
Substrate (S)	1	4.9**	7.47**	38.0**
Irrigation levels (L)	4	2.2**	0.21**	0.02**
Linear Regression		8.74**	0.61**	0.08**
Quadratic Regression		0.07^{ns}	0.01^{ns}	0.003^{ns}
Deviation Regression		0.03^{ns}	0.1**	0.004*
Interaction (A* L*S)	4	0.14^{ns}	0.04 ^{ns}	0.01**
Resídue	49	0.06	0.02	0.001
CV (%)		8.21	1.61	2.69
Type of water		dS/m	-	$cmol_c/dm^3$
Supply water (A1)		2.7^{a}	8.51 a	1.17a
Wastewater (A2)		3.25b	8.67b	1.23b
Type of substrate				
Cattle substrate (S1)		2.36^{a}	8.24a	2.00b
Goat substrate (S2)		3.65b	8.95b	0.41a

[1] ^{ns}: not significant (P>0,05); *: significant (P<0,05); C.V.: coefficient of variation. Means followed by the same letter in vertical do not differ by Tukey test.



A B

Figure 1. Monitoring of electric conductivity (A) and pH (B) of the water supply (A1) and treated wastewater (A2) used for irrigation during experimental period



A B

Figure 2. Effect irrigation levels and cultivation the peppers on soil properties

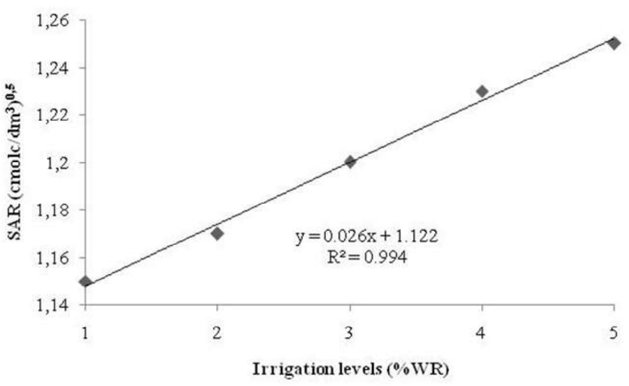


Figure 3. Effect irrigation levels on soil properties in cultivation the peppers

This increase can be attributed to water salinity, the low volume of the container, as also observed by Sousa *et al.* (2008). These results show that amount of dissolved salts in irrigation water provides increased electrical conductivity in the soil saturation extract. Lima Neto *et al.* (2015) observed that irrigation water and raw material used influence the elevation for substrate salinity. In concerning the water supply, wastewater used increased amounts of chemical attributes of organic substrates in approximately of 20% to Ec, 1.8% to pH and 5.1 to SAR. Silva *et al.* (2014) also obtained similar results.

In increasing the amount of water occurs increment in electrical conductivity of the substrate saturation extract. Applying 20% NH (L1) the Ec obtained was approximately of 27% lower compared with 60% NH (L3) related L3 and L5 (100% NH) elevated Ec of 15.4% (Figure 2A). According to Richards (1954), one of the characteristics of saline soil is present electrical conductivity (Ec) > 4 dS/m, which was not observed this experiment. When assessing wastewater treated doses of the same origin in Ultisol Eutrophic Firmino *et al.* (2015) observed marked increase in value of the electric conductivity of the soil. These authors also claim that use of recycled water for irrigation with high concentrations of salts and sodium can cause salinization and sodification soil. The variations pH as increases in 20% the water requirement of the crop irrigation levels were of 0.1 pH units, ranging from 8.4 to 8.7. Comparing the initial pH of cattle substrate (7.84) and goat (7.35) notes rise in pH of substrates subjected to irrigation levels with types of water after Bico pepper cultivation, which may be due pH of applied irrigation water (Figure 2B), the presence of exchangeable cations (Ca, Mg, K and Na) provided on the substrate did not compete with the acidic in nature cations (al + 3 and H +) per absent, as also stated Firmino *et al.* (2015). Nascimento and Fideles Filho (2015) to investigate the chemical soil amendments submitted to different water qualities in irrigation realized that the final soil attributes were changed in an increasing manner. The potential impact of irrigation water quality on soil structure can be evaluated using sodium content and sodium absorption ratio (SAR) values, Figure 3. However, the SAR values were far below the limit (> 15) established to define saline-sodic soils (Mahdy, 2011). Mahmoud *et al.* (2010) reported that high concentrations of K and Na in the applied probably led to an increase in exchangeable sodium percentage (ESP) and a subsequent degradation of soil structure. Micheal *et al.* (2008) reported that oil and grease in wastewater used for irrigation can accumulate in the soil and may lead to a significant reduction in the soil's ability to transmit water.

According to Andrade *et al.* (2015) increased SAR can reduce the contribution of organic matter, due to reduced microbial population, which is responsible for mineralization of organic matter, which in turn releases the nutrients to the soil solution. This information is importance in relation to this research considering that analyzed wastewater treated and the supply water levels on substrates consisting of different manures, as shown in Figure 3, using 100% NH of pepper the SAR was of 1.25 $(cmolc/dm^3)^{0.5}$. The increase in SAR indicates raise of the proportion of sodium in soluble soil phase, with reduction of other cations, which can promote nutrient imbalances, difficulting at absorption of calcium, magnesium and potassium, elements essential to plants (Pessoa *et al.*, 2010). Erthal *et al.* (2010) stated that high concentrations of Na^+ in soil solution compared to Ca^{2+} and Mg^{2+}, can cause deterioration of the soil structure, the dispersion of colloids and subsequent blockage of macropores, causing decrease in permeability to water and gases. If irrigation water with a high SAR is applied to a soil for years, the sodium in the water can displace the calcium and magnesium in the soil. This will cause a decrease in the ability of the soil to form stable aggregates and a loss of soil structure.

Conclusion

The increased irrigation levels in 20% crop water requirement elevated the electrical conductivity, pH and sodium absorption ratio of substrates. Water reuse in irrigation increases the chemical properties of the substrates. It is recommended to apply leaching blades to remove excess chemical elements of the substrates.

Conflict of Interest: The authors have not declared any conflict of interest.

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