HYDROCHEMICAL ASSESSMENT OF WATER FOR IRRIGATION IN THE BAIXO AÇU-RN REGION.

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ABSTRACT: The quality of water is an important factor when it comes from water for irrigation purposes having in view its chemical composition and its possible impacts when coming into contact with the soil. Thus, the aim of this work was to evaluate the hydrochemical quality in water for irrigation of the Baixo Açu region, in Rio Grande do Norte. A database was used with 50 analyzes, of which 20 well, 18 river and 12 dam. In the samples were determined: pH, EC, Ca, Mg, Na, Cl, HCO3- and CO32-. For each sample Sodium Adsorption Ratio (SAR), Magnesium Adsorption Ratio (MgAR), Kelly Index (KI) and Soluble Sodium Percentage (SSP) were calculated. The largest restrictions for well water were 25%, 40% and 95% using MgAR, KI and SSP, respectively. For river water, 44.4% and 94.4%, using KI and SSP, respectively. For dam water, 25%, 8.3% and 100% using MgAR, KI and SSP, respectively. No sample presented from moderate to severe risk using SAR.
KEYWORDS: irrigation water quality; soil salinity; permeability.

AVALIAÇÃO HIDROQUIMICA DA ÁGUA PARA IRRIGAÇÃO DA REGIÃO DO BAIXO AÇU-RN

RESUMO: A qualidade das águas é um fator importante quando se trata de águas para fins de irrigação tendo, em vista, a sua composição química e seus possíveis impactos ao entrar em contato com o solo. Dessa forma, objetivou-se com este trabalho avaliar a qualidade hidroquímica em águas para irrigação da região do Baixo Açu, no Rio Grande do Norte. Foi utilizado banco de dados com 50 análises, sendo 20 de poço, 18 de rio e 12 de açude. Nas amostras foram determinados: pH, CE, Ca, Mg, Na, Cl, HCO_3^- e CO_3^{2-}. Para cada amostra foi

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calculada a Razão de Adsorção de Sódio (RAS), a Razão de Adsorção de Magnésio (RAMg), o Índice de Kelly (IK) e a Porcentagem de Sódio Solúvel (PSS). As maiores restrições para águas de poço foram de 25%, 40% e 95% usando a RAMg, IK e PSS, respectivamente. Para água de rio, 44,4% e 94,4%, usando IK e PSS, respectivamente. Já para água de açude, 25%, 8,3% e 100% usando RAMg, IK e PSS, respectivamente. Nenhuma amostra apresentou risco de moderado a severo usando como índice a RAS.
PALAVRAS-CHAVE: qualidade da água de irrigação; salinidade do solo; permeabilidade do solo.

INTRODUCTION

The Northeast occupies a large part of the Brazilian semi-arid region and it shows as characteristics low rainfall, irregular rainfall distribution and high evapotranspiration rate. These factors become limiting for agricultural production in the region, requiring the application of water via irrigation to supply the water demands of the crops, making the region the main producer and exporter of fresh tropical fruits in Brazil (Lopes, P. R. C, et. al), highlighting the fruit pole of Baixo Açu, in Rio Grande do Norte. The region has fertile soils and the use of irrigation through water catchment, makes the region of great economic interest for the agricultural companies that are installed in Baixo Açu.

However, it is not only the amount of water that is required for irrigation application, but also the water quality, since all water used for agricultural purposes contains dissolved salts that can cause effects on the chemical and physical characteristics of the soil influencing the capacity productive (Almeida, 2010).

According to Silva (2011), the salts are capable of causing variations in the structure, permeability and aeration of the soils causing damages to the plant growth (Silva et al., 2011). The excess of salts, as well as excess of some elements in relation to others in their chemical composition is of interest to the agricultural producers (Maia et al., 2018), being necessary the hydrochemical evaluation of the irrigation water quality in order to evaluate its chemical composition.

The hydrochemical evaluation in water for irrigation is done by using indexes to evaluate the water quality for agricultural purposes, such as the Kelly Index (KI), Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP) and Magnesium Adsorption Ratio (MgAR), among others. Even though these indexes have been proposed for a long time, given

their relevance to water quality assessment for irrigation, they are being used recently in work around the world, for example: Harish & Abhilash (2016) Al-Ruwaih & Shafiullah (2017), Abadom & Nwankwoala (2018) and Maia *et. al*. (2018).

Thus, the aim of this work was to evaluate the hydrochemical quality in water for irrigation of the Baixo Açu region, in Rio Grande do Norte.

MATERIAL AND METHODS

The Baixo Açu Region is located in the north-central part of the state of Rio Grande do Norte, in the geographical grid between the parallels 4º48 'to 5º41' south latitude and meridians 37º30 'to 38º5' West of Greenwich. The classification, according to Koppen the thermal and pluviometric regime point to BSwh ', as very hot and semi-arid climate. The rainfall distribution is irregular in time and space having the annual average precipitation of about 679 mm, in which the rainy season occurs in the summer and fall. The average annual temperature of the region is 27.5ºC, in which the months of December and July stand out because they present the maximum and minimum temperatures respectively, 33.3ºC and 22.7ºC (Carmo Filho et al., 1991).

It was used a database with 50 water analyzes from the Baixo Açu region, 20 of which fron the well, 18 river and 12 dam. In order to evaluate the hydrochemical quality of the water, the physical and chemical characteristics were determined: pH, electrical conductivity (EC), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}) and potassium (K^{+}), chloride bicarbonate (HCO_3^{-}) and carbonate (CO_3^{-}). The methodology applied in the work was proposed by Richards (1954). For each sample Sodium Adsorption Ratio (SAR), Magnesium Adsorption Ratio (MgAR), Kelly Index (KI) and Soluble Sodium Percentage (SSP) were calculated by equations 1, 2, 3 and 4, respectively, with Ca, Mg, K and Na in $mmol_c\ L^{-1}$.

$$SAR = Na\sqrt{\frac{2}{Ca+Mg}} \qquad (1)$$

$$MgAR = 100\frac{Mg}{Ca+Mg} \qquad (2)$$

$$KI = \frac{Na}{Ca+Mg} \qquad (3)$$

$$SSP = \frac{100Na}{Ca+Mg+K+Na} \qquad (4)$$

The interpretation of the samples regarding the degree of restriction was applied to the values that presented no risk in the use, SAR <18 $(mmol_c/L)^{0.5}$ (Richards, 1954), MgAR <50% (Ayers & Westcot, 1999), KI <1 (Kelly, 1940) and SSP <20% (Wilcox, 1955).

RESULTS E DISCUSSION

Analyzing the Baixo Açu region water of in its hydrochemical quality, Table 1 shows the assessments according to the degree of restriction adopted, in which, for SAR, 100.0% of the water samples from well, river and dam present restriction as to its use in the practice irrigated agriculture, indicating that the amount of Ca + Mg in water reduces the risk of sodicity.

Table 1. Percentage of samples according to risk of use based on Sodium Adsorption Ratio (SAR), Magnesium Adsorption Ratio (MgAR), Kelly Index (KI) and Soluble Sodium Percentage (SSP) for Baixo Açu water.

Source	Risk	SAR	MgAR	KI	SSP
		---------- % ----------			
Well	None	100	75.0	60.0	5.0
	Moderate/ Severe	0.0	25.0	40.0	95.0
River	None	100	100.0	55.6	5.6
	Moderate/ Severe	0.0	0.0	44.4	94.4
Dam	None	100	75.0	91.7	0.0
	Moderate/ Severe	0.0	25.0	8.3	100.0

MgAR data show that 75.0%, 100.0%, 75.0% of water from well, river and dam, respectively, did not present restriction, indicating that for well and dam they have a degree of restriction of moderate to severe for MgAR of 25%, requiring a greater attention to these, due to the greater presence of Mg when compared to Ca. For IK 60.0%, 55.6% and 91.7%, for well, river and dam water, there is no restriction of use, however, for well and river water 40% and 44% 4%, respectively, restriction of use in irrigation. However, when SSP was evaluated, it was noticed that only 5.0%, 5.6%, of the analyzed well and river samples showed no restriction of use and in dam water, all analyzes presented moderate to severe degree in the application of water.

SAR classifies the water from the river, well and dam of Baixo Açu as suitable for use in irrigation because they present low risk of exchangeable sodium. When the samples were evaluated using KI, they indicate a higher concentration of Na in the water when related to SAR. KI values for well and river presented a degree of restriction for irrigation use of 40.0% and 44.4%, respectively, already indicate a considerably lower value for dam water with 8.3% of restriction. Nevertheless, when the SSP is evaluated, attention is drawn to the exchangeable sodium risk that 95.0%, 94.4%, 100.0% of the analyzed samples show a restriction of use.

According to Joshi et al. (2009), the water quality applied via irrigation may vary depending on the type and amount of dissolved salts, these salts are originated from the weathering or dissolution of the rocks, which include the dissolution of elements such as limestone and plaster, when transported by the rains to the water bodies and later used for irrigation.

It is necessary to pay attention to the application of water with excess of sodium, since, according to Singh & Kumar (2015), when Na concentrations are high in the water can cause changes in soil properties, since, sodium tends to replace calcium and magnesium causing damage in the soil structure giving beginning to the process of soil impermeability.

Richards (1954) in his studies concluded that the increase of salt concentrations in sodium soils promoted dispersion of soil colloids causing a greater incidence of drainage problems, consequently, making it difficult the infiltration of water in the soil and the decrease of aeration and little root development as well as the toxic effect presence of sodium on crops.

Magnesium concentration in the water is one of the methods used in the assessment of the hydrochemistry, since in water, Ca and Mg tend are in equilibrium (Joshi et al., 2009). Higher Mg concentrations in the water cause increase of their salinity and affect the yield. According to Crisostomo (2002), Mg is a fundamental component of chlorophyll and activator of several enzymes. However, Ayers & Westcot (1999) report that high concentrations of Mg can cause induced Ca deficiency by the large amount of exchangeable Mg in the soil, in their experimental results it was observed that yields of barley, corn, wheat and sugar beet crops were reduced when the samples showed the Ca/Mg ratio is less than 1.

CONCLUSIONS

The largest restrictions for well water were 25%, 40% and 95% using MgAR, KI and SSP, respectively, for river water, 44.4% and 94.4%, using KI and SSP, respectively, and for dam water, 25%, 8.3% and 100% using MgAR, KI and SSP, respectively. No sample presented a moderate to severe risk using SAR.

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