ACCUMULATION OF PRIMARY MACRONUTRIENTS BY PEANUTS IRRIGATED BY PULSES AND BRACKISH WATER

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ABSTRACT: Salinity triggers a series of damages in mineral nutrition of plants, causing loss in production. The objective was to evaluate effect of use of brackish water and pulsed and continuous drip irrigation on accumulation of nutrients in peanut crop. Experimental design was randomized blocks, 6 x 2 factorial scheme, with six levels of electrical conductivity of irrigation water (ECa: 0.2; 1.6; 2.8; 4.0; 5.2 and 6.4 dS m^{-1}) and two types of irrigation management (with pulses and continuous). At 63 days after sowned, accumulations of macronutrients N, P, K, and elements sodium (Na) and chloride (Cl). Pulse irrigation mitigated deleterious effects of salinity enabling greater accumulation of nutrients by peanut compared to continuous irrigation. The decreasing order in accumulation of nutrients by peanuts crop irrigated by pulses and continuously was: K > N > P. Pulsed irrigation is efficient in mitigating effects of use of brackish water on cultivation of peanuts.

KEYWORDS: extraction of nutrient, salinity, nutritional management, water management.

ACÚMULO DE MACRONUTRIENTES PRIMÁRIOS PELO AMENDOIM IRRIGADO POR PULSOS E ÁGUA SALOBRA

RESUMO: A salinidade desencadeia uma série de malefícios na nutrição mineral das plantas, ocasionando perda na produção. Objetivou-se avaliar o efeito do uso de águas salobras e da irrigação por gotejamento pulsado e contínuo sobre o acúmulo de nutrientes na cultura do amendoim. O delineamento experimental utilizado foi o de blocos ao acaso em esquema fatorial 6 x 2 com seis condutividades elétricas da água de irrigação (0,2; 1,6; 2,8; 4,0; 5,2 e 6,4 dS m^{-}

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[1]) e duas formas de aplicação da irrigação (com pulsos e contínua). Aos 63 dias após a semeadura foram quantificados os acúmulos dos macronutrientes N, P e K, além de sódio e cloreto. A irrigação por pulsos mitigou os efeitos deletérios da salinidade possibilitando maior acúmulo de nutrientes pela cultura do amendoim em comparação à irrigação contínua. A ordem decrescente no acúmulo dos nutrientes pela cultura do amendoim irrigado por pulsos e de forma contínua foi: K > N > P. A irrigação pulsada é eficiente na mitigação dos efeitos do uso de água salobras no cultivo de amendoim.
PALAVRAS-CHAVE: Extração de nutrientes, salinidade, manejo nutricional, manejo da água.

INTRODUCTION

The adoption of techniques and tools that rationalize inputs and promote gains in plant production is important to development of intensive and sustainable agricultural system (MENEZES et al., 2020). Water quality and irrigation strategies are important factors that affect agricultural production, especially in soils of arid/saline regions (FEIZI et al., 2010). In this context, pulsed or pulse irrigation is framed, a recent type of irrigation that maximizes use of water and fertilizers (MENEZES et al., 2020).

Pulsed irrigation is contemporary concept in which small frequent irrigations are adopted to saturate soil and meet water demand of crop. This modality of irrigation has positive effects on increasing yields, improving plant quality, saving water and reducing energy consumption (BAKEER et al., 2009). The use of low-quality groundwater has become inevitable especially in arid and semiarid regions, due to competition for good quality water for human and industrial consumption (KATERJI et al., 2000).

It is estimated that 2% of Brazilian soils are salinized (Embrapa Solos - Soil Maps in Brazil), which occur in Rio Grande do Sul, in the Pantanal region of Mato Grosso and, with a predominance in the semi-arid region of the Northeast (RIBEIRO et al., 2003). Despite adoption of saline water use strategies in these regions, association between use of brackish water and pulse irrigation in plant growth and production is still unclear.

Thus, the objective of this work was to evaluate effect of use of brackish water and pulsed and continuous drip irrigation on accumulation of nutrients in peanut crop.

MATERIAL AND METHODS

The study was conducted in September and November 2019, in open field of experimental area of Department of Agricultural Engineering of Federal Rural University of Pernambuco, Campus Sede, Recife-PE, Brazil. According to Köppen classification, climate is characterized as tropical rainy, type As" to Ams", with rainy season from April to July (SILVA et al., 2012). Precipitation, average temperature and relative humidity, reference evapotranspiration (ETo) and global radiation (Figure 1) were recorded in the experimental area, through an automatic Campbell Scientific meteorological station (model CR1000/CFM100/OS100) adjacent to the area. The precipitation in the cultivation period was 103.7 mm.

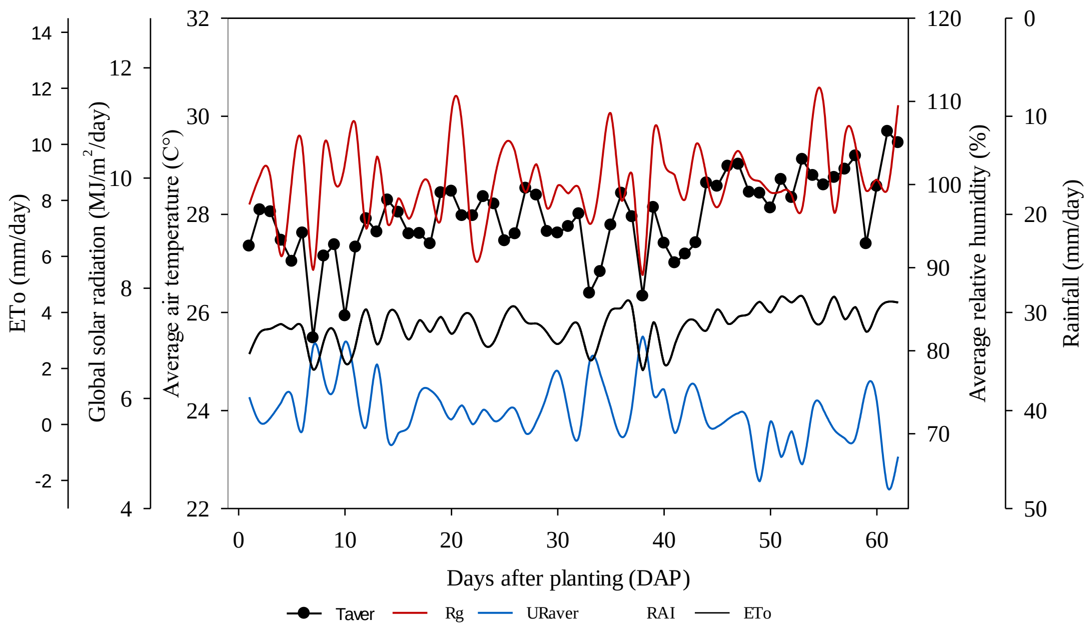

Figure 1. Rainfall depths (RD), mean air temperature (MAT), relative air humidity (RAH), reference evapotranspiration (ETo) and global solar radiation (Rg) during cultivation period.

The experimental design was randomized blocks, 6 x 2 factorial scheme, which consists of six levels of electrical conductivity of irrigation water (ECa: 0.2; 1.6; 2.8; 4.0; 5.2 and 6.4 dS m^{-1}) and two types of irrigation management (pulse and continuous) with four replications, total 48 experimental plots. The electrical conductivity levels of the irrigation were arranged at equidistant intervals until the highest CEa it was established double limiar salinity of the culture by Ayers & Westcot (1999), of 3.2 dS m^{-1}. Electrical conductivity levels of water used in irrigation were obtained by addition of sodium chloride (NaCl) to local urban water supply (ECa = 0.2 dS m^{-1}), which were used with conductivity meter until aimed levels. In control treatment (0.2 dS m^{-1}) only supply water was used.

The experimental area was 38 m lenght and 10.5 m width (supplement 1), 48 drainage lysimeters with capacity to 240 L each one. Also, circular shapes were placed. Each lysimeter had 0.50 m of superior edge external diameter and external height of 0.70 m. The lysimeters were placed equidistant at 1.0 m in lines and between them. The boxes used were 0.40 m above ground surface.

In each lysimeter was added layer of gravel (25 mm granulometry) to facilitate drainage through drain cover. Geotextile blanket was inserted covering entire superior face of gravel to retain soil particles. Drainage system was formed by ½" water hose adapter in the end of lysimeter, which were connected to low density polyethylene tube (LDPE PN 30 DN 16 mm) and 2 L of ethylene terephthalate (PET) bottle. Electrical conductivity levels of water used in irrigation were obtained by addition of sodium chloride (NaCl) to local urban water supply (ECa = 0.2 dS m^{-1}), which were used with conductivity meter until aimed levels. In control treatment (0.2 dS m^{-1}) only supply water was used.

The irrigation system used was drip irrigation system, which consists of six components. For example, six sets of reservoir with capacity of 500 L, disc filter and 0.5 CV horizontal axis centrifugal pump, solenoid type valves controlled by composite control panel of Arduino type electronic controller, 16 channel relay module, 10 A hive type switching power supply with Real Time Clock RTC DS3231, ½" threaded anti vacuum valve and self compensating drippers with nominal flow of 2 L h^{-1}. These were arranged in pairs per lysimeter with distance of each other 0.20 m, adding flow rate of 4 L h^{-1} in each lysimeter. The service pressure was regulated at 10 m.c.a by manometer pressure and water flow control.

The crop evaluated was peanut, cultivar BR 1, early variety, with an average cycle of 90 days that presents good adaptation to the climate of the semiarid region. Six seeds were sown per lysimeter in depth of 5 cm to ensure germination. The thinning was carried out in 10 DAE, one plant per lysimeter. According to Embrapa (2009), phytosanitary monitoring and cultural treatments were carried out after planted. The harvest was carried out when culture reached physiological maturation point for treatments with high salinity, which was 63 days after sowned (DAS).

In harvest, aerial parts of evaluated treatments were collected and separated to determine accumulation of nitrogen (N), phosphorus (P) and potassium (K), and elements sodium (Na) and chloride (Cl). Thus, all plants materials, such as aerial parts and grains were taken to laboratory and washed with deionized water. Then, materials were packed in paper bags properly identified with respective treatments and placed in oven at 65º C until constant weight was obtained.

After dried, materials were weighed on electronic scale with precision of 0.0001 g in order to quantify dry biomass. Then, it was processed in sieve mill type Willey with 2 mm, stored to quantification of concentrations of nutrients and elements Na and Cl. Open digestion was used to N extraction, using as heat source digester block and mixture of sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2) and digester mixture to digest dry matter. According to Silva (2009), about nutrients P, K and Na, digestion was carried out in closed system, which uses microwave oven as heat source and concentrated nitric acid (HNO_3) to digest dry matter. Chloride digestion was performed using hot water extraction method (Bezerra Neto & Barreto, 2011).

The data obtained were subjected to analysis of variance by F test, there was significant effect, regression analysis (salinity levels) and comparison of means (irrigation management) with Scott-Knott test at 5% probability.

RESULTS AND DISCUSSION

According to analysis of variance (Table 1) there was a significant effect of interaction between factors management of irrigation (pulsed irrigation and continuous irrigation) and electrical conductivity of irrigation water (ECa) on accumulation of P. There was also an isolated influence of these factors on accumulation of N and K.

Table 1. Analysis of variance for the accumulation of secondary micronutrients and Na in peanuts cultivar BR 1, as a function of irrigation management and salinity levels.

SV	DF	Mean Square				
		Macronutrients			Micronutrient	Elemento
		N	P	K	Cl	Na
Management (M)	1	3.888**	0.032**	6.429**	26.29x10^{5}**	10.087**
Salinity (S)	5	1.414**	0.020**	1.079**	4.13x10^{5}**	3.218**
M x S	5	0.010^{ns}	0.002**	0.009^{ns}	2.82x10^{4} ^{ns}	0.447**
Block	3	0.027^{ns}	0.000^{ns}	0.310**	5.23x10^{5}*	0.166^{ns}
Resídue	33	0.022	0.000	0.060	21899	0.098
CV	%	8.26	10.27	12.21	14.55	20.76

** significant (p ≤ 0,01), * significant (p ≤ 0,05) and ns not significant by the F test.

Supply of brackish water through pulsed or continuous drip irrigation promoted nutritional disorders in peanut crop with increase in ECa levels. However, pulsed irrigation minimized effect of ECa on accumulation of N compared to continuous irrigation (Figure 2A).

Accumulation of P was considerably affected by levels of CEa. However, magnitude of reduction in P accumulation was greater in continuous irrigation compared to pulsed irrigation (Figure 2B). The increase in salinity levels linearly reduced accumulation of K with this greater effect on continuous irrigation compared to pulsed irrigation (Figure 2C).

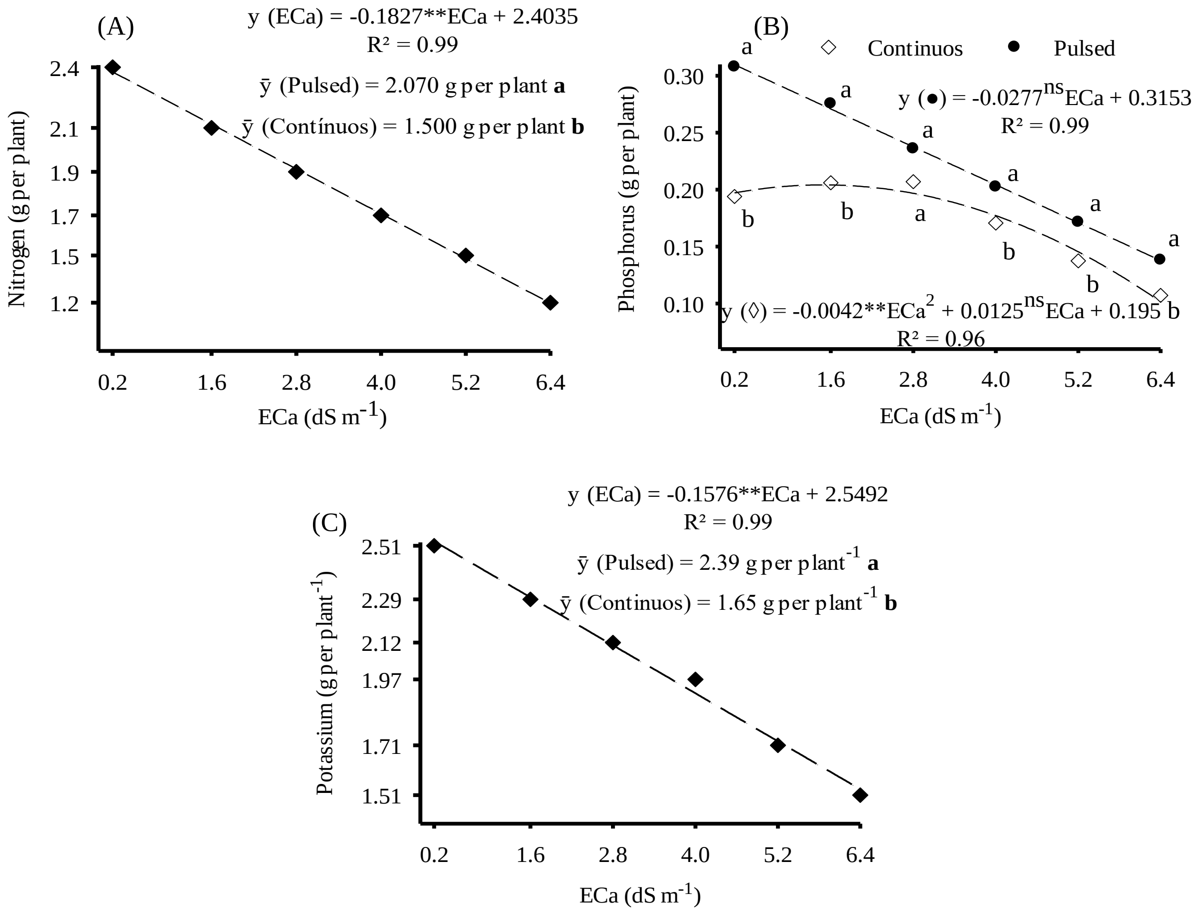

Figure 2. Accumulation (A) of nitrogen and (C) Potassium under isolated effect of factors salinity levels and types of irrigation management; unfolding of interaction between these factors on accumulation of phosphorus (B) and in peanut plant BR 1, Recife, 2020. Different letters indicate significant differences between types of irrigation management (pulse and continuous) by Scott Knott test ($p < 0.05$).

Reduction in accumulation of N in a saline environment can be attributed to increase in concentration of chloride (Cl^-) which is a dominant anion and which directly competes in absorption of NO^{3-}. In a melon irrigated with salt water by drip, there was a reduction in accumulation of P similar to found in our study (COSTA et al., 2018). The reduction in accumulation of N with saline environment can be attributed to increases in concentration of chloride (Cl^-), which is dominant anion and competes directly in absorption of NO^{3-}. Furthermore, Na affects absorption of NH^{4+} under saline conditions (DLUZNIEWSKA et al., 2006). In the present study, excess of Na and Cl present in irrigation water have increased accumulation, which contributes to low accumulation of N in peanut. These results confirms antagonism of both ions to N uptake. Especially in continuous drip irrigation, which N is considerably reduced in accumulation compared to pulse drip irrigation (Figure 2A).

P is the second essential nutrient most required by plants, which demands 0.3 to 0.5% of P in dry mass for full development of plant growth (PESSARAKLI et al., 2015). P accumulation and exportation were considerably affected by CEa levels. However, magnitude of reduction in P accumulation was greater in continuous drip irrigation than pulse drip irrigation. In melon irrigated with saline drip water, there was reduction in P accumulation similar to what was found in the present study (COSTA et al., 2018). Moderately sensitive cultures show a reduction in accumulation of P with increased salinity, due to precipitation or antagonism with anions such as Cl^- (GRATTAN & GRIEVE, 1992; MAKSIMOVIC & ILIN, 2012). In the present study, P accumulation have shown highest ECa level (6.4 dS m^{-1}). Also, in both irrigation managements (continuous and pulse) were lower than P average accumulation found by Nandi et al. (2020), Crusciol & Soratto (2007), and Correia et al. (2012), which were 0.09, 0.04 and 0.07 g $plant^{-1}$, respectively. It may ocurrs due to toxic effect of salinity.

The reduction in accumulation of K with increase in ECa is related to antagonism between Na^+ and K^+ that occurs during root absorption because in saline medium Na^+ is in a higher concentration compared to K (TUTEJA et al., 2012). These concentrations have shown great effect on continuous drip irrigation compared to pulse drip irrigation. Although, high CEa level reduces K accumulation by 1.54 g $plant^{-1}$, average which was found in this treatment was higher than peanut crop, such as 0.44, 0.17 and 0.42 g $plant^{-1}$, which were found in researchs of Nandi et al. (2020), Crusciol & Soratto (2007) and Correia et al. (2012), respectively.

CONCLUSIONS

Salinity reduced accumulation and export of all nutrients evaluated, but increased accumulation of sodium and chloride. Despite this, pulse irrigation promoted greater accumulation of nutrients by peanut crop in relation to continuous irrigation, with decreasing order in accumulation of nutrients by irrigated peanut crop was: K > N > P.

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