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USO DE COBERTURA MORTA E ÁGUA SALINA NA PRODUTIVIDADE DA CULTURA DO MILHO

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1 RESUMO

O objetivo do trabalho foi avaliar a produtividade da cultura do milho irrigado com água de maior e menor salinidade em solo com e sem cobertura morta vegetal. A pesquisa foi realizada em campo, na Fazenda experimental da UNILAB, Redenção-CE. O delineamento experimental foi em bloco casualizado, em esquema fatorial 6 × 2, referente a seis estratégias de uso de cobertura morta vegetal: EC1= sem cobertura morta durante todo o ciclo - testemunha; EC2= com cobertura morta durante todo o ciclo; EC3= com cobertura morta até 45 dias após a semeadura (DAS) e sem cobertura morta até o final do ciclo; EC4= sem cobertura morta até aos 45 DAS e com cobertura morta até o final do ciclo; EC5= com cobertura morta até 60 DAS e sem cobertura morta até o final do ciclo e EC6= sem cobertura morta até 60 e com cobertura morta até o final do ciclo e duas condutividade elétrica da água de irrigação (A1=0,8 dS m^{-1} e A2=3,0 dS m^{-1}), em cinco repetições. Foram analisadas as seguintes variáveis: massa de espiga com e sem palha, de 1000 grãos e a produtividade. O uso da estratégia EC3 possibilitou aumento para massa da espiga com e sem palha e 1000 grãos. A salinidade da água de irrigação foi atenuada pela estratégia EC3 para massa da espiga com e sem palha. As estratégias EC3 e EC5 apresentaram maior produtividade com água de baixa salinidade e com água de maior salinidade quando utilizou-se a estratégia EC3.

Palavras-chave: salinidade, proteção do solo, *Zea mays* L.

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USE OF DEAD COVERAGE AND SALINE WATER IN THE PRODUCTIVITY OF CORN CROP

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2 ABSTRACT

This work aimed to evaluate the productivity of the corn crop irrigated with water of greater and lesser salinity in soils with and without mulch. The research was carried out in the field, at the experimental farm at UNILAB, Redenção-CE. The experimental design was a randomized block, in a 6 × 2 factorial scheme, referring to six strategies for using vegetable mulch: EC1= no mulch throughout the cycle - control; EC2= with mulch throughout the cycle; EC3= with mulch up to 45 days after sowing (DAS) and without mulch until the end of the cycle; EC4= no mulch up to 45 DAS and with mulch until the end of the cycle; EC5= with mulch up to 60 DAS and without mulch until the end of the cycle and EC6= without mulch up to 60 and with mulch until the end of the cycle and two electrical conductivity of the irrigation water (A1=0.8 dS m^{-1} and A2=3.0 dS m^{-1}) in five repetitions. The following variables were analyzed: ear mass with and without straw, 1000 grains and yield. The use of the EC3 strategy allowed an increase in ear mass with and without straw and 1000 grains. The salinity of the irrigation water was attenuated by the EC3 strategy for ear mass with and without straw. Strategies EC3 and EC5 showed higher yields with low salinity water and high salinity water when the EC3 strategy was used.

Keywords: salinity, soil protection, *Zea mays* L.

3 INTRODUCTION

In the Poaceae family, corn (*Zea mays* L.) is native to Central America and is cultivated in virtually every region of the world, adapting to both the northern and southern hemispheres (LOPES et al., 2019). In Brazil, the crop is sown in all states throughout the year, favoring Brazil as the second largest producer and exporter of corn in the world (CONAB, 2021).

In northeastern Brazil, it is common to find water with high electrical conductivity, as well as saline soils. This is due mainly to the source material but also to the imbalance between high evapotranspiration and low precipitation (HOLANDA et al., 2016). Among the negative effects caused by salts, the closure of leaf stomata and reduced transpiration stand out, resulting in a decrease in water and nutrient absorption by plants (DIAS et al., 2017).

The use of mulch is a promising conservation practice because of the increase in soil water storage and crop yield, increasing the reduction in soil temperature and evaporation losses and mitigating the effects of salts on plants (CARVALHO et al., 2018; COSTA et al., 2021).

The objective of this work was to evaluate the effects of irrigation with high- and low-salinity water and different mulching strategies on corn cultivation.

4 METHODOLOGY

The research was developed at the Piroás experimental farm belonging to the University of International Integration of Afro-Brazilian Lusophony/UNILAB, located in Redenção, Ceará. The climate of the region is of the Aw ' type and is characterized as tropical rainy and very hot, with predominant rainfall in the summer and autumn seasons (KOPPEN, 1923).

The soil in the experimental area is classified as Red–Yellow Argisol (EMBRAPA, 2018). The chemical attributes are shown in Table 1.

Table 1. Physical and chemical characteristics of the soil

Features	Values
MO (g kg $^{-1}$)	15.62
N (g kg $^{-1}$)	0.98
P (mg kg $^{-1}$)	15
K^+ (cmol $_c$ kg $^{-1}$)	1.6
Ca^{2+} (cmol $_c$ kg $^{-1}$)	6
Mg^{2+} (cmol $_c$ kg $^{-1}$)	1.9
Na^+ (cmol $_c$ kg $^{-1}$)	0.23
$H^+ + Al^{3+}$ (cmol $_c$ kg $^{-1}$)	2.31
Al (cmol $_c$ kg $^{-1}$)	0.2
SB (cmol $_c$ kg $^{-1}$)	8.3
CEes (dS m $^{-1}$)	0.31
pH	6.6

MO = organic matter, SB = sum of bases, CEC = cation exchange capacity, V = base saturation and CEes = electrical conductivity of the saturated soil extract. **Source:** Authors (2021)

The corn culture mixture (*Zea mays* L.) was sown manually in August 2020, with 4 seeds per well, at a spacing of 1.0 × 0.3 m.

The experimental design used was a randomized block with a 6 × 2 factorial arrangement with four replications, with the first factor being the salinity of the irrigation water (A1 = 0.8 dS m $^{-1}$ and A2 = 3.0 dS m $^{-1}$) and the second factor being the mulching strategies, where EC1 = without cover throughout the cycle; EC2 = with cover throughout the cycle; EC3 = with cover up to 45 days after sowing; EC4 = without cover up to 45 days after sowing; EC5 = with cover up to 65 days after sowing; and EC6 = without cover up to 65 days after sowing.

A drip irrigation system was used. The emitter flow rate was 8.0 L h $^{-1}$. The amount of water applied was calculated on the basis of the crop coefficient (Kc) (DOORENBOS; KASSAM, 1994) and reference evapotranspiration (ETo) estimated via the class A tank method, which was installed near the experimental area, with a 2-day irrigation shift. Saline water was prepared using NaCl, CaCl2.2H2O and MgCl2.6H2O salts at a ratio of 7:2:1 in nonsaline water (0.8 dS m $^{-1}$), following the relationship between ECa and its concentration (mmolc L $^{-1}$ = EC × 10), according to Rhoades et al. (2000).

For irrigation, drippers with a flow rate of 8 L h $^{-1}$ spaced at 0.30 m and a distribution uniformity coefficient (CUD) of approximately 92% were used.

The irrigation time was estimated via Eq. 1:

$$Ti=\frac{ETc \times Ep}{Ea \times q} \times 60 \quad (1)$$

where:
Ti - irrigation time (min);
ETc - crop evapotranspiration (mm);
Ep - spacing between drippers;
Ea - application efficiency (0.9); and,
q - flow rate (L h $^{-1}$).

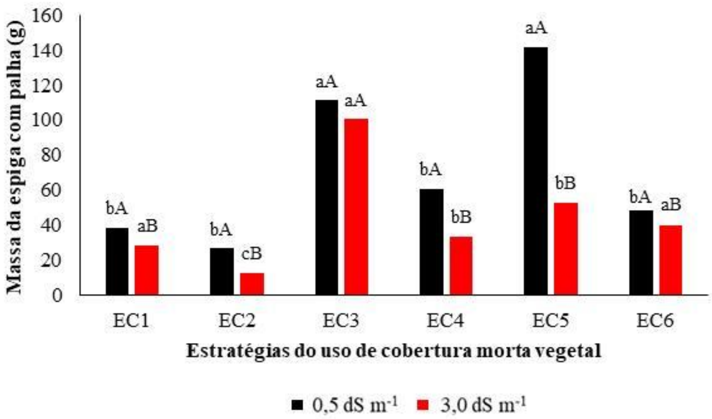
A leaching fraction of 0.15 was added to the sheet to be applied (AYERS; WESTCOT 1999).

At the end of the crop cycle, six corn plants were harvested from each useful plot, identified, and left to dry. The following variables were subsequently evaluated: ear weight with husk - MECP, ear weight without husk - MESP, 1,000-grain weight - MG1.000 (using an analytical balance, expressed in grams), and yield - PROD. The data were subjected to analysis of variance, and after verifying significance, Tukey's mean comparison test ($p < 0.05$) was performed via the ASSISTAT 7.7 BETA program (SILVA; AZEVEDO 2016).

5 RESULTS AND DISCUSSION

Figure 1 shows that ear weight with straw was influenced by the factors studied (irrigation water and mulch). Compared with the use of high-salinity water, the use of the EC5 strategy with low-salinity water resulted in greater ear weight with straw. Flowering occurs during this period, meaning that the sodium present in the irrigation water possibly has an antagonistic effect on magnesium and consequently affects phosphorus availability to the plant, reducing grain maturation and production and resulting in a lower mass yield (RODRIGUÊS et al., 2021; SOUSA et al., 2022).

Figure 1. Ear mass associated with straw from corn crops irrigated with high- and low-salinity water under different mulch strategies.



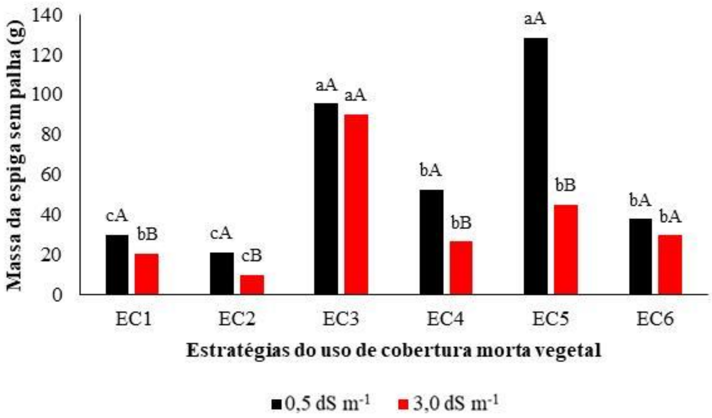
Columns followed by the same lowercase letters at the same level of coverage strategies or uppercase letters at the same level of salinity do not differ significantly from each other according to the Tukey test ($P \leq 0.05$).
Source: Authors (2021)

With respect to the use of higher-salinity water, EC3 was statistically similar to lower-salinity water but presented higher values than the other strategies were. The maintenance of mulch during this period (pollination) mitigated salt stress. Costa et al. (2008) reported that the use of mulch for soil protection reduces water evaporation during irrigation, preventing the precipitation of soluble salts in the root zone and mitigating its effects on the development and, consequently, production of the corn crop.

Results divergent from those of the present work were reported by Costa et al. (2021), who worked with corn crops as a function of salinity and mulch, with an isolated effect occurring for the ear mass with straw; that is, the soil cover did not mitigate the effects of salts on the plant.

Figure 2 shows the interaction between irrigation water and mulch. The EC3 strategy is superior to the other strategies at both salinity levels, whereas the EC5 strategy is superior only for water with lower salinity. This shows that maintaining mulch is more effective at 45 DAS than does strategy EC5, which is more effective at 65 DAS.

Figure 2. Mass of the ear without straw of the corn crop irrigated with high- and low-salinity water under different mulch strategies.



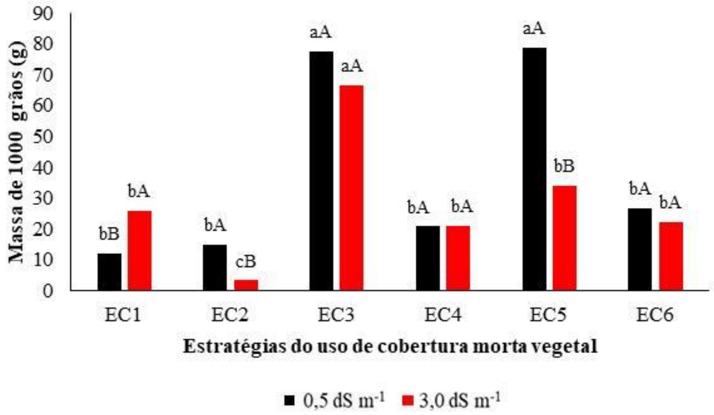
Columns followed by the same lowercase letters at the same level of coverage strategies, or uppercase letters at the same level of salinity, do not differ significantly from each other according to the Tukey test ($P \leq 0.05$).
Source: Authors (2021)

Sousa et al. (2022) also reported a reduction in straw-free ear mass when high-salinity water was used compared with low-salinity water. This effect can be explained by the fact that salinity can cause several effects, individually or simultaneously, of water, osmotic, and nutritional stresses to the crop during its growth, causing physiological disorders that lead to decreased production (NAZÁRIO et al., 2013).

Similarly, Canjá et al. (2021) obtained promising results for this same variable in peanut crops. These same authors concluded that the strategy of using mulch minimized the deleterious effects of salinity on the root zone, mitigating the impacts of salt stress during grain filling.

For the 1000-grain mass (Figure 3), the interval that presented the highest yield was EC3, with 77.6 g when irrigated with lower salinity water and 66.7 g for water with higher electrical conductivity, which did not differ statistically from the maximum value (78.7 g) of the EC5 strategy with 0.5 dS m-1 irrigation water. The use of mulch up to 45 DAS (EC3) provided the crop with a relatively high grain yield even under salinity stress. This behavior can be explained by the fact that the conservation practice of soil cover can mitigate salinity stress, since this practice tends to increase soil water storage and increase crop productivity (COSTA et al., 2021; GADELHA et al., 2021).

Figure 3. A mass of 1,000 corn grains were irrigated with high- and low-salinity water under different mulch strategies.

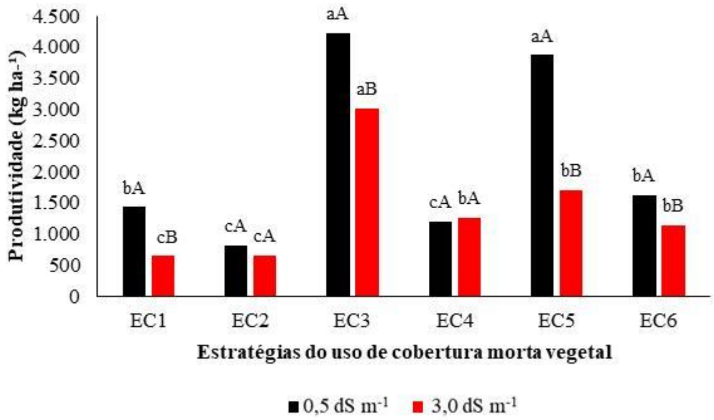


Columns followed by the same lowercase letters at the same level of coverage strategies, or uppercase letters at the same level of salinity, do not differ significantly from each other according to the Tukey test ($P \leq 0.05$).
Source: Authors (2021)

Similar trends were reported by Carvalho et al. (2019) when studying corn crops under different soil cover conditions, where conservation practices enabled increases in all analyzed variables. Salinity also harms crops, as demonstrated by the results of Costa et al. (2021), who reported a decrease in the mass of 1,000 grains.

As shown in Figure 4, the interaction between irrigation water and mulching strategies is evident. Strategies EC3 and EC5 are superior to the other strategies, with yields of 4,220 kg ha $^{-1}$ and 3,872 kg ha $^{-1}$, respectively. With respect to water with relatively high salinity, strategy EC3 achieved a total productivity of 3,016 kg ha $^{-1}$. Melo Filho et al. (2017) reported that mulching reduces the evaporation of water available to plants, preventing an increase in salt concentration near the root zone.

Figure 4. Productivity of corn irrigated with high- and low-salinity water under different mulch strategies.



Columns followed by the same lowercase letters at the same level of coverage strategies, or uppercase letters at the same level of salinity, do not differ significantly from each other according to the Tukey test ($P \leq 0.05$).
Source: Authors (2021)

The average productivity found in this study is above the average grain yield of Ceará (1,232 kg ha $^{-1}$) and below the national average (5,543 kg ha $^{-1}$) (CONAB, 2021). Similar results to those of the present study were reported by Costa et al. (2021), who worked with the same crop, where irrigation with lower salinity water in the presence of mulch provided the highest grain yield (2,100 kg ha $^{-1}$). Feng et al. (2017) reported a similar trend when growing corn with relatively high-salinity water.

6 CONCLUSION

The use of the strategy with mulch up to 45 DAS and without mulch until the end of the crop cycle allowed an increase in ear mass with and without straw and 1000 grains.

The salinity of the irrigation water was attenuated by the mulch strategy up to 45 DAS for ear masses with and without straw.

The strategies with mulching up to 45 DAS and with mulching up to 60 DAS presented relatively high productivity with low-salinity water. High-salinity water was used when the mulching strategy reached 45 DAS.

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