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CRESCIMENTO VEGETATIVO DA MORINGA EM DISTINTOS REGIMES DE IRRIGAÇÃO ASSOCIADOS A COMPOSIÇÕES DE DIFERENTES SUBSTRATOS

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1 RESUMO

A moringa possui ampla adaptabilidade e se condiciona, com muita facilidade, ao clima e solo do Nordeste brasileiro. Ainda são escassas as informações sobre a produção de mudas desta espécie sob composições de substratos associados a regimes de irrigação. Desta forma, o objetivo desse trabalho foi caracterizar o comportamento vegetativo de plantas de moringa submetidas a distintas composições de substratos e regimes de irrigação. O experimento foi realizado em ambiente telado, no período de setembro a outubro de 2020, na área experimental da Universidade Estadual do Piauí, Uruçuí. Adotou-se um delineamento experimental em esquema fatorial, sendo, o primeiro fator, dois regimes de irrigação (50 e 100% da ETo) e o segundo fator, cinco substratos (SB1 = latossolo vermelho; SB2 = substrato comercial; SB3 = solo + esterco; SB4 = solo + cinza vegetal; SB5 = solo + borra de café), com 5 repetições. Aos 45 dias após a semeadura (DAS) foram avaliadas a altura de plantas e o diâmetro do caule. Os parâmetros de crescimento inicial da cultura da moringa foram afetados significativamente pela interação (regimes de irrigação x substratos), sendo os melhores resultados obtidos, na maioria dos substratos utilizados, com a aplicação do regime hídrico de 100% da ETo.

Palavras-chave: *Moringa oleifera* Lam, produção de mudas, déficit hídrico.

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VEGETATION GROWTH OF MORINGA IN DIFFERENT IRRIGATION REGIMES ASSOCIATED WITH COMPOSITIONS OF DIFFERENT SUBSTRATES

2 ABSTRACT

Moringa has wide adaptability and is very easily conditioned to the climate and soil of northeastern Brazil. Information on the production of seedlings of this species under compositions of substrates associated with irrigation regimes is still scarce. Thus, this work aimed to characterize the vegetative behavior of moringa plants submitted to different compositions of substrates and irrigation regimes. The experiment was carried out in a screened

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environment, from September to October 2020, in the experimental area of the State University of Piauí, Uruçuí. An experimental design was adopted in a factorial scheme, the first factor being two irrigation regimes (50 and 100% of ETo) and the second factor, five substrates (SB1 = red oxisol; SB2 = commercial substrate; SB3 = soil + manure; SB4 = soil + vegetable ash; SB5 = soil + coffee grounds), with 5 repetitions. At 45 days after sowing (DAS), plant height and stem diameter was evaluated. The initial growth parameters of the moringa crop were significantly affected by the interaction (irrigation regimes x substrates), with the best results obtained, in most of the substrates used, with the application of the water regime of 100% of ETo.

Keywords: Moringa oleifera Lam, seedling production, water deficit.

3 INTRODUCTION

The multiple stresses to which plants are frequently exposed limit their growth and development. Water deficiency is one of the environmental stressors that damages most plant physiological and metabolic processes, thus affecting the distribution of plant species (LARCHER, 2006).

This is evident given that plant growth and development are affected by tissue water deprivation caused by high evaporimetric rates or a limited water supply. This deficiency results in protoplast dehydration, resulting in a reduction in cell volume and an increase in solute concentration. From this perspective, the growth process, particularly expansion, which depends on cell turgor, is ultimately affected under water deficit conditions (TAIZ et al., 2017).

The *moringa oleifera* Lam . has broad adaptability and is able to establish itself in dry and humid subtropical regions, even dry tropical regions and humid forests. Furthermore, it also tolerates drought, flowers and produces fruit, adapting to a wide range of soils. However, it thrives best in well-drained dark soil or dark clay soil, favoring neutral to slightly acidic soil (PEREIRA et al., 2019).

With respect to the aspects considered in seedling production, the substrate to be used is another factor that influences germination and initial plant development, becoming a determining factor for seedling producers to obtain good performance (BARON et al., 2011). Several characteristics and properties of the substrate can influence germination, such as structure, pH, aeration, water retention capacity, and the degree of pathogen contamination, in addition to the availability of nutrients, oxygen, temperature, and light (SILVA et al., 2014). However, for Araújo et al. (2018), the choice of substrate should be made on the basis of availability, cost of the material, the species to be cultivated, and production conditions.

According to Araújo (2016), with respect to native tree species, agronomic aspects are still understudied, particularly those that could better elucidate their behavior in the absence of factors essential to their survival, such as water. In the current context, given the growing issue of climate change, as evidenced by reduced precipitation levels and increased drought periods, studies aimed at understanding the effects of water restriction and plant responses to this limiting factor can contribute to management, seedling production for reforestation, species distribution, and improved water use.

In view of the above, the objective of this work was to evaluate the vegetative development of moringa plants cultivated under different substrate compositions associated with two irrigation regimes.

4 MATERIALS AND METHODS

The experiment was carried out in pots in a screened environment with 50% mesh from September to October 2020 in the experimental area of the State University of Piauí, Cerrado do Alto Parnaíba Campus, Uruçuí, with local coordinates of latitude 07° 13' 46" S, longitude 44° 33' 22" W and altitude of 167 m, in an area that comprises the cerrado biome.

The climate of the region, according to the Köppen classification, is Aw, tropical, with an average temperature of 27.2 °C and average annual precipitation ranging from 750 to 2000 mm. Rainfall and a better regularity of rainfall distribution occur between October and March, and the dry season, with a water deficit, occurs from April to September.

The vessels used to conduct the experiments were made of flexible plastic material with a volumetric capacity of 5 liters and with holes at the lower end to drain excess water.

The experimental design used was completely randomized (CRD) in a 2 × 5 factorial arrangement, with the first factor consisting of two irrigation regimes (RH 1 = application of a depth corresponding to 50% of the reference evapotranspiration (ETo) and RH 2 = application of a depth corresponding to 100% of the ETo) and the second factor consisting of five types of substrates (SB 1 = soil (red latosol); SB 2 = commercial substrate; SB 3 = soil + manure; SB 4 = soil + plant ash; SB 5 = soil + coffee grounds), with 5 replicates, totaling 50 experimental units.

Irrigation management was carried out via reference evapotranspiration (ETo) for the application of irrigation depths, which were calculated with the aid of an electronic spreadsheet where the daily values of reference evapotranspiration (ETo) were recorded and estimated via the Penman–Monteith method (ALLEN et al., 1998) via climate data obtained from the National Institute of Meteorology (INMET) at an automatic agrometeorological station located in the municipality of Uruçuí, Piauí.

For the application of irrigation water, a 1000 mL measuring cylinder was used, where daily, the volume to be applied was calculated according to the area of the pot and the ETo:

$$Vol = 1000 \times Av \times ETo \qquad (1)$$

In which,

Vol - Volume of water to be applied, in mL;

ETo - reference evapotranspiration, in mm;

Av - Surface area of the vessel, in ^{m2}.

To evaluate the vegetative growth of the moringa crop, 45 days after sowing (DAS), the height characteristics of the plants were measured, measured by the distance between the soil surface and the apex of the youngest leaf, using a tape measure graduated in centimeters, and the stem diameter, measured via a digital caliper, with the values expressed in millimeters.

For statistical analysis, SISVAR software (FERREIRA, 2019) was used. To interpret the results, analysis of variance was performed, applying the "F" test, and if there were significant results, the means of the qualitative variables were compared via the Tukey test at 5% probability.

5 RESULTS AND DISCUSSION

Table 1 shows that all the growth variables analyzed were significantly affected by the interaction between the factors studied (water regimes and substrates) at 1 probability, as determined via the F test.

Table 1. Summary of the analysis of variance for the plant height (ALT) and stem diameter (DC) data of moringa seedlings grown under different substrate compositions associated with the two water regimes.

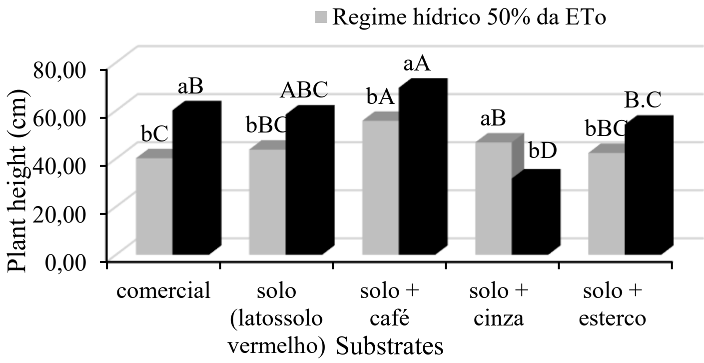
Source of variation	GL	Mean Squares	
		The $_{LT}$	D $_{C}$
Water Reg. (A)	1	1021.52 **	33.43 **
Substrate (B)	4	698.52 **	7.89 **
Interaction (A x B)	4	474.52 **	4.11 **
Block	4	7.02 ns	0.79 ns
Error	36	10.19	0.40
Corrected total	49		
CV (%)		6.35	10.98

GL – degrees of freedom; CV – coefficients of variation; ** and ns – significant at 1% probability and not significant according to the F test, respectively.
Source: The authors (2021)

Figure 1 shows that for the plant height variable (ALT), the highest result was obtained in the treatment involving the application of the depth corresponding to 100% ETo, with the substrate composition being composed of equal parts (1:1) of soil and coffee grounds, with a depth of 69.6 cm. Under the 50% ETo regime, the height of the moringa plants was negatively affected by the restriction of water requirements for all substrate compositions, with the exception of the substrate composed of soil and plant ash, which presented a greater response than those irrigated without water restriction (100% ETo).

In the comparison between the highest (soil + coffee) and lowest (soil + ash) results among the substrate composition treatments, within the 100% ETo water regime, a percentage difference of approximately 54.31% was observed. This result may have occurred because of the organic material used (coffee grounds), which contributed to greater water and nutrient retention, favoring a greater increase in plant height. Similar results are reported by Santos and Castilho (2016).

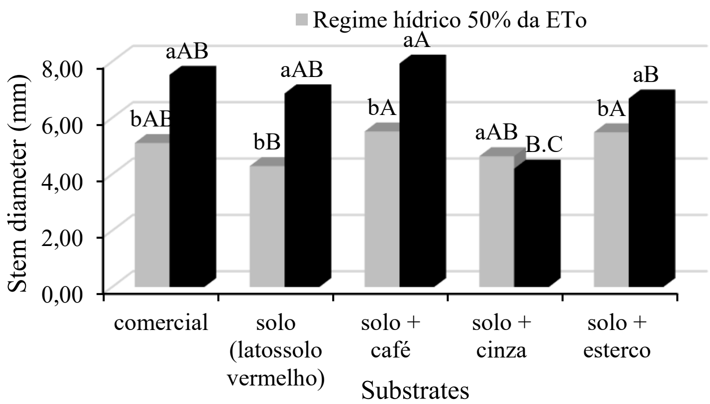
Figure 1. Plant height of moringa crops grown in different substrate compositions associated with two irrigation regimes.



Averages followed by the same lowercase letter between water regimes within each substrate and averages followed by a capital letter between substrates within each water regime do not differ by themselves according to the Tukey test at 5% probability.
Source: The authors (2021)

Figure 2 shows the results for the stem diameter (SD) variable. Notably, the highest results were obtained in the treatment concerning the provision of a water regime of 100% ETo, in the substrate compositions composed of equal parts (1:1) of soil and coffee grounds (7.93 mm), in the commercial substrate (7.53 mm), and in the substrate composed of red latosol (6.87 mm). Under the 50% ETo regime, the diameter of the moringa plants was negatively affected by the restriction of water requirements for all substrate compositions.

Figure 2. Stem diameter of the moringa crop grown with different substrate compositions associated with the two irrigation regimes.



Averages followed by the same lowercase letter between water regimes within each substrate and averages followed by a capital letter between substrates within each water regime do not differ by themselves according to the Tukey test at 5% probability.
Source: The authors (2021)

Consistent with the results obtained in this study, Nezami et al. (2008) reported that one of the effects of reduced water availability on plant morphology is a reduction in stem diameter due to reduced stem radius growth. Under such conditions, the growth of the main stem and lateral branches is suppressed, resulting in a smaller amount of dry matter in the stem. Thus, stem growth is likely influenced by the same principles that govern growth restriction in other plant parts when faced with water deficit.

The results obtained under the 50% ETo water regime can be explained by the fact that all aspects of plant growth and development are affected by tissue water deficiency caused by excessive evaporative demand and/or limited water supply. As a consequence of this deficiency, protoplast dehydration occurred, resulting in a decrease in cell volume and, possibly, an increase in solute concentration. Thus, the growth process, especially expansion, which is entirely dependent on cell turgor, is the first process affected by water deficit (TAIZ et al., 2017).

With respect to the results obtained in the treatment with a substrate composed of soil + plant ash, under a water regime of 100% ETo, the lowest results were observed for the analyzed variables (plant height and stem diameter) under these experimental conditions. These results were possibly due to the highly pulverized composition of the alternative material used (plant ash). Thus, mixing this material with the soil in equal proportions caused waterlogging of the substrate, providing excess moisture and creating unfavorable conditions for air circulation, thus affecting the growth and development of the moringa crop and resulting in smaller seedling heights and diameters.

6 CONCLUSION

Water restriction caused by the application of 50% ETo led to reductions in the height and stem diameter of moringa plants. In general, the substrate compositions (commercial, red latosol, soil + coffee, and soil + manure) provided the best conditions for the growth of moringa seedlings when they were irrigated without water restriction (100% ETo).

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