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Effect of Different Irrigation Levels on the Productivity of Two Sweet Potato Varieties (Ipomoea batata)

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Abstract
Sweet potato (*Ipomoea batatas*, L.) is a crop that despite exhibiting great resistance to pests and little response to the application of fertilizers, water deficit harms the photosynthetic system of the crop by restricting the stomatal opening, therefore, Irrigation becomes an important technique for obtaining greater productivity. Thus, the objective of this article was to evaluate the productivity of two varieties of sweet potato subjected to different amounts of irrigation water. The experiment was conducted at the Nampula Agricultural Station, at the Mozambique Agricultural Research Institute, located in the city of Nampula. The cultivars white and orange pulp were evaluated using three treatments: full irrigation, supplementary irrigation and rainfed. A completely randomized design, was used, with three replications. The results showed significant differences between treatments at p-value <0.05. However, the Tukey test showed differences between the means observed in ANOVA where the full irrigation treatment, presented greater fresh matter productivity followed by the supplementary treatment.

Keywords: Sweet potato; Irrigation; Yield; Productivity.

Glossary of Abbreviations
Completely Randomized Design (CRD)
Full Irrigation (FI)
Faculty of Agricultural Sciences (FAS),
Hectare **(**ha**)**
Irrigation Treatment (IT)
Mozambique Agricultural Research Institute (IIAM)
Supplementary Irrigation (SI)
Supplementary Treatment (ST)
Catholic University of Mozambique (UCM)

Introduction

Sweet potatoes (Ipomoea potatoes, L.) originate from tropical America, from where they were first disseminated to tropical Asia and Africa by explorers, Spanish and Portuguese traders, then from Colombia (Alam, 2021).

The crop requires little fertility management, develops in doses and in adverse conditions, which can be a low-cost and nutritious solution for developing countries. It can also provide low-cost forage with an interesting protein content for animal feed (Klinger, 2018). This tuberous root presents large qualitative and quantitative variations, and can be found between latitudes of 42º N to 35º S, from sea level to 3000 m altitude (Galeriani, 2020). It develops best in a tropical climate, compared to crops such as corn, rice and sorghum, it can be considered one of the most efficient in terms of the amount of net energy produced per unit of area and unit of time.

It is an economically and socially important culture. It provides relatively low production costs mainly due to greater resistance to pests and diseases, achieving satisfactory yields with reduced inputs even in areas with low natural fertility (Alam, 2021). In developing countries, sweet potato cultivation is established from seedlings made with vegetative material, commonly using parts of the branch, namely: old, when taken from already established crops, and new, when taken from nurseries (Ledo, 2020).

It is a crop with different bioactive compounds, such as carotenoids, anthocyanins, phenolics and flavonoids. These phytochemicals are important in human health and disease prevention (Pilon et al., 2021). Studies linked to this topic have been important in recent years due to their special nutritional and functional properties. Bioactive carbohydrates, proteins, carotenoids, flavonoids, anthocyanins, phenolic acids and minerals are several nutrients present in the leaves and roots of sweet potatoes (Cardoso, 2018).

In Mozambique, sweet potatoes are among the top ten food crops produced (FAO, 2018). Many of the country's poorest producers and most malnourished families depend on roots and tubers as an important source of food and nutrition (Scott et al., 2018). Roots and tubers produce large amounts of energy per day compared to cereals, on the other hand, the protein content of sweet potato leaves and roots ranges from 4.0% to 27.0% and 1.0% to 9.0% (Pilon et al., 2021). In this sense, sweet potatoes can be considered an excellent new source of health-promoting natural compounds, such as β-carotene and anthocyanins, for the functional foods market (Marcos, 2022). Furthermore, the high concentration of anthocyanin and β-carotene in sweet potatoes, combined with the high stability of the coloring extract, makes it a promising and healthier alternative for communities in general and in particular for children aged 0 to 5 years. (Vizzotto, 2018), as well as the processing of sweet potato starch and flour can create new economic activities and employment for farmers and rural families, and can add nutritional value to food systems (Menasche, 2019).

Therefore, the article under study aims to evaluate the productivity of two varieties of sweet potato subjected to different amounts of irrigation water.

Material and method

Location of the experimental área

The work was conducted at the Nampula Agricultural Station, at the Mozambique Agricultural Research Institute (figure 1), located in the city of Nampula, in the neighborhood of Muahivire Expansão, Napacala circle. The district is bordered to the north by the districts of Mecuburi and Muecate, to the south by the district of Mogovolas, to the west by the district of Meconta and to the west by the district of Murrupula. This has an area of 335 km2 next to national road number 501, which is 7 km from the headquarters of Nampula, on Rua de Corrane, between (15º.09' South Latitude, 39º30' East Longitude and 432 meters Altitude). Its average total precipitation is around 1114.2 mm annually, with average and minimum temperatures of 21ºC (INIA, 2007).

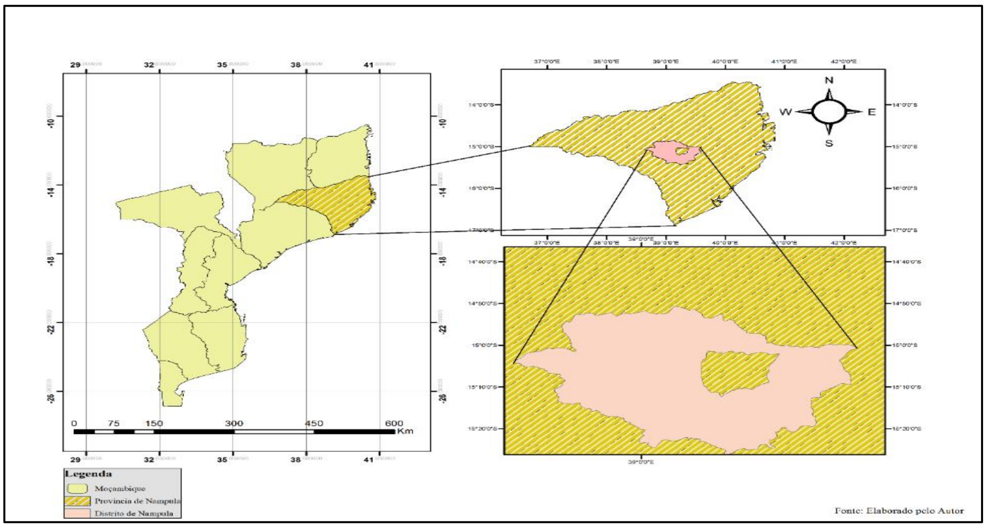


Figure 1: geographical location of the Nampula agronomic station (INIA, 2007).

The two cultivars: Bophelo, Blesbok, were introduced in 18 plots of 5 m x 4 m (20 m^2) with a 2 m border between plots, at three water levels: full irrigation (FI), supplementary irrigation (SI) and rainfed (RF). Irrigation treatments were started 30 days after planting, applying drip irrigation, dripper flow (3.8 L/h). The index was calculated by dividing the dry matter of the tubers obtained on a given harvest date by the total dry weight of the plant. 120 days after planting, the harvest was harvested.

Climate

Figures 2 and 3, represent annual rainfall data for Nampula, in the periods of 2015/2016 and 2016/2017. In general, the northern region is wetter than the south, with the exception of the Lower Zambezi Valley, in Tete Province, where rainfall is less than 600 mm annually (IAM, 2007).

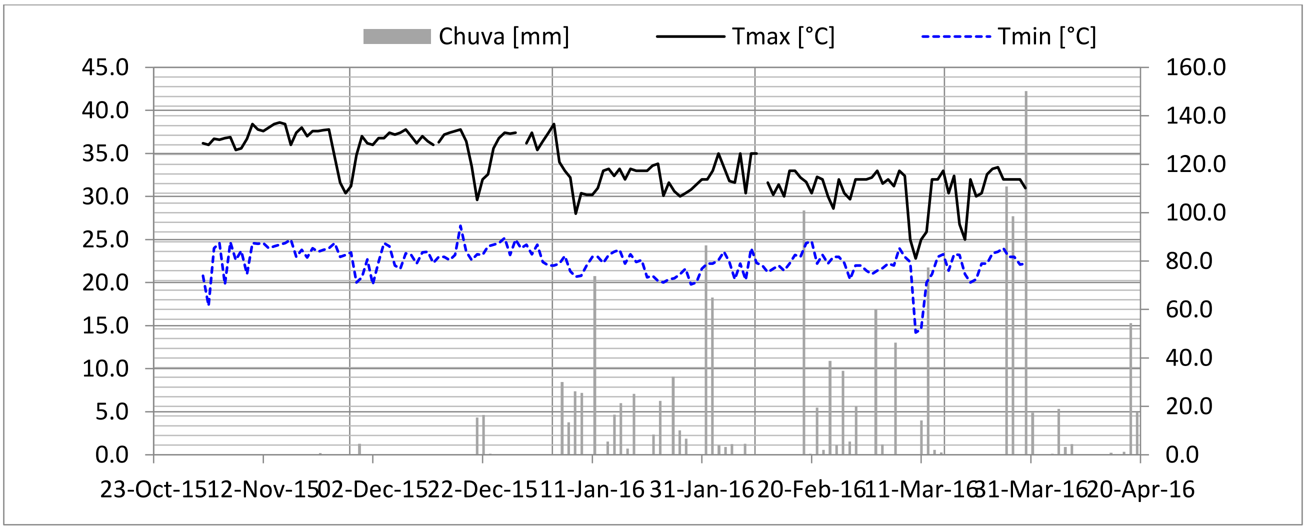


Figure 2: rainfall in the period of 2015/2016.

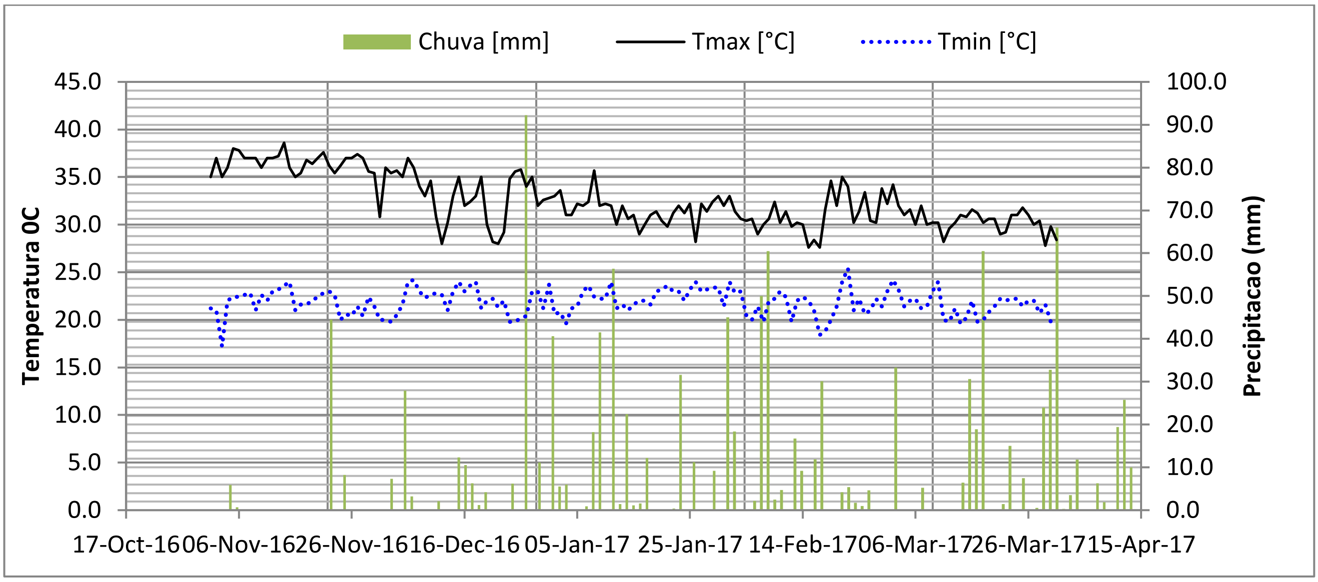


Figure 3: rainfall in the period 2016/2017.

In the city of Nampula, the annual rainfall reaches 1,245 mm, but with strong variations between the summer months, from 62 mm in November to 190 mm in January. The average monthly temperature varies from 18.5ºC to 26.5ºC, being highest between October and December, at the beginning of the rainy season, and mildest between June and July, in the dry season. The monthly average of maximum and minimum temperatures in the city of Nampula is 25ºC to 32ºC and 16ºC to 22ºC respectively, for an altitude of 441 m (Martins, 2021).

Soil

The soil in the study area was classified as being sandy, predominantly yellow-brown-grayish, whether from the interior sandy cover (ferralic arenosols), or from the coastal sandy dunes (haplic arenosols), and also by the soils of the strip from coastal sandstone, with a sandy texture, to sandy clay loam with an orange color. The hydromorphic sandy soils of depressions and lows occur alternating with the higher parts of the land (INE, 2017).

Type of search

This is a quantitative research, as it evaluates the productivity of two varieties of sweet potato, subjected to different levels of irrigation.

Experimental test

The experimental design was complete causal blocks, with three replications. The treatments resulted from six combinations of two cultivars (white and orange pulp) at three different levels of irrigation water (full irrigation = FI; supplementary irrigation = SF and dryland = RF).

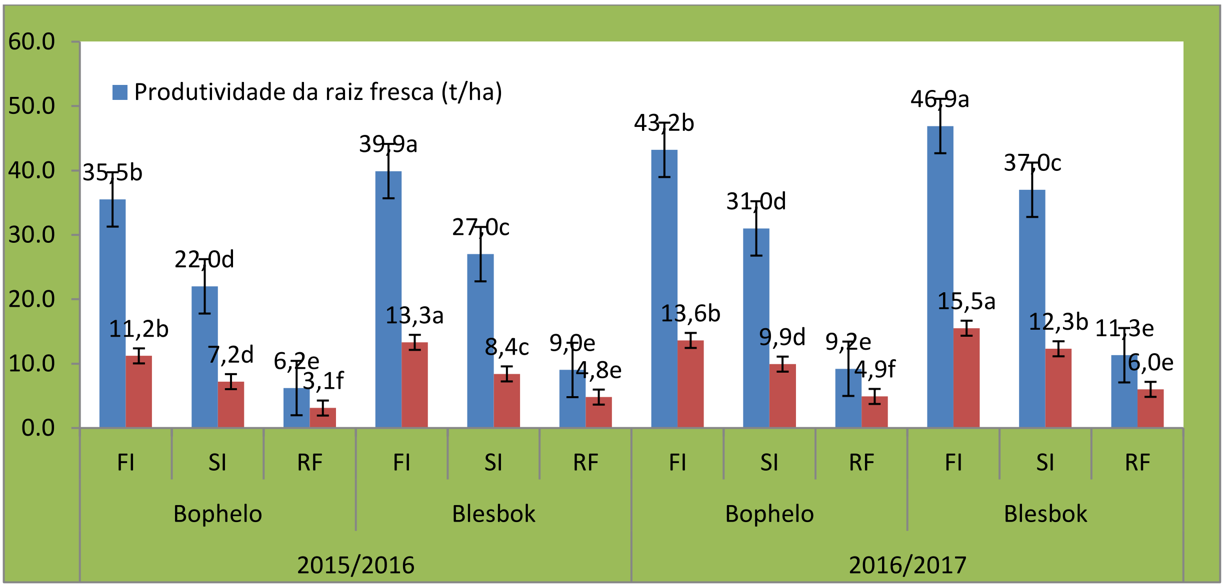
Statistical treatment

After evaluating the experimental trial, the fresh and dry mass data were subjected to analysis of variance and the means of the treatments were compared with each other, applying the Tukey test, at a

5% level of significance, using the Sisvar statistical software. version 5.6 (Ferreira, 2018).
The mathematical model adopted for the analysis was: yij = m + ti + eij. Where:
yij = value observed in the experimental unit that received treatment i, repetition j;
m= general effect of the average;
ti = effect of treatment i;
eij = random error (residual).

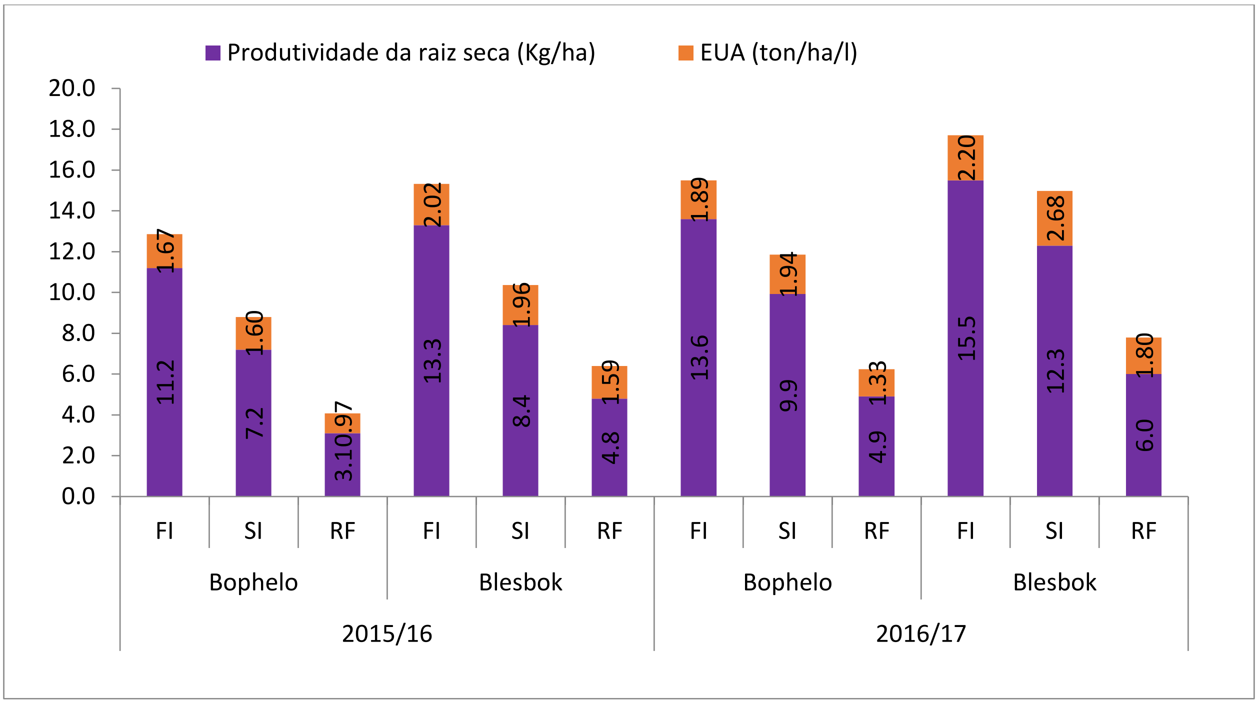
Results and discussion

Sweet potato cultivation, despite providing relatively low production costs, especially in terms of inputs, even in areas with low natural fertility, is influenced by water efficiency (Mantovani, 2018). Through the information generated in (Figure 3), it can be seen that the full irrigation treatment for the two sweet potato varieties showed a very high total fresh root productivity of 35.5, 39.9, 43.2 and 46.9 t/ha followed by supplementary irrigation that presented 22.0, 27.0, 31.0 and 37.0 dry root in the periods (2015/2016 and 2016/2017), respectively. Therefore, it is observed that the dryland treatment had lower productivity for both varieties. This was probably due to periods of low rainfall, which occurred in the months of November after the installation of the experiments (Figure 2), where there was no greater regularity of rainfall, as well as adequate temperatures, sufficient to provide good growth and development of the plant root (Sarmento, 2019).



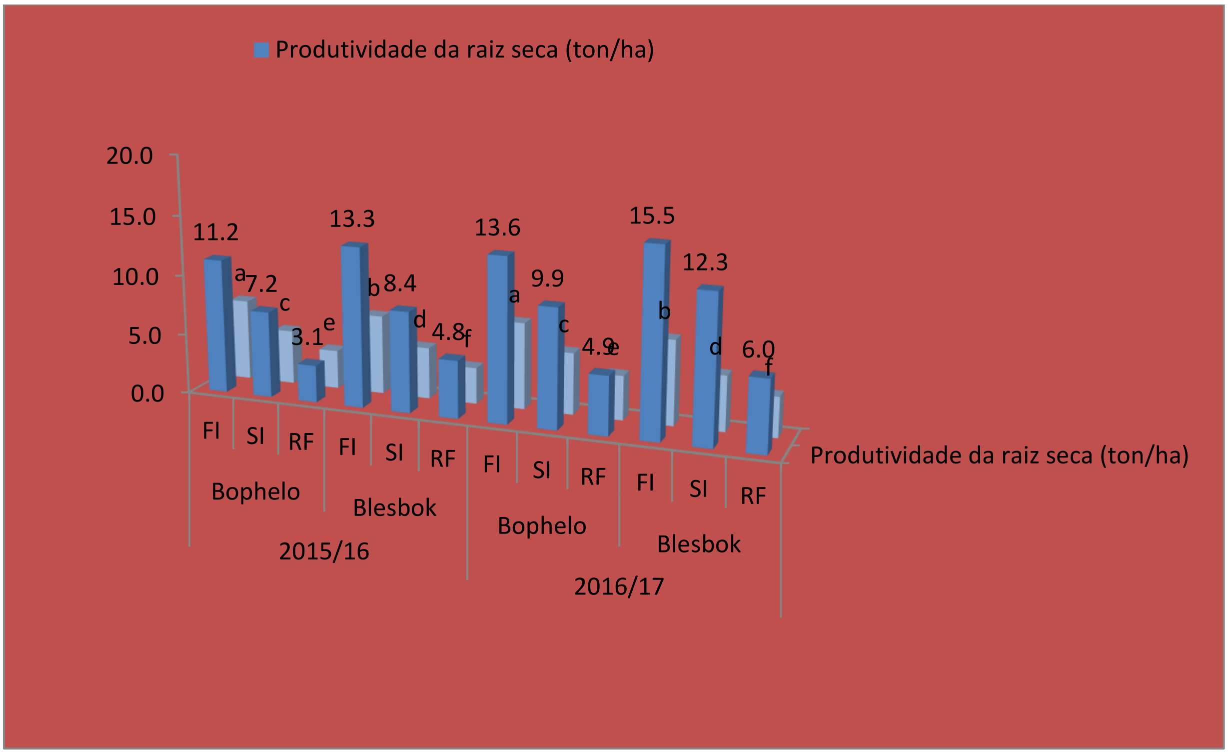
Graph 3: fresh and dry root productivity in the periods 2015/2016 and 2016/2017.

With regard to water use efficiency, for the two sweet potato cultivars (Graph 4), it was found that there is a relationship with biomass production or commercial production by the amount of water applied or evapotranspiration. In this case, the RF treatment had low water use efficiency. It is known that in irrigated agriculture, raising and determining levels of this efficiency are quite complex and require interdisciplinary knowledge and considerations; However, da Costa (2018), mentions that there are ways to increase the efficiency of water use, highlighting the appropriate manipulation of irrigation.



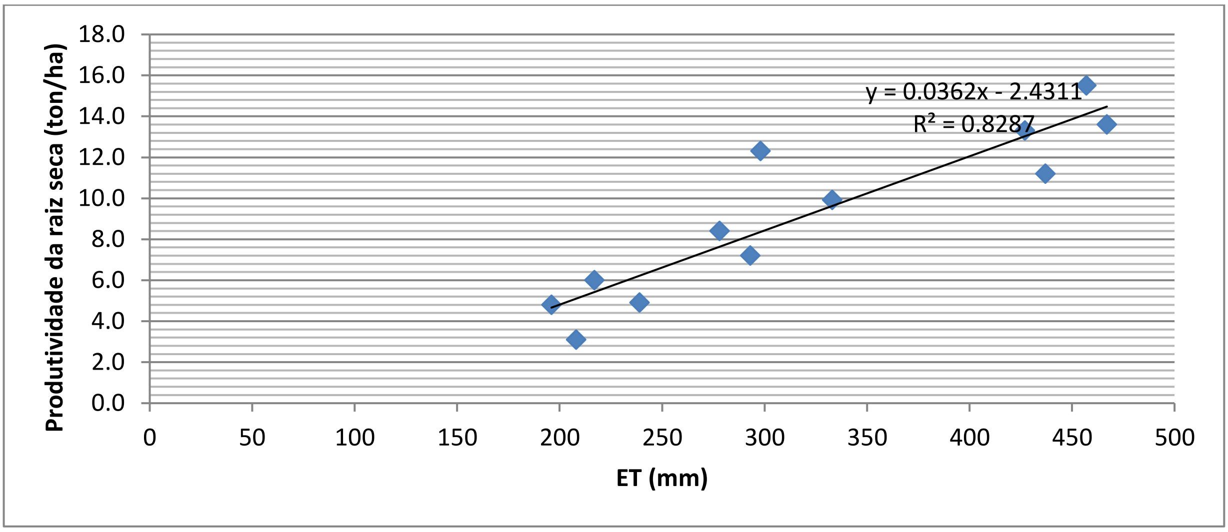
Graph 4: dry matter productivity as a function of water use efficiency.

Regarding the dry root productivity observed in sweet potato cultivars (Graph 5), the dry matter index was notable in the FI treatment, followed by the SI treatment. However, dos Santos (2019) argues that the average number of roots, dry matter, ash, starch, fiber, soluble solids and pH increased in cultivars that showed higher weight yield and total productivity, respectively.



Graph 5: dry root productivity as a function of ET.

Among the biological processes that affect crop productivity, water deficit stands out, which harms the photosynthetic system of plants by restricting stomatal opening (Médio, 2021). Therefore, graph 6 clearly illustrates the impact of irrigation on sweet potato productivity.



Graph 6: linear regression analysis between productivity and water use.

The data presented shows excellent behavior regarding the linearity of observed data in relation to calculated data (R > 0.82), expressing the influence of irrigation on sweet potato productivity. However, irrigation emerges as an important technique for obtaining greater agricultural yields (Araújo, 2018).

Conclusion

For the experimental conditions, the level that provided the greatest fresh matter was full irrigation with (35.5; 39.9; 43.2 and 46.9 per hectare) followed by supplementary irrigation (22.0; 27.0; 31.0 and 37.0 per hectare).

The white-fleshed cultivar proved to be more efficient in using water, being more suitable mainly for regions where the demand for evapotranspiration was satisfied.

The study showed that in the months in which the temperature was low, precipitation was greater, drastically increasing the productivity of the two cultivars, with the exception of the rainfed treatment (RF).

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