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Growth of Rúcula (*Eruca vesicaria* [L.] Cav.) in Different Densities under Aquaponic System with Tambaqui (*Colossoma macropomum*, Cuvier)

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Abstract

The integrated production of fish and vegetables has a wide production versatility, in addition to providing food security in a sustainable way. This study aimed to evaluate the effect of different seed densities on the growth of rúcula plants (Eruca vesicaria) in an aquaponic system with tambaqui (Colossoma macropomum). The responses obtained in the aquaponic system were positive with the three densities, with germination occurring in the first week. As the seeds become denser, germination tends to increase by 120%, that is, 2 more seeds per planted cell when compared to D1. Regarding the length of rúcula seedlings, the best average was obtained in D2 with 3.7 cm, an increase of 70.5 and 9.46% when compared to D1 and D2, respectively. The number of leaves and stem diameter showed no statistical difference at 5% probability. All correlation coefficient estimates were positive and Principal Component Analysis (PCA) showed variability of 46% on dimension 1 and 35.1% on dimension 2, totaling 81.1% of the total data variability. It was found that in germination and plant height, D1 had significantly lower values when compared to the other densities. While the number of leaves and the diameter of the stem did not suffer significant effect with the density of the seeds. Taking these aspects into account, the aquaponics system proved to be efficient for animal and plant development, benefiting both systems, being recommended for the production of rúcula seedlings.

Keywords: Aquaculture. Recirculation systems. Horticulture.

1. INTRODUCTION

The rúcula (*Eruca vesicaria*) is one of the main leafy vegetables produced in Brazil via hydroponics (SILVA *et al*, 2013), but not much studied in aquaponic systems. It has high nutritional value, short cycle and wide acceptability by the consumer market, ensuring year-round production (GENUNCIO *et al*, 2011).

The tambaqui (*Colossoma macropomum*) is a freshwater fish native to the Amazonian rivers with good development in systems due to its rusticity and adaptability, another factor to be commented is its acceptance in the consumer market in several regions of Brazil (BARÇANTE *et al*, 2015).

In recent years, the need for the production of healthy foods has been growing, due to this, there is a need for the use and research of aquaponics systems, plant and animal cultivation systems with the purpose of rational water use (STERZELECKI *et al*, 2021).

There are still few works developed with native species and horticultural plants in aquaponic systems, therefore, the present work had as objective to analyze the growth of rúcula sown at different densities when cultivated in aquaponics system with tambaqui.

2. MATERIAIS AND METHODS

The experiment was set up at the Aquaculture Biosystems Laboratory (figure 1), in Universidade Federal Rural da Amazônia - UFRA, in a protected environment with daily monitoring of temperature and relative humidity, the system was composed of an animal culture tank, a decanter, a biofilter and a plant cultivation bench. The average initial fish biomass per experimental unit was 1 kg/m3, fed with 5% of the biomass, 3 times a day.

For water quality, physical-chemical parameters were measured daily: pH, temperature, dissolved oxygen and conductivity. Nitrogen compounds were measured weekly. Tambaqui obtained an average weight gain of 10g and a feed conversion of 1.5. To evaluate the productivity of basil seedlings, sowing was carried out in polystyrene trays with 128 cells filled with coconut fiber, at three densities called D1, D2 and D3, with four replications, cultivated and evaluated for 20 days.

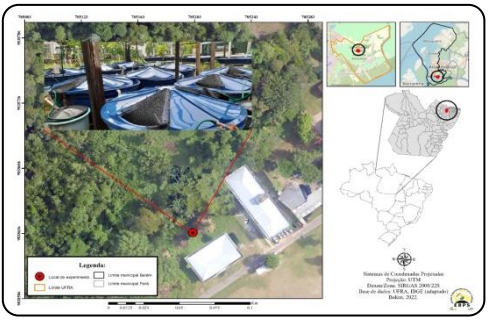

Fig 1 – Experiment location map

At the end of the experiment, the number of germinated seedlings was evaluated, the plant growth was measured, along with the diameter of the stem with the aid of a digital caliper, and the fresh weight of the seedling was measured using a precision scale from the EBPS laboratory.

Statistical analysis of variables and generation of graphs was performed using R Studio software, version 1.3.1093. For Analysis of Variance (ANOVA) and Tukey's Post-Hoc Test, the ExpDes.pt library and the "dic" function were used, which already performs analysis of normality of residues by the Shapiro-Wilk test and equality of variances by the Bartlett test to test the assumptions of the parametric analyses, with a significance level of 5%. For the Pearson Correlation matrix, the psych library and the "pairs.panels" function were used, with a significance level of 5%. For the multivariate analysis of principal components, the factoextra library and the "fviz_pca_biplot" function were used.

3. RESULTS AND DISCUSSION

The responses obtained in the aquaponic system were positive with the three densities, with germination occurring in the first week. As the seeds become denser, germination tends to increase by 120%, that is, 2 more seeds per planted cell when compared to D1 (figure 2A). Regarding the length of arugula seedlings, the best average was obtained in D2 with 3.7 cm, an increase of 70.5 and 9.46% when compared to D1 and D2, respectively (figure 2B). As for the number of leaves and stem diameter, there was no statistical difference at 5% probability (figure 2C and 2D).

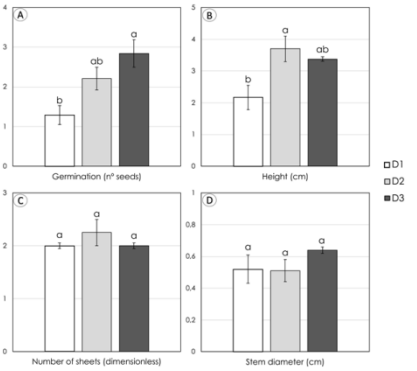

Fig 2 - Germination (a), height (b) number of leaves (c) and stem diameter (d) of rúcula (*Eruca vesicaria*) plants at different densities in tambaqui (*Colossoma macropomum*) aquaponic system. The different letters show statistical differences, detected by the Tukey test at the 5% level of significance.

A necessary and crucial factor for the seed germination process is water availability (ARAÚJO *et al*, 2018), as the seed has a reserve in the endosperm that is only metabolized when it encounters ideal environmental conditions. Vegetative growth is the irreversible increase of protoplasmic material totally dependent on water, where the plant gains size and biomass, and with the development of the root system and the expansion of the leaves, it produces its photoassimilates (PEIXOTO *et al*, 2009).

In interpreting the estimated correlations between the variables, all correlation coefficient estimates were positive, indicating that the tendency of one variable to increase when the other increases (Figure 3A), but the rankings of the coefficients ranged from weak to moderate.

Pearson's correlation measures the degree of linear correlation between two variables and its measurement can be in relation to direction or intensity, and has as a response a coefficient that varies from -1 to 1 (GISEV *et al*, 2013). It is evident that the correlation value does not change when changing the measurement unit of the variables, and that the coefficient has a dimensionless character, therefore it is presented without a unit (FILHO *et al*, 2009).

The relationships between the variables of germination, height, number of leaves and diameter can be visualized from the multivariate analysis using the Principal Component Analysis (PCA) method, where the variability of the data was explained in 46% in dimension 1 and 35, 1% in dimension 2, totaling 81.1% of the total data variability (Figure 3B).

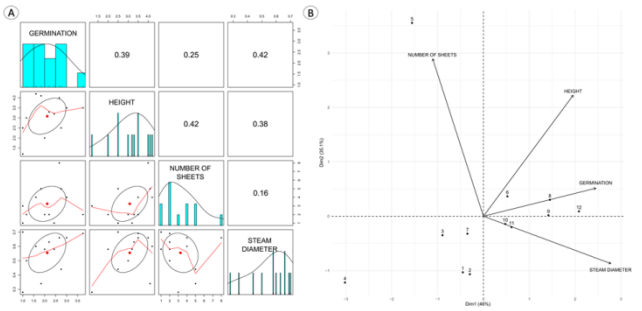

Fig 3 - Pearson's correlation coefficient (a) and principal component analysis - PCA (b) for the variables germination, height, leaf number and stem diameter of rúcula (*Eruca vesicaria*) under different densities in tambaqui (*Colossoma macropomum*) aquaponic system.

PCA is of great importance to verify the contribution of variables and their influence on data variation, the closer a variable is to the circle of correlations, the better its representation in the factorial map, while the variables close to the center of the graph are the least important for the first components (KARAMIZADEH *et al*, 2013).

4. CONCLUSION

It was found that in germination and plant height, D1 had significantly lower values when compared to the other densities. While the number of leaves and stem diameter did not fluctuate the effect with seed density. Taking these aspects into account, the aquaponics system proved to be efficient for animal and plant development, benefiting both systems, being recommended for the production of rúcula seedlings.

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