DOMESTIC EFFLUENT TREATED FOR THE CULTIVATION OF ANTHURIUM
(ANTHURIUM ANDRAEANUM LIND.)

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ABSTRACT

Purpose: The objective of this research was to evaluate the growth and production of anthurium (Anthurium andraeanum Lind.) irrigated with dilutions of treated domestic effluent (EDT), aiming to reduce the use of water and recycle the nutrients present in the effluent.

Theoretical framework: Faced with the scarcity and irregularity of rainfall in the Recôncavo da Bahia, it emphasizes the need and urgency in the search for alternative sources of water for irrigation, such as wastewater, with the potential to supply the water and nutritional demands of plants, especially those with less restriction, like ornamentals.

Method/design/approach: The experimental design was completely randomized, using five dilutions of EDT (0, 25, 50, 75 and 100%) in drinking water, with four replications. Plant height, number of leaves, leaf area, number of flowers and shoot dry mass were evaluated.

Results and conclusion: Plants irrigated with EDT dilutions and fertilized with 50% of the recommended nitrogen and potassium showed growth and production similar to plants irrigated with water supply and fertilized with 100% of the recommended mineral fertilizer, which allows recommending the use of EDT for irrigation of anthurium with 50% reduction of mineral fertilization.

Research implications: The results obtained reinforce the importance of taking advantage of the nutrient content present in the effluent, with the possibility of partially replacing mineral fertilizers, favoring savings in quality water and mineral fertilizers.

Originality/value: Savings of good quality water and mineral fertilizers, in addition to providing a safe destination for the effluent.

Keywords: Reuse, Ornamental, Water Resources, Wastewater.

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RESUMO

Objetivo: O objetivo desta pesquisa foi avaliar o crescimento e a produção de antúrio (Anthurium andraeanum Lind.) irrigado com diluições de efluente doméstico tratado (EDT), visando reduzir o uso de água e reciclar os nutrientes presentes no efluente.

Referencial teórico: Diante da escassez e irregularidade das chuvas no Recôncavo da Bahia, enfatiza-se a necessidade e urgência na busca por fontes alternativas de água para irrigação, como a água residuária, com potencialidade para suprir as demandas hídrica e nutricional das plantas, sobretudo daquelas com menor restrição, como as ornamentais.

Método: O delineamento experimental foi inteiramente casualizado, utilizando-se cinco diluições de EDT (0, 25, 50, 75 e 100%) em água de abastecimento, com quatro repetições. Avaliou-se a altura da planta, número de folhas, área foliar, número de flores e massa seca da parte aérea.

Resultados e conclusão: As plantas irrigadas com as diluições de EDT e adubadas com 50% da recomendação de nitrogênio e potássio apresentaram crescimento e produção semelhante às plantas irrigadas com água de abastecimento e adubadas com 100% da recomendação de fertilizante mineral, o que permite recomendar o uso de EDT para irrigação de antúrio com redução de 50% da adubação mineral.

Implicações da pesquisa: Os resultados obtidos fortalecem a importância de aproveitar o conteúdo de nutrientes presentes no efluente, com possibilidade de substituir parcialmente a adubação mineral, favorecendo a economia de água de qualidade e fertilizantes minerais.

Originalidade/valor: Economia de água de boa qualidade e de fertilizantes minerais, além de proporcionar uma destinação segura para o efluente.

Palavras-chave: Reuso, Ornamental, Recursos Hídricos, Água Residuária.

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1 INTRODUCTION

The scarcity and irregularity of the rains in the Recôncavo region of Bahia has been limiting the development of agriculture under a dry regime, with negative socioeconomic impacts, which makes the search for alternative sources of water for irrigation increasingly necessary and urgent.

As irrigated agriculture is a major consumer of water and the growing scarcity of water resources, there is an incentive for research into techniques for treating and harnessing effluent in agriculture, especially in less restrictive crops (Asano, 2006; Sousa, Ceballos, Henrique, Dantas & Lima, 2006). The implementation of innovation and reuse technologies has emerged as a factor in reducing environmental impact and costs, while offering a competitive advantage (Silva et al., 2022).

Strict enforcement actions have been carried out by public bodies responsible for the quality of the environment and, aware of the environmental degradation caused by the release of wastewater into the watercourses, producers have been seeking specific solutions in order to treat, dispose of or reuse the waste (De Souza et al., 2023). Furthermore, the high cost of fertilizers and the guarantees that the risks of contamination to public health and the
Domestic Effluent Treated for the Cultivation of Anthurium (*Anthurium Andraeanum* Lind.)

Environment will be minimal if adequate precautions are taken have led to a significant increase in the use of waste water in the agricultural sector.

Health, economic and environmental aspects make water reuse a viable and promising option for agriculture, among these is the water and nutritional potential of wastewater, since effluents from conventional treatment systems present significant concentrations of nutrients essential for crop growth and productivity, besides providing the addition of organic matter, which acts as soil conditioner, improving the structure and water retention capacity (De Souza et al., 2018). Furthermore, in view of the high cost of treatment systems for discharging effluents into receiving bodies, reusing water for irrigating crops provides a safe destination to the effluent, avoiding inappropriate disposal and contributing to environmental preservation (Oliveira, Paz, Gonçalves & Oliveira, 2017).

However, if effluent treatment or irrigation management with this resource is not adequate, the use of this practice may become harmful to human health and the environment. In the soil, negative effects are caused mainly when there is absence of leaching and presence of excessive evapotranspiration, promoting the accumulation of salts in the root zone (Bernstein, 1974), which can jeopardize the development of plants.

Among the agricultural segments, the flower and ornamental plant sector is one of the least prioritized in the use of good quality water when there is a water shortage, since in this situation the priority of supply is to attend to human consumption. Thus, the reuse of water from different activities, whether domestic or industrial effluent, for less restrictive activities, such as irrigation in landscape or floricultural enterprises, has contributed to the growth and expansion of the sector, making possible production in regions where it was practically unviable before.

In Brazil, in the last few years, the commercial production of ornamental plants has been arousing great interest from producers and investors, due to its high profitability, demand for small areas, intensive production and the rapid return on capital invested. However, in order to achieve the expected productivity, water is required in quantity and quality.

The Brazilian floriculture market has grown significantly driven by higher income availability of the population and the product (Lima Júnior, Nakatani, Monaco Neto, Lima Kalaki & Camargo, 2015). The growth of biophilia during and after the COVID pandemic has increased the agribusiness of flowers and ornamental plants, and from 2020 to 2021, the flower market in the country grew 15%, generating about 209 thousand direct jobs (Instituto Brasileiro de Floricultural - IBRAFLOR, 2022).

Anthurium, a tropical flower belonging to the *Araceae* family, is among the most sought after ornamental plants, outstanding for the beauty, coloration, foliage and durability of its flowers. They are plants that are easy to adapt both to internal and external environments (Lima, Campos, & Carvalho, 2020), used for hollow decoration or as cut flowers and for decoration of gardens, usually shaded. It is considered a rustic plant, which require little care and an excellent alternative for family farming (Carvalho, Santa-Cecília, Almeida & Reis, 2015).

In view of the panorama of water scarcity that afflicts the Northeast region of Brazil, and the need to look for alternative sources of water to ensure agricultural production, the use of water coming from treated domestic sewage for the production of ornamental species is a promising alternative, since this activity presents fewer restrictions for the use of these waters, besides the economic importance and profitability in the sector of Brazilian agribusiness of flowers and ornamental plants. In this sense, the objective of this research was to evaluate the growth and production of irrigated anturium with different dilutions of treated domestic effluent, in the Recôncavo region of Bahia, aiming to develop technologies for minimizing the use of water and recycling of the nutrients present in the effluent.
2 THEORETICAL FRAME

Currently in Brazil, water is the main limiting factor for agricultural development, above all as far as reductions in crop productivity caused by water shortages are concerned. This condition has led to the search for complementary water resources, such as the use of wastewater, which are a source of water and nutrients for crops and a promising solution for the problem of water scarcity and the great demand for water by agriculture, provided that the necessary norms and procedures are followed to ensure the health of the population and the environment (Costa et al., 2022).

Among the sectors that have spread water reuse the most, the agricultural sector stands out, which, when it uses this practice in a controlled way, allows the conservation of water bodies and provides considerable quantities of nutrients to the soil, improving its fertility and consequently increasing the productivity of crops and reducing the costs of chemical fertilization (Sánchez-Román, Queluz & Pereira, 2014).

There are many benefits of using wastewater for agricultural irrigation, among these are the preservation of drinking water for more restrictive uses and the availability of water and nutrients throughout the crop cycle, regardless of the seasons or the periods of drought (Shaer-Barbosa, Santos & Medeiros, 2014; Cuba, Carmo, Souza & Bastos, 2015). Another important aspect is the creation of a safe destination for these waters, avoiding inappropriate disposal and contributing to environmental preservation. Conversely, if effluent treatment or irrigation management with this resource is not adequate, the use of this practice may become harmful. Risks related to reuse refer to human contamination by direct involvement during effluent management (Laaffat, Aziz, Ouazzani & Mandi, 2019); contact with contaminated soil (Boytte, Quaife, Horswell & Siggins, 2017) and ingestion of food grown on impaired or contaminated soil during irrigation.

The indiscriminate use of untreated effluents in irrigation can result in the spread of various diseases such as significant infections caused by nematodes, bacteria, protozoa and viruses, harming both workers and end consumers of irrigated products. This was confirmed by Blumenthal, Peasey, Palacios and Mara (2000) during the conduct of new studies related to public health and the use of treated and untreated effluents for irrigation in Israel, Mexico, India, Germany, the United States and Brazil. At that time, the objective of the studies was, among others, to update the recommendations of the World Health Organization - WHO for agricultural reuse and aquaculture.

Although the planned reuse is widely spread and used worldwide, in Brazil, despite water scarcity in some regions, this practice has not been used intensively. There are few records of the planned reuse of treated effluents mainly in agriculture. However, it is known that there is indiscriminate use of poor quality water, especially for the irrigation of agricultural products (Marouelli & Silva, 1998). Despite the risk of disease transmission, water contaminated by untreated municipal effluents has been used indiscriminately to irrigate vegetables in the green belts of large urban centers, without any greater supervision or control by the competent bodies.

According to Bastos and Mara (1993), the lack of sewage treatment systems in most municipalities of Brazilian cities and the lack of water sources with good quality, since these, in their majority, are affected by the process of urbanization and agricultural activities, favor the practice of indiscriminate reuse of wastewater. This situation is further undermined by the lack of regulations and/or recommendations for agricultural reuse, the lack of technical support and the lack of control by the competent public bodies.

In view of the benefits and limitations of irrigating crops with wastewater, it is necessary to manage them properly and in a controlled way, evaluating their characteristics and taking into consideration the type of crop, the soil and the way in which this product will be consumed. In this context, good planning in the practice of reuse allows for the continuity of activities.
carried out by man, and, due to the large flows involved, special attention should be given to
the use of wastewater in agricultural activities, especially irrigation (Spanish, 2003).

In order for the practice of water reuse to be expanded in the country, guidelines and
programs must be drawn up by means of federal legislation, which must contain the definitions
of the origins of reused water, as well as the ways of using it, the quality parameters, the
instruments that help to improve research and develop the theme throughout the country

In Brazil, there is still no specific legislation for reclaimed water that guarantees sanitary
quality at the physico-chemical-biological level for the different possibilities of destination. In
the case of agricultural irrigation, the level of restriction is mainly conditioned to the type of
consumption of the crop. Brazilian researches with effluent reuse are still recent and need clear
technical criteria, the elaboration of specific normative rules, and the development of
otechnologies compatible with our national conditions. In the case of non-edible species, with
less restriction for irrigation using effluents, as is the case of ornamental species, their use is
more flexible, however precautions must be taken to avoid damage to the environment and to
public health.

Treatment criteria for agricultural reuse allow treated effluents to contain significant
concentrations of organic matter and as much of the nutrients contained in raw sewage as
possible. These criteria should be associated with maintaining biochemical oxygen demand
(BOD) up to a maximum of 100 mg L\(^{-1}\), maintaining nutrients and eliminating pathogens at
levels established by local legislation, when available, or in accordance with World Health
Organization guidelines. In countries with a predominantly hot climate, such as Brazil, the most
suitable technology for the treatment of effluents for agricultural use are stabilization ponds
(Spanish, 2003).

Floriculture is one of the most profitable agricultural segments per unit area and
provides a quick return on investments applied (Fava & Camilli, 2014). The Brazilian
agribusiness of flowers and ornamental plants has grown significantly in recent years, driven
by the greater availability of income in the population and the product (Lima Júnior et al., 2015).
From 2020 to 2021, the flower market in the country grew by 15%, generating about 209,000
direct jobs (IBRAFLOR, 2022).

Anthurium is a tropical plant, widely used in floriculture and landscaping, and which
stands out for its durability and diversity of colors. It is cultivated in several countries of the
world, for the purposes of cut flower, potted flower or for garden decoration (Matthes et al.
2014). In addition, it is characterized by being a rustic plant, easy to grow, which besides being
an excellent alternative for family farming, is also considered one of the cut flowers with great
expression in the world market, for its exotic ornamental qualities and exuberant coloring (Do
Nascimento at al., 2010).

In Brazil, there are few recommendations for fertilizing the cultivation of anthurium in
the field, however some studies have revealed that it is a very demanding crop in terms of
nutrients, especially in the first two years of cultivation (Nomura, Fuzitani & Junior, 2012) that
could affect its yield and quality (Cuquel & Grossi, 2004; Sakai, 2004; Dufour & Guérin, 2005).

Nitrogen deficiency in anthurium can reduce the production and quality of flowers, in
addition to increasing the juvenile period (Tombolato et al., 2002; Dufour & Guérin, 2005) and
cause root damage and secondary fungal and bacterial infections (Pfleger & Gould, 2009;
Deshmukh & Mehetrep, 2010). Phosphorus deficiency, on the other hand, results in atrophic
plants, with small, dark green and narrow leaves, with short petioles. In older leaves,
phosphorus deficiency causes chlorosis, with necrotic areas along the margins of the leaves also
affecting the root system. The supply of potassium directly affects the development of the plant,
controlling the absorption and evaporation of water. It plays an essential role in the yield and
quality of flowers (Tombolato et al., 2002). Symptoms of potassium deficiency are a decrease
in the length of the floral stem (Dufour & Guérin, 2005) and red and orange spata may have blue spots or areas (Tombolato et al., 2002).

For the increase in stalk length, spade size, number of flower stems per plant, as well as the anticipation of flowering, it was recommended to apply nitrogen, phosphorus and potassium in dosages of 30, 20 and 50 g/m², respectively, at 3, 6 and 9 months after planting. For the production crop, chemical fertilizing is recommended, with application of 200 kg/ha nitrogen, 50 kg/ha for phosphorus (P₂O₅) and 150 kg/ha potassium (K₂CO₃), always using as a basis the results of soil analyzes (Tombolato, Furlani, & Castro, 2004). Castro A., Costa, Castro M., Aragão and Willadino (2007) state that fertilization is one of the factors that most influence the development, production and quality of the anthurium, and that inadequate recommendations can lead to the loss of production. However, when there is reference to organic fertilization in the cultivation of anthurium; it is usually applied in conjunction with chemical fertilization (Matthes et al., 2014).

Considering the water and nutritional potential of the wastewater from treated domestic sewage and its use in ornamental crops with lower risk of environmental contamination, its use for irrigation of ornamental species could represent an advantageous option allowing the production of plants with higher quality and reduced cost, in addition to creating a destination for the use of this water. Some studies carried out with the use of wastewater for the irrigation of ornamental plants showed positive results in the use of this practice (De Andrade, Gheyi, Nobre, Dias & Nascimento, 2012; Souza, Nobre, Gheyi, Dias & Soares, 2010; Medeiros, Soares, Gheyi & Fernandes, 2007; Medeiros, Gheyi & Soares, 2010; Brito et al., 2014; Oliveira et al., 2017; Gonçalves et al., 2018; Souza et al., 2018; De Souza et al., 2020; Gonçalves, Bishop, Bandeira, Gheyi & Paz, 2020).

The difficulty of identifying alternative sources of water for irrigation, the high cost of fertilizers and the guarantees that the risks of contamination to public health and the environment will be minimal if adequate precautions are effectively taken have led to a significant increase in the use of wastewater in the agricultural sector. In this scenario, the main reuse water applications may include irrigation of ornamental species, as they are less restrictive.

3 METHOD

The experiment was conducted in the period from October 2016 to March 2017, in the home of vegetation in the experimental area of the Graduate Program in Agricultural Engineering of the Federal University of Recôncavo da Bahia, located in the municipality of Cruz das Almas (BA) with the geographical coordinates 12°40′12″ S, 39°6′7″ W and altitude of 220 m. The climate of the region is classified as humid to subhumid, with average annual rainfall of 1,143 mm (D’Angiolella, Castro Neto & Coelho, 2000). According to the Köppen classification, it falls into type Aw a Am, tropical hot and humid.

The experimental design used was entirely casualized with five treatments, consisting of dilutions of treated household effluent and water supply (Table 1), and four repetitions, totaling twenty experimental plots (Figure 1). Each experimental plot was composed of a 20 dm³ plastic vessel containing a three-leaf Anthurium andraeanum Lind. molt (Figure 2). For the filling of the vessels, soil of the type Latossolo was used dystrocohesive Yellow taken from the first layer of 0-20 cm, with the following chemical characteristics: pH (water), = 5; MO (%) = 1.65; SB and CTC (cmolc dm⁻³) = 1.54 and 4.79, respectively, and physical: 776 g kg⁻¹ of total sand, 181 g kg⁻¹ of clay and 43 g kg⁻¹ of silt. The soil was corrected with the addition of limestone (0.75 g kg⁻¹ of the soil) thirty days before the transplanting of the seedlings and the day before the transplanting was carried out fertilization with phosphorus (577 mg kg⁻¹), using as a
source the monoammonium phosphate (MAP), according to the recommendations of Novais, Neves and Barros (1991).

The seedlings (Figure 2) were obtained from plants grown in a nursery located in the municipality of Aratuípe (Bahia), produced under sombrite and in fertilized sandy beds following the recommendation Tombolato et al. (2004) for plants in production.

The treatments were started seven days after the transplant and consisted of irrigating the plants with the different dilutions of treated domestic effluent in water supply. The waters used for the preparation of the solutions came from the municipal supply system (water supply) and from the Sewage Treatment Station - ETE (Treated Domestic Effluent) of the Bahian Water and Sanitation Company (EMBASA), located in the municipality of Muritiba, Bahia, and the physical-chemical analysis of these waters was carried out (Table 1). Nitrogen and potassium (NK) mineral fertilization was performed via irrigation water, using 100 or 50% of the recommendation of Novais et al. (1991) (Table 2).

Fertilization with N and K (94 and 312.5 mg kg⁻¹, respectively) was divided into three applications, the first being carried out at 7 days after transplantation and the others at 22 and 32 days after transplantation. 1.9 g of urea and 6.25 g of potassium sulfate were used for each
Domestic Effluent Treated for the Cultivation of Anthurium (*Anthurium Andraeanum* Lind.)

vessel of the control treatment and 0.95 g of urea and 3.1 g of potassium sulfate per vessel for effluent treatment.

**Table 1 - Characteristics of treated domestic effluent and municipal water supply used in the survey**

<table>
<thead>
<tr>
<th>Components</th>
<th>Units</th>
<th>Treated domestic effluent</th>
<th>Water from supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td>6.85</td>
<td>7.41</td>
</tr>
<tr>
<td>ECa</td>
<td>dS m⁻¹</td>
<td>1.39</td>
<td>0.387</td>
</tr>
<tr>
<td>P</td>
<td>mg L⁻¹</td>
<td>16</td>
<td>NA</td>
</tr>
<tr>
<td>K⁺</td>
<td>mg L⁻¹</td>
<td>29</td>
<td>0.17</td>
</tr>
<tr>
<td>PARAGRAPHH⁻</td>
<td>mg L⁻¹</td>
<td>2.18</td>
<td>NA</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>mg L⁻¹</td>
<td>11.</td>
<td>NA</td>
</tr>
<tr>
<td>Na⁺</td>
<td>mg L⁻¹</td>
<td>6.42</td>
<td>1.73</td>
</tr>
<tr>
<td>Ca²⁺</td>
<td>mg L⁻¹</td>
<td>0.81</td>
<td>0.51</td>
</tr>
<tr>
<td>Mg²⁺</td>
<td>mg L⁻¹</td>
<td>1.56</td>
<td>0.88</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>mg L⁻¹</td>
<td>5.75</td>
<td>1.87</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>mg L⁻¹</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>CO₃²⁻</td>
<td>mg L⁻¹</td>
<td>0.00</td>
<td>A</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>mg L⁻¹</td>
<td>1.76</td>
<td>0.41</td>
</tr>
<tr>
<td>EWS</td>
<td>(Mmol L⁻¹)⁰.⁵</td>
<td>8.34</td>
<td>2.93</td>
</tr>
</tbody>
</table>

Note: ND - Not determined; A* - Absent; P* - Present; SAR - Sodium absorption rate

**Source:** Prepared by the authors (2023).

**Table 2 - Treatments studied in anturium plants (*Anthurium andraeanum* Lind.)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>EDT dilutions</th>
<th>Fertilization with NK</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 - witness</td>
<td>0% EDT + 100% AA</td>
<td>100%</td>
</tr>
<tr>
<td>Q2</td>
<td>25% EDT + 75% AA</td>
<td>50%</td>
</tr>
<tr>
<td>Q3</td>
<td>50% EDT + 50% AA</td>
<td>50%</td>
</tr>
<tr>
<td>Q4</td>
<td>75% EDT + 25% AA</td>
<td>50%</td>
</tr>
<tr>
<td>Q5</td>
<td>100% EDT + 0% AA</td>
<td>50%</td>
</tr>
</tbody>
</table>

Note: EDT - treated domestic effluent; AA - water supply; NK - mineral fertilization with nitrogen and potassium.

**Source:** Prepared by the authors (2023).

Irrigation was carried out manually, with the aid of irrigators, with a one-day irrigation shift, with the water slide applied to keep the soil moisture close to the field capacity determined by the difference in the weight of each pot with soil in the field capacity and the weight of the pot on the specific day of irrigation.

At ninety days after transplantation, the plants were evaluated and harvested, with measurements of plant height (AP) with the aid of a millimeter tape measure, number of leaves (NF) and flowers (NFL), performing manual counting and the foliar area (AF), calculated from Equation 1 (Da Silva, Lima, Bendini, Nomura & Moraes, 2008):

\[ FY = c * (C * L) \]  

(Eq. 1)

Where:

FA - Foliar area (cm²)

\( c \) - correction coefficient 0.9672

CF - Sheet length (cm)

LF - Sheet width (cm)

The dry mass of the upper part (MSPA) obtained by weighing the dry material (stalks and flowers) in a forced circulation oven after 72 hours was also evaluated using precision scales.
The data obtained were submitted to the analysis of variance by the F test and when significant the means were compared by the Tukey test at 0.05 probability.

4 RESULTS AND DISCUSSIONS

There was no significant effect (p>0.05) of the treatments on the anthurium plants for the variables evaluated (Table 3). The plants irrigated with treated domestic effluent and fertilized with 50% of the nitrogen and potassium recommendation presented mean values of all variables statistically equal to those of the plants irrigated with water supply and fertilized with 100% of the mineral fertilizer recommendation (witness treatment) (Table 4).

Table 3. Summary of the analysis of plant height variance (AP), number of leaves (NF), foliar area (FY), number of flowers (NFL) and dry mass (MS) of irrigated anthurium plants (Anthurium andraeanum Lind.) with different dilutions of treated household effluent (EDT)

<table>
<thead>
<tr>
<th>Variation Source</th>
<th>G.L.</th>
<th>AP (cm)</th>
<th>NF</th>
<th>FY (cm²)</th>
<th>NFL</th>
<th>MS (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBS (%)</td>
<td>4</td>
<td>16.38ns</td>
<td>0.05ns</td>
<td>812.73ns</td>
<td>0.17ns</td>
<td>0.01ns</td>
</tr>
<tr>
<td>Residue</td>
<td>15</td>
<td>28.72</td>
<td>0.40</td>
<td>1410.05</td>
<td>0.15</td>
<td>0.03</td>
</tr>
<tr>
<td>C.V. (%)</td>
<td></td>
<td>19.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General average</td>
<td></td>
<td>27.22</td>
<td></td>
<td>109.47</td>
<td>0.95</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Note: *ns* not significant at 5% probability by F. C.V. test - coefficient of variation.

Source: Prepared by the authors (2023).

Table 4. Average plant height (AP), number of leaves (NF), foliar area (FY), number of flowers (NFL) and dry mass (MS) of anthurium plants (Anthurium andraeanum Lind.) irrigated with different dilutions of treated domestic effluent (EDT) at 90 days after transplantation

<table>
<thead>
<tr>
<th>Treatment</th>
<th>AP (cm)</th>
<th>NF</th>
<th>FY (cm²)</th>
<th>NFL</th>
<th>MS (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% EDT + 100% AA + 100% NK</td>
<td>28.20</td>
<td>4.50</td>
<td>128.35a</td>
<td>0.75a</td>
<td>0.46a</td>
</tr>
<tr>
<td>25% EDT + 75% AA + 50% NK</td>
<td>23.87</td>
<td>4.25</td>
<td>116.90a</td>
<td>1.00 a</td>
<td>0.63a</td>
</tr>
<tr>
<td>50% EDT + 50% AA + 50% NK</td>
<td>27.22</td>
<td>4.25</td>
<td>98.73a</td>
<td>1.25a</td>
<td>0.55a</td>
</tr>
<tr>
<td>75% EDT + 25% AA + 50% NK</td>
<td>29.25</td>
<td>4.25</td>
<td>110.77a</td>
<td>1.00 a</td>
<td>0.55a</td>
</tr>
<tr>
<td>100% EDT + 0% AA + 50% NK</td>
<td>27.55</td>
<td>4.25</td>
<td>92.61a</td>
<td>0.75a</td>
<td>0.51a</td>
</tr>
</tbody>
</table>

Note: Averages followed by equal letters in the same column do not differ by the Tukey test at the probability level of 0.05.

Source: Prepared by the authors (2023).

These results reveal that, even with the recommendation of fertilizing reduced by 50%, the availability of nutrients for the plants, in particular for the nitrogen, phosphorus and potassium present in the effluent in organic form, were sufficient to attend to the demands of the crop. This performance is probably due to macro- and micronutrients dissolved in the household effluent, corroborating inferences from other authors, which highlight the importance of the use of domestic wastewater for the supply of nutrients and as a possibility of partial substitution of chemical fertilizers (Rebouças, Dias, Gonzaga, Gheyi & Souza Neto, 2010; De Andrade et al., 2012).

The height of the plant (AP) is a parameter of great importance for the production of cut flowers, since the longer length of the floral stem, added to the good quality and durability of the flowers, provides more options for use in ornamentation and decoration and, consequently, greater economic value to the product. No significant effect was identified among the mean height of plants irrigated with water supply or with dilutions of treated domestic effluent, which shows that the effluent, in the dilutions used, met the nutritional demand of the crop, even with the 50% reduction of the recommendation of nitrogen and potassium (Table 4). Other researchers (De Andrade et al., 2012; De Freitas et al., 2012; De Souza et al., 2010) observed...
significant differences between PA averages in irrigated sunflowers with different types of water, obtaining increases in the height of plants irrigated with wastewater compared to those irrigated with water supply.

The exuberance of the foliage highlights the anturium among other ornamental plants and highlights the importance of proper nitrogenous fertilization, since the imbalance of this nutrient decreases the synthesis of cytokinins, which are phytohormones promoting the vigorous growth and durability of the plant, and the nitrogen deficiency anticipates the senescence of the leaves (Mengel & Kirkby, 1987).

The number of leaves (FN) did not differ between the evaluated treatments and the overall mean FN obtained at 90 days after transplantation was 4.30 (Table 4). Morais et al. (2017) when assessing the potential of four accesses of the species of Anthurium plowmanii, A. raimmundii, A. bonplandii and A. Affine for the production of cut foliage observed that the average production of plant leaves per year ranged from 6.6 (A. plowmanii) to 10.5 (A. bonplandii). On the contrary, Maitan and Jasmine (2020) evaluating the development of Anthurium solitarium grown on different substrates, observed that NF was higher in plants grown on bamboo compound substrates, which may have been due to higher levels of macro and micronutrients in these substrates, especially nitrogen.

The foliar area (PA) is also an important parameter for evaluating plant growth, since photosynthesis depends on intercepting light energy and converting it into chemical energy, and consequently, greater dry mass of the leaves, as a consequence of the increase in respiratory rate (Saquet, Streif & Bangerth, 2000), which combined with the supply of nutrients for the other metabolic processes results in adequate plant growth. In the evaluation of the PA of the plants, the similarity between the means of the treatments shows that the treated domestic effluent met the demand for nutrients for cultivation even with the mineral fertilization reduced by half, when compared to the plants irrigated with water supply and fertilized with 100% of the recommendation of mineral fertilizer (Table 4).

Even with the reduction in the supply of phosphorus and potassium in the treatments with the dilutions of domestic effluent treated in water supply, there was no significant difference between the averages for all the variables evaluated, which is probably due to a greater availability of nutrients for the plants present in the effluent, in particular nitrogen, since this nutrient is the one that most limits production, providing a reduction of up to 60% in productivity as a result of its deficiency (Smiderle, Gianluppi D. & Gianluppi V., 2003). Prado and Leal (2006), studying nutritional deficiencies in the sunflower culture, found that the nitrogen deficiency significantly reduced the development of the plants, affecting the number of leaves, the height, the diameter of the stalk and the foliar area. In addition, the wastewater contains phosphorus and potassium, which also contributes to the good development of plants (De Souza et al., 2010).

The results obtained permit the recommendation of the use of treated domestic effluent for the cultivation of anturium, strengthening the importance of taking advantage of the content of nutrients (macro- and micro-nutrients) present in the residual water, in such a way as to partially replace the mineral fertilizer, favoring the economy of good quality water and of mineral fertilizers, besides providing a destination for the effluent, avoiding the inadequate discarding, with a consequent contamination of the water resources, and the economy with costs for treating this waste.

5 FINAL CONSIDERATIONS

The plants irrigated with the dilution of treated domestic effluent and fertilized with 50% of the nitrogen and potassium recommendation showed growth and production similar to the plants irrigated with water supply and fertilized with 100% of the mineral fertilizer
recommendation, which shows that it is possible to substitute the water supply with treated domestic effluent, for irrigation together with the reduction of 50% of the recommendation of mineral fertilization with nitrogen and potassium without impairing the growth and production of the anturium plants. These results make it possible to carry out new research in order to adjust the concentrations of treated domestic effluent for irrigating anturium and other ornamental species, with a guarantee of the response of the plants as to growth and productivity, and with certainty for the producers and for the environment.

Therefore, research is recommended on the possibility of using different substrates and dilutions of treated household effluent in different ornamental species.

REFERENCES


Domestic Effluent Treated for the Cultivation of Anthurium (*Anthurium andraeanum* Lind.)


