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BIOMASS AND ESSENTIAL OIL PRODUCTION OF BASIL AT RECIRCULATION INTERVALS OF NUTRIENT SOLUTIONS PREPARED WITH TREATED DOMESTIC EFFLUENTS

Lucylia Suzart ALVES[1], Hans Raj GHEYI[2], Mairton Gomes da SILVA[3], Vital Pedro da Silva PAZ[3]

[1] Private Practice, Feira de Santana, Bahia, Brazil.
[2] Center of Technology and Natural Resources, Federal University of Campina Grande, Campina Grande, Paraíba, Brazil.
[3] Soil and Water Engineering Nucleus, Federal University of Recôncavo da Bahia, Cruz das Almas, Bahia, Brazil.

Corresponding author:
Mairton Gomes da Silva
mairtong@hotmail.com

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Abstract
Considering the growing water crisis, using wastewater helps reduce the pressure on good-quality water consumption. In this context, this study aimed to evaluate the growth, production, and essential oil content of Alfavaca Basilicão and Grecco a Palla basil genotypes with a DFT (deep flow technique) hydroponic system adapted to PVC tubes at different recirculation intervals of nutrient solutions prepared with treated domestic effluents. The experiment was performed in a greenhouse with Alfavaca Basilicão and Grecco a Palla basil genotypes analyzed individually. It was a completely randomized design with four replicates in a 2 x 3 factorial scheme: two types of water (public-supply water and wastewater) and three recirculation intervals of nutrient solutions (2, 4, and 6 hours). At 35 days after transplanting, the study evaluated plant height, stem diameter, shoot fresh mass, shoot dry mass, water consumption, water use efficiency, and essential oil content and yield. The types of water did not significantly influence the variables of growth, production, and essential oil content of the basil genotypes. Basil cultivation with the DFT system in tubes is technically feasible with nutrient solutions prepared with treated domestic effluents and recirculation every 2 and 6 hours for Grecco a Palla and Alfavaca Basilicão genotypes, respectively. The means of essential oil content were 1.6 and 1.7% (v/m) for Alfavaca Basilicão and Grecco a Palla genotypes, respectively.

Keywords: *Ocimum basilicum*. *Ocimum minimum*. Soilless Cultivation. Water Resources. Wastewater.

1. Introduction

The agricultural sector represents around 70% of global water consumption (Tahtouh et al. 2019). Considering the population growth, the challenge of current agriculture is increasing crop production (Fuentes-Castañeda et al. 2016) in terms of quality and quantity, under water scarcity (Costa et al. 2020; Santos et al. 2021), while the demand for food is increasingly higher (Mkhwanazi and Vilane 2018; Suthar et al. 2018).

In this context, other lower-quality water sources such as wastewater (Al-Khamisi et al. 2018) have been used in irrigation (Santos Júnior et al. 2016a; Abd-Elwahed 2018; Guimarães et al. 2018; Souza et al. 2018). Besides water provision, these sources also offer nutrients to plants (Trinh et al. 2013; Dantas et al. 2018; Rêgo et al. 2019; Xavier et al. 2019).

In traditional soil cultivation, the incorrect management of these waters may create a source of contamination for irrigators, which according to Rababah (2007), may cause serious health problems from consuming irrigated produce. According to Xavier et al. (2018), the regulations for wastewater reuse specify microbiological quality standards, recommending the minimum treatment required for effluents, the type of crop to be irrigated, and irrigation methods.

An environmentally and sanitarily viable solution for the destination of wastewater is cultivation under hydroponic conditions. In hydroponics, according to Cuba et al. (2015), the plant shoot is not contaminated because the effluent is only in contact with the roots in a closed channel.

Hydroponic cultivation can be an alternative for small farmers in rural communities in the Brazilian semiarid region, considering that cultivation can be performed in small areas, allowing good-quality production throughout the year. According to Cuba et al. (2015), the production infrastructure can be installed near wastewater treatment plants, thus reducing costs with effluent transportation.

The NFT (nutrient film technique) system is the most used in hydroponic cultivation (Zanella et al. 2008; Silva et al. 2020a). However, there is an unreliable source of energy supply in case of electricity failure, indispensable for nutrient solution circulation in hydroponic channels (Santos Júnior et al. 2015; Silva et al. 2016a; Roy et al. 2018), considering that even short failures may lead to total production loss (Fecondini et al. 2010). Hence, the DFT (deep flow technique) system adapted to tubes has emerged, maintaining nutrient solution levels during cultivation, thus meeting plant water needs in case of interruptions in the electricity supply (Silva et al. 2016a). Another advantage of this system is the electricity consumption savings because the interval of nutrient solution circulation does not need to be as short as in NFT (15 minutes).

The DFT system adapted to tubes has been used to cultivate different crops, such as coriander (Silva et al. 2016b; Silva et al. 2018; Silva et al. 2020b), ornamental sunflower (Santos Júnior et al. 2016bc; Souza et al. 2020), lettuce (Cova et al. 2017; Freitas al. 2021), bell pepper (Furtado et al. 2017), rocket (Campos Júnior et al. 2018), endive (Alves et al. 2019a; Silva et al. 2020a), basil (Alves et al. 2019b; Azevedo Neto et al. 2019; Gonçalves et al. 2019; Silva et al. 2019; Alves et al. 2021), chives (Silva Júnior et al. 2019), and parsley (Martins et al. 2019).

In northeast Brazil, basil is used for cooking, especially its fresh leaves (Maia et al. 2017). Basil leaves are also used to extract an essential oil rich in phenolic compounds with multiple uses in food, cosmetic, perfume, and pharmaceutical industries (Bernstein et al. 2010; Heidari 2012), and linalool, one of the most appreciated components of the essential oil (Luz et al. 2009; Huang et al. 2011; Veloso et al. 2014).

Given the above, the present study aimed to evaluate the growth, biomass production, essential oil content and yield, water consumption, and water use efficiency of basil grown with a DFT hydroponic system adapted to tubes at different recirculation intervals of nutrient solutions prepared with treated domestic effluents.

2. Material and Methods

The study was conducted with two basil genotypes – Alfavaca Basilicão (*Ocimum basilicum* L.) and Grecco a Palla (*Ocimum minimum* L.) - under hydroponic conditions in a greenhouse from July to September 2015. The greenhouse was 7.0-m-wide and 24.0-m-long, with a ceiling height of 2.8 m, protected on the sides by a black screen (50% light intensity), and covered on the top with 150-µm-thick polyethylene film. The facilities are part of the experimental area of the Graduate Program in Agricultural Engineering at the Soil and Water Engineering Nucleus of the Federal University of Recôncavo da Bahia/UFRB, in Cruz das Almas, Bahia, Brazil (12º 40’ 19” S, 39º 06’ 23” W, altitude of 220 m above mean sea level).

Two basil genotypes were analyzed individually in a completely randomized design, in a 2 x 3 factorial scheme with four replicates, each consisting of 12 plants: two types of water (public-supply water and wastewater) interacting with three recirculation intervals of nutrient solutions (2, 4, and 6 hours). These waters were used to prepare the nutrient solution and replace the water volume consumed. The nutrient solution was recirculated in the hydroponic channels automatically with analog timers, one for each recirculation interval treatment, and each event lasted 15 minutes.

The hydroponic channels were made of PVC tubes with a nominal diameter of 0.075 m, arranged at zero-slope, forming an approximately 0.02-m-deep layer of solution. The channels were 6-m-long and spaced at 0.30 m on the cultivation bench. Plants were spaced in the channels at 0.20 m and planted in circular holes of 0.05 m in diameter.

Each plot was represented by an independent hydroponic channel and composed of a plastic tank (60-L capacity) to store the nutrient solution equipped with a float valve that allowed maintaining a constant volume of solution (50 L) and an electric pump for the circulation of nutrient solution to the channel. Each plot also had an individualized supply system to refill the water consumed by plants. This supply system consisted of a 0.15-m-diameter PVC tube with a capacity of 15 L, a graduated scale fixed outside, next to a transparent tube installed vertically to read the water level in the supply system.

On July 27, 2015, seeds of Alfavaca Basilicão and Grecco a Palla basil genotypes were sown in phenolic foam (2.0 cm x 2.0 cm x 3.8 cm), placing one seed per cell and covering it with vermiculite. In the first 15 days after sowing, irrigations were performed with local supply water at electrical conductivity (ECw) of 0.25 dS m^{-1}. Then, the seedlings were transferred to a nursery (NFT system) to receive the nutrient solution at 50% strength, according to Furlani et al. (1999). The irrigations in the nursery were controlled with an analog timer at intermittent 15-minute intervals, from 6 a.m. to 6 p.m. From 6 p.m. to 6 a.m., the nutrient solution was recirculated once every 2 hours for 15 minutes.

The seedlings remained in the nursery for 15 days and were then taken to the definitive cultivation system. The central part of each hydroponic channel received 12 seedlings of each basil genotype, using a nutrient solution of 100% strength (Furlani et al. 1999).

In the cultivation phase, the nutrient solutions were prepared with the waters of the respective treatments (supply water or treated domestic effluent). The wastewater came from the Sewage Treatment Plant (ETE) of the Bahia State Water and Sanitation Company (EMBASA), located in Muritiba, Bahia, Brazil. The effluents arriving at the ETE undergo primary treatment in a grid system to retain large solids. Subsequently, secondary treatment is performed in upward-flow anaerobic digestion chambers, a stabilization pond, and a drying bed. The physicochemical properties of the waters were analyzed at the Sanitation Laboratory of the Federal University of Campina Grande, Paraíba, Brazil, obtaining the following results: pH = 7.16; EC = 1.0 dS m^{-1}; constituents (mg L^{-1}): P = 0.05; K^+ = 29.32; N_{total} = 21.85; Na^+ = 138; Ca^{2+} = 15; Mg^{2+} = 18.96; Cl^- = 175.83; HCO_3^- = 238.51; SO_4^{2-} (absent); CO_3^{2-} (present, traces); SAR = 5.55 (mmol $L^{-1})^{0.5}$. Supply water showed the following results: pH = 6.41; EC = 0.25 dS m^{-1}; constituents (mg L^{-1}): P = (traces); K^+ = 6.63; N_{total} = (traces); Na^+ = 39.79; Ca^{2+} = 20.40; Mg^{2+} = 21.12; Cl^- = 66.38; HCO_3^- = 25.01; SO_4^{2-} (present, traces); CO_3^{2-} (absent); SAR = 2.93 (mmol $L^{-1})^{0.5}$.

Nutrient solutions were prepared by dissolving fertilizer salts in the supply water and wastewater according to recommendations by Furlani et al. (1999), resulting in electrical conductivity values of the solutions (ECsol) of 2.23 and 2.98 dS m^{-1} and pH of 5.8 and 6.2, respectively. The nutrient solutions were distributed in the tanks of the hydroponic plots. During the experiment, pH and ECsol were monitored every two days. When the pH values were outside the ideal range (between 5.5 and 6.5) for hydroponic cultivation, corrections were made by adding 30% HCl or sodium hydroxide (20 g L^{-1}).

At the end of the experiment, the ECsol values for cultivation with supply water were 1.49, 1.60, and 1.41 dS m^{-1} (Grecco a Palla genotype) and 1.65, 1.62, and 1.60 dS m^{-1} (Alfavaca Basilicão genotype), respectively, at recirculation intervals of 2, 4, and 6 hours, without any nutrient addition to the solution during the cycle. For wastewater, these values corresponded to 2.27, 2.25, and 2.36 dS m^{-1} (Grecco a Palla genotype) and 2.26, 2.57, and 2.48 dS m^{-1} (Alfavaca Basilicão genotype), respectively.

At 35 days after transplanting (DAT), 12 plants were harvested and evaluated for plant height (PH), stem diameter (SD), and shoot fresh mass (SFM). The PH was measured by the distance between the collar and stem apex. The SD was measured in the collar region using a digital caliper. Shoot dry mass (SDM) was obtained after drying the aerial parts of the plant in a forced-air circulation oven at 45ºC until constant weight. The SFM and SDM values were determined on a precision scale (0.01 g).

For determining water consumption (WC), the water levels in the supply tanks were read daily at a preset time to estimate the consumed volume, according to Equation 1. The WC was accumulated for 35 days and WC was based on the consumed volume in the plot divided by the number of plants. Water use efficiency (WUE) was also determined from the relationship between mean production (SFM or SDM) and accumulated WC per plant (Equation 2).

$$V_{ETC} = \frac{(R_f - R_i)\ x\ \pi\ x\ D^2}{4\ x\ n\ x\ \Delta T}\ x\ 10^3 \qquad (1)$$

$$WUE\ (g\ L^{-1}) = \frac{SFM\ or\ SDM}{WC} \quad (2)$$

Where: V_{ETC} is the evapotranspired volume or WC, L plant^{-1} day^{-1}; R_f and R_i are the final reading (after replenishment) and initial reading (before replenishment) of water level in the supply tank, m; D is the internal diameter of the supply tank, m; ΔT is the time interval between readings, days; n is the number of plants in the cultivation channel.

The essential oil was extracted by hydrodistillation in 30 g of leaf dry mass, following the method described by Alves et al. (2015). The distillation time (2 hours) was counted from the first drop of essential oil deposited in the collector. The final volume of the extracted essential oil was verified in a Clevenger-type apparatus. Essential oil content and yield were calculated from the volume and leaf dry mass (LDM) data.

The statistical analysis was performed separately for each basil genotype. The data were subjected to analysis of variance by the F test, and when significant, the means were compared with Tukey's test at a 0.05 probability level.

3. Results

The Alfavaca Basilicão genotype did not show a significant effect of isolated factors or their interaction on any variable (Table 1). The type of water significantly affected ($p<0.05$) WUE based on the SFM of the Grecco a Palla genotype, and the recirculation intervals of nutrient solutions caused a significant effect on SD, SFM, SDM, WC, and WUE on an SFM basis.

Table 1. Summary of the F test of the analysis of variance for plant height (PH), stem diameter (SD), shoot fresh mass (SFM), shoot dry mass (SDM), water consumption (WC), and water use efficiency (WUE) of the SFM (WUE-SFM) and SDM (WUE-SDM) of Alfavaca Basilicão and Grecco a Palla basil genotypes, using supply water and wastewater, at different recirculation intervals of nutrient solutions (RINS) with the DFT hydroponic system, 35 days after transplanting.

Source of variation	F-test						
	PH	SD	SFM	SDM	WC	WUE-SFM	WUE-SDM
	Alfavaca Basilicão						
Water (W)	ns	ns	ns	ns	ns	ns	ns
RINS	ns	ns	ns	ns	ns	ns	ns
W x RINS	ns	ns	ns	ns	ns	ns	ns
CV (%)	5.66	9.58	26.00	38.07	16.76	13.56	25.16
	Grecco a Palla						
Water (W)	ns	ns	ns	ns	ns	*	ns
RINS	ns	*	**	*	*	*	ns
W x RINS	ns	ns	ns	ns	ns	ns	ns
CV (%)	10.58	12.87	29.20	34.76	27.97	9.48	17.11

* and ** significant at 0.05 and 0.01 probability levels, respectively; ns – not significant; CV – coefficient of variation.

The PH values 35 days after transplanting were 58.1 and 27.6 cm for Alfavaca Basilicão and Grecco a Palla basil genotypes, respectively (Table 2). These findings are consistent with the harvest recommendations of heights over 20 and 50 cm for Grecco a Palla and Alfavaca Basilicão genotypes. The mean SD of the Alfavaca Basilicão genotype was 10.3 mm (Table 2). For Grecco a Palla, regardless of the type of water, the SD was 7.4 mm. As for recirculation intervals, SD was approximately 19% lower when the nutrient solution was recirculated in the hydroponic channels every 4 hours than at a 2-hour interval (mean of 8.3 mm).

As for basil production (Table 2), the means of SFM and SDM of the Alfavaca Basilicão genotype were 153.7 and 14.0 g plant^{-1}, regardless of the type of water and recirculation intervals of nutrient solutions. For the Grecco a Palla genotype, regardless of the water used, the means of SFM and SDM were 198.9 and 14.5 g plant^{-1}. Regarding the effect of recirculation intervals on this genotype, the highest SFM and SDM production values were obtained at 2-hour intervals, resulting in 260.6 and 18.4 g plant^{-1}, respectively. The intervals of 4 and 6 hours did not show differences between the SFM and SDM production values. On average, SFM and SDM were 35.5 and 29.8% lower at these intervals than at the 2-hour interval.

Table 2. Mean values of plant height (PH), stem diameter (SD), shoot fresh mass (SFM), shoot dry mass (SDM), water consumption (WC), and water use efficiency (WUE) based on the SFM (WUE-SFM) and SDM (WUE-SDM) of Alfavaca Basilicão and Grecco a Palla basil genotypes, using supply water and wastewater, at different recirculation intervals of nutrient solution (RINS) with the DFT hydroponic system, 35 days after transplanting.

Source of variation	PH	SD	SFM	SDM	WC	WUE-SFM	WUE-SDM
	cm	mm	g plant^{-1}		L plant^{-1}	g L^{-1}	
Water types	Alfavaca Basilicão						
Public-supply	59.4^{A}	10.1^{A}	156.8^{A}	13.5^{A}	5.8^{A}	26.6^{A}	2.3^{A}
Wastewater	56.7^{A}	10.4^{A}	150.7^{A}	14.4^{A}	5.9^{A}	25.3^{A}	2.4^{A}
RINS							
2 hours	58.2^{A}	10.6^{A}	171.3^{A}	16.0^{A}	6.2^{A}	27.4^{A}	2.5^{A}
4 hours	57.6^{A}	10.2^{A}	146.4^{A}	13.4^{A}	5.8^{A}	24.8^{A}	2.2^{A}
6 hours	58.5^{A}	10.0^{A}	143.4^{A}	12.6^{A}	5.6^{A}	25.5^{A}	2.2^{A}
Water types	Grecco a Palla						
Public-supply	28.8^{A}	7.5^{A}	216.4^{A}	17.7^{A}	5.6^{A}	38.5^{A}	2.7^{A}
Wastewater	26.3^{A}	7.4^{A}	181.5^{A}	15.3^{A}	5.1^{A}	34.9^{B}	2.6^{A}
RINS							
2 hours	29.1^{A}	8.3^{A}	260.6^{A}	20.6^{A}	6.6^{A}	38.9^{A}	2.7^{A}
4 hours	25.8^{A}	6.7^{B}	150.3^{B}	14.0^{B}	4.4^{B}	34.0^{B}	2.6^{A}
6 hours	27.9^{A}	7.4^{AB}	185.8^{B}	14.9^{B}	5.0^{AB}	37.3^{AB}	2.7^{A}

Means followed by the same letter in the columns do not differ statistically by Tukey's test at a 0.05 probability level.

The mean values of WC and WUE based on SFM and SDM of the Alfavaca Basilicão genotype were 5.9 L plant^{-1}, 25.9, and 2.3 g L^{-1}, respectively, during the cultivation cycle of 35 days (Table 2). For the Grecco a Palla genotype, WC was 5.4 L plant^{-1}, regardless of the type of water, and the overall mean WUE based on SDM was 2.7 g L^{-1}. Conversely, based on SFM, the WUE (38.5 g L^{-1}) was higher when preparing the nutrient solution with supply water and approximately 9% lower when using treated domestic effluents (Table 2). As for recirculation intervals, the WUE based on SFM was approximately 13% lower at a 4-hour interval than at a 2-hour interval (38.9 g L^{-1}), meaning that this decrease was influenced by the reductions in SFM production and water consumption.

As for the essential oil of basil, there was no significant effect ($p>0.05$) of the types of water on oil content and yield (Table 3). The recirculation intervals of nutrient solution showed a significant effect ($p<0.05$) on the oil yield of the Grecco a Palla genotype due to the significant effect on its SDM, considering that such yield was the product between leaf dry biomass and oil content.

The content and yield of the essential oil were 1.6% (v/m) and 1.7 mL plot^{-1} (12 plants) for the Alfavaca Basilicão genotype (Table 3). For the Grecco a Palla genotype, the mean oil content was 1.7% (v/m). The mean value for the oil yield of the Grecco a Palla genotype was 1.9 mL plot^{-1} (12 plants), regardless of the type of water. The highest oil yield was recorded at the recirculation interval of 2 hours (2.5 mL plot^{-1}), significantly higher (66.7%) than the 4-hour interval (1.5 mL plot^{-1}).

4. Discussion

The lack of a significant effect of the types of water on the evaluated variables of basil genotypes (Table 2 and Table 3) indicates that using treated domestic effluents to prepare the nutrient solution for cultivation under hydroponic conditions is technically feasible. These results agree with those of other researchers such as Bressan (2015), who did not find significant changes in growth variables (plant height, stem diameter, leaf area, and the number of leaves) and production variables (fresh mass of leaves and stems) of Genovese basil cultivated in pots with soil and irrigated with waters of different qualities, including reuse water. Riera-Vila et al. (2019) cultivated basil in pots with peat substrate and reported a higher yield when irrigating plants with wastewater than only with supply water without nutrients.

Table 3. Summary of the F test of the analysis of variance and mean values of oil content (OC) and the oil yield (OY) of Alfavaca Basilicão and Grecco a Palla basil genotypes, using supply water and treated domestic effluents, at different recirculation intervals of nutrient solution (RINS) with the DFT hydroponic system in PVC tubes, 35 days after transplanting.

Source of variation	F-test			
	OC	OY	OC	OY
	Alfavaca Basilicão		Grecco a Palla	
Water (W)	ns	ns	ns	ns
RINS	ns	ns	ns	*
W x RINS	ns	ns	ns	ns
CV (%)	16.59	37.81	14.88	27.05
	Means#			
	(%)	(mL plot^{-1})$^{+}$	(%)	(mL plot^{-1})
Water types				
Public supply	1.5^{A}	1.6^{A}	1.6^{A}	1.9^{A}
Wastewater	1.6^{A}	1.8^{A}	1.8^{A}	2.0^{A}
RINS				
2 hours	1.6^{A}	2.0^{A}	1.8^{A}	2.5^{A}
4 hours	1.5^{A}	1.5^{A}	1.6^{A}	1.5^{B}
6 hours	1.7^{A}	1.7^{A}	1.7^{A}	1.8^{AB}

* significant at a 0.05 probability level; ns – not significant; CV – coefficient of variation; # means followed by the same letter in the columns do not differ statistically by Tukey's test at a 0.05 probability level; + the plot consisted of 12 plants.

Other studies with lettuce cultivated with the NFT hydroponic system (Cuba et al. 2015) and in pots with coconut fiber (Fonteles et al. 2015), and ornamental sunflower (Souza et al. 2018; Souza et al. 2020) and basil (Alves et al. 2019b) cultivated with the DFT hydroponic system in PVC tubes, showed that using wastewater to prepare the nutrient solution was feasible for these species.

Considering the genetic character of the studied basil genotypes, Alfavaca Basilicão preferentially grew vertically, while Grecco a Palla spent energy producing lateral branches. Other studies have reported the increased height of the Alfavaca Basilicão genotype (Menezes et al. 2017; Gondim Filho et al. 2018; Santos 2019), showing mean height values of 51.2, 60.2, and 68.7 cm at 17, 28, and 60 DAT, respectively, in the control treatment (nutrient solution prepared with supply water) under hydroponic and semi-hydroponic conditions.

Besides the increased height of Alfavaca Basilicão plants (Table 2), there was also a higher stem expansion. The SD is a significant variable for hydroponic cultivation because the weight of the aerial part may cause the lodging of plants in the cultivation channels (Gondim Filho et al. 2018) or due to thin stems (Menezes et al. 2017). Gondim Filho et al. (2018) observed a higher SD value (11.5 mm) for the Alfavaca Basilicão genotype and a lower one (6.3 mm) for Grecco a Palla. In contrast, Santos (2019) did not report significant differences between mean SD values for the Grecco a Palla genotype (9.6 mm) and Alfavaca Basilicão (8.1 mm), under semi-hydroponic conditions using coconut fiber as substrate.

The negative effect of recirculation intervals of 4 and/or 6 hours on the evaluated variables of the Grecco a Palla genotype (Table 2) may have occurred because of the absence or low content of dissolved oxygen (parameter not quantified) from the increase in both the volume of roots in the cultivation channel and/or the temperature during the hottest hours of the day. Several authors (Kiferle et al. 2012; Niñirola et al. 2014; Silva et al. 2016a; Silva et al. 2020b) have stated that one concern with the DFT system is hypoxia, that is, insufficiency of adequate levels of dissolved oxygen for plant development due to the gradual consumption of oxygen dissolved in the nutrient solution.

The adequate oxygenation level of nutrient solutions for plant development varies according to the species and within the same species, as observed in the present study where recirculation intervals did not hinder the production of the Alfavaca Basilicão genotype (Table 2). These results reinforce those by Santos et al. (2019), who used the DFT hydroponic system in PVC tubes and did not find significant changes in the variables of growth and production of Toscana Folha de Alface basil at recirculation intervals of 4 and 6 hours.

Recirculation intervals highly depend on the time of year due to temperature variations. For instance, Silva Júnior et al. (2019) recorded reductions of approximately 17 and 4% in the SFM production of chives in the summer and autumn, respectively, when recirculation was performed twice a day, compared to three times a day in cultivation with solutions prepared with supply water.

The SFM of 260.6 g plant^{-1} obtained for the Grecco a Palla genotype (Table 2) is compatible with the reports by Bione et al. (2014a) for basil plants under hydroponic conditions (NFT system) at 49 DAT (230 g plant^{-1}). Although the genotype was not informed, the plants had similar foliage characteristics to Grecco a Palla. Santos (2019) found a lower SFM production in basil cultivation with coconut fiber substrate than in the present study, with approximately 150 g plant^{-1} (leaves and stems) for Alfavaca Basilicão and Grecco a Palla genotypes at 60 DAT.

In Brazil, basil leaves can usually be marketed fresh or dried, mainly for condimental purposes (Palaretti et al. 2015). In conventional cultivation, basil is exploited with extractivism, with periodic plant harvests (Amaro et al. 2012). Over time, this harvest intensity may reduce the quality and yield of plants, making their cultivation economically unfeasible. Unlike traditional cultivation, harvesting under hydroponic conditions can be performed early, consequently allowing more harvests throughout the year and reducing the risks of low production and quality because a new nutrient solution may be used for each new cultivation.

Over a period (from 14 to 48 DAT) similar to that of the present study, Bione et al. (2014b) recorded a higher water consumption of basil with the NFT hydroponic system, approximately 9.0 L plant^{-1} (solution prepared with supply water). In the study by Alves et al. (2019b) with basil cultivated with DFT hydroponic systems in PVC tubes and NFT, the WC of Alfavaca Basilicão and Grecco a Palla genotypes did not exceed 4.0 L plant^{-1} (solution prepared with treated domestic effluents).

Overall, the WC values of the basil genotypes of the present study were within the same magnitude. In this case, the higher means of WUE based on SFM of the Grecco a Palla genotype are due to the higher fresh biomass production. The quantification of WC during the crop cycle allows knowing in advance the amount of water required to prepare the nutrient solution and replace the consumed water before starting cultivation.

As for the essential oil of basil, studies by Alves et al. (2015) and Fattahi et al. (2019) in pots with soil, Alcantara et al. (2018) in the field, and Gondim Filho et al. (2018) with the DFT hydroponic system in PVC tubes, found that the essential oil content of basil (*Ocimum basilicum* L.) did not exceed 1% using supply water for either irrigation or nutrient solution preparation. These values are lower than those recorded in the present study (Table 3).

5. Conclusions

The municipal supply water and treated domestic effluents used to prepare the nutrient solutions did not influence the evaluated variables of Alfavaca Basilicão and Grecco a Palla basil genotypes.

It is technically feasible to use treated domestic effluents to prepare nutrient solutions for the hydroponic cultivation of basil.

The Grecco a Palla genotype was more sensitive to the recirculation interval of nutrient solutions, obtaining higher mean values of growth variables and production of phytomass and essential oil at the 2-hour interval.

The studied factors did not influence the essential oil content in the basil genotypes.

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