Content of basil essential oil on a loam texture soil under water regimes and different harvest stages

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Abstract

The essential oil of basil (Ocimum basilicum L.) has high economic value and is produced in the plant by secondary metabolism. Its quantity and composition tend to vary as a response of the plant to stress situations due to changes in the environment and phenological phase. This work aimed to evaluate the development, the chemical composition, content, and the yield of essential oil of basil rich in Linalool, as a function of the soil water tensions and the harvest stages, in a loam texture soil. The experiment was carried out in a greenhouse and consisted of three harvest times (BF - beginning of flowering, FF - full flowering, and EF - end of flowering) and five values of soil water tension to define when to irrigate (20, 30, 40, 50, and 60 kPa), totalizing 15 treatments. The irrigation in the soil water tension of 60 kPa generated a reduction in the content and the yield of essential oils compared with 20 kPa, only in the FF harvest stage. However, it did not modify the composition of the essential oil. Regardless of the soil water tension to define irrigation, the highest levels and yields of essential oil were found in the EF harvest stage. Harvest stages did not change the composition of the essential oil or the content of Linalool. In turn, the contents of the components Cineol, Camphor, ∝-Terpeneol, and Isobornyl acetate increased with the harvesting period from BF to EF. Eugenol had the opposite trend, reducing the content from BF to EF. Linalool, a component in greater proportion in essential oil, showed a higher content in soil water tensions up to 50 kPa, decreasing only by 60 kPa. In loam textured soils, it is recommended that basil producers, who aim to extract Linalool, irrigate when the soil water tension reaches up to 50 kPa, with the harvest at any stage of flowering.

Keywords: medicinal plant; essential oil; hydric stress; linalool; irrigation.;

1. Introduction

Basil is a herbaceous plant present in almost all regions of the world and has several uses, from the consumption of its leaves, in natura or dried, as a food flavoring [1], as a plant for medicinal use [2] and also for the extraction of its essential oil for application in the pharmaceutical, chemical, and cosmetics industries [3]; [4]; [5]; [6].

Basil is considered a medicinal plant due to the presence of essential oil in its leaves and inflorescences, and the concentration may vary according to the variety, climate, region, and harvest stage [7]; [8]. The substances found in the essential oil vary according to the basil genotypes. In Australia, some varieties presented methyl chavicol and linalool as main components, in several concentrations [9]. In India, the varieties were rich in methyl chavicol [10]. In Brazil, some varieties have linalool as the main component [11]; [12], being the Ocimum basilicum the most cultivated lamiacea [13].

The essential oils are extremely concentrated, hydrophobic, and extracted through distillation by steam drag [14]. It is estimated that 250,000 tons of essential oils are produced worldwide [15]. The global production of basil essential oil is in the range of 50 to 100 tons per year [14], having a high market value and generating profitability for the producer. The essential oil of Ocimum basilicum is produced in the plant by secondary metabolism and its quantity and composition
tend to vary as a response of the plant to situations of stress due to changes in the environment and

phenological phase [16]; [17].

The occurrence of stress due to hydric excess or deficiency is one of the major factors responsible for changes in the production and development of medicinal plants, directly affecting height, stem diameter, number of leaves, leaf area and dry and fresh mass, which are the parts used to extract the essential oil. Several authors observed variations in the growth of basil plants when subjected to water stress, resulting in a reduction in the size of the plant and consequently a reduction in the fresh and dry mass of the basil [18]; [19]; [20]; [21]; [22]. [23] observed that nutrition, irrigation, and harvest stage were the factors that most influenced the basil plant development.

The hypotheses of this study were the following: H1- hydric stress increases the content and yield and modifies the basil essential oil composition; H2 - the harvesting stage affects basil essential oil content and composition.

The objective of this research was to evaluate the basil essential oil content, yield, and composition, under different soil water tensions and harvesting stages, in a loam soil texture.

2. Materials and Methods

2.1 Experimental area

This work was carried out in pots inside a greenhouse whose dimensions were 30 meters long, 7m wide and 6m high at the highest point. The period with irrigation differentiation occurred from September 10, 2016, to January 18, 2017.

The area is located in the Rural Engineering Department of the Faculty of Agronomic Sciences (FCA / UNESP), Botucatu - SP, Brazil, at geographic coordinates latitude 22 ° 51'03 ”South and longitude 48 ° 25'37” West, with 786 meters altitude.

2.2 Experimental treatments

The experiment consisted of 15 treatments composed of three harvest stages (BF - beginning of flowering, FF - full flowering, and EF - end of flowering) and five different soil water tensions (20, 30, 40, 50 and 60 kPa) to define when to irrigate. Each treatment had four repetitions, and each repetition was composed of four pots with three plants per pot, that is, one plant for each harvest stage. The experimental design was completely randomized, and the irrigation system was independent for each treatment.

2.3 Plants origin and crop management

The Basil IAC variety was supplied by IAC - Instituto Agronômico de Campinas and had Linalool as its primary component. The sweet basil seedlings were obtained by cutting and transplanted into 60-day-old pots. During the first 40 days after transplanting (DATP), the irrigation management was identical for all pots. It consisted of keeping the soil close to the field capacity, adopted as corresponding to the 10 kPa soil water tension, in order to guarantee the proper rooting of the crop.

The beginning of the application of treatments related to soil water tensions started at 40 DATP and extended during the 3 harvests that occurred at 70, 100, and 130 DATP, which corresponded, respectively, to the beginning of flowering, full flowering, and end of the flowering. Before each harvest, all treatments were irrigated to raise the soil water tension to 10 kPa, and then a plant was removed per pot. The height and diameter of the stem at the base were measured, separating the inflorescences and all heavy material for subsequent drying in a forced air circulation oven at 40 °C, to obtain the dry and fresh masses of the plants and extract the essential oil.

The irrigation management with the differentiation of treatments in five stresses started at 40 DATP and extended during the three harvests that occurred at 70, 100, and 130 DATP, which corresponded, respectively, to the beginning of flowering, full flowering, and end of flowering. Before each harvest, all treatments were irrigated to raise the soil water tension to 10 kPa, and then one plant was removed per pot. The plant height and diameter of the stem at the base were measured, separating the inflorescences and weighing the plant material for subsequent drying in an oven with forced air circulation at 40°C, to obtain the dry and fresh masses of the plants and extract the essential oil.

2.4 Meteorological data

Climatological data, such as air temperature and relative humidity inside the greenhouse, were measured with Campbell Scientific's meteorological station (Figures 1 and 2).

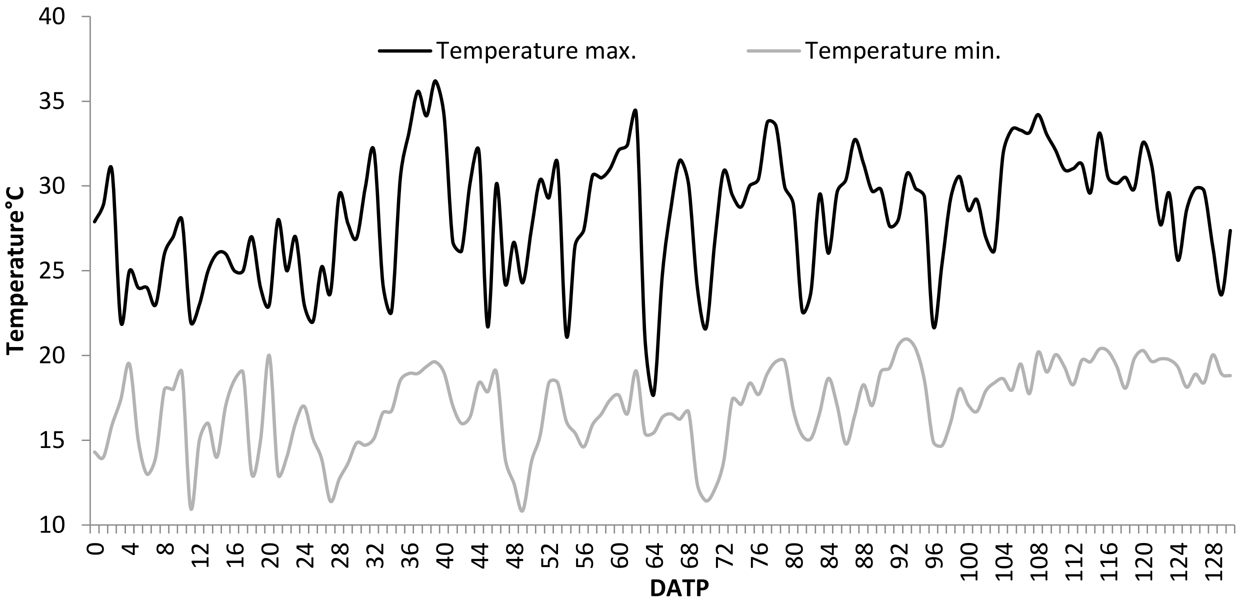

Figure 1 – Air temperature distribution during basil cycle in 2016 – 2017 (DATP: Days after transplantation).

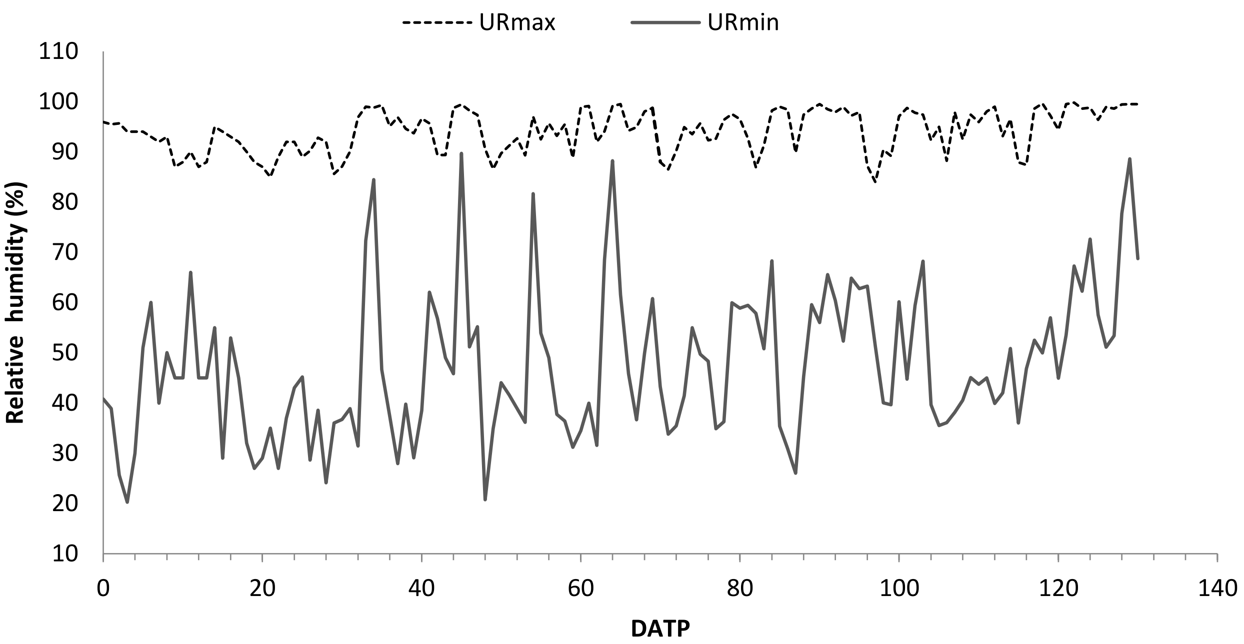

Figure 2 – Relative humidity distribution during basil cycle in 2016 – 2017 (DAPT: Days after transplantation).

2.5 Soil characteristics

The soil used was classified as distrophic red latosol (medium/loam) [24] and collected at the 0 – 20 cm deep layer, in a location with no agricultural presence or any soil handling in the last 10 years. The soil was sifted to remove vegetation and mineral residue, such as roots, stems, leaves, and rocks, and placed in 14-liter pots for subsequent pH correction and base fertilizing. Soil samples were collected, and the chemical characteristics were analyzed, according to [25], and the physical attributes with the methodology proposed by [26] (Tables 1 and 2).

Table 1 – Soil chemical analysis.

Soil Layer	pH	O.M.	P_{resin}	H+Al	K	Ca	Mg	SB	CEC	V%
	$CaCl_2$	g dm^{-3}	mg dm^{-3}	$mmol_c$ dm^{-3}						
0 – 20cm	4,1	16	4	77	0.7	3	1	5	81	5

O.M. - organic matter; Presin - phosphor in resin; SB - sum of bases; CEC - cationic exchange capacity, V% - Base saturation.

Table 2 – Soil physical analysis.

Layer	Sand (g kg^{-1})	Loam (g kg^{-1})	Silt (g kg^{-1})	Soil texture
0 – 20cm	652	291	57	Medium

From the chemical analysis results, the soil was corrected with dolomitic limestone to elevate the base saturation to 75%. The fertilization was performed with 30 mg of N per liter of soil (urea – 45%), 40 mg of K per liter of soil (white potassium chlorite) and 200 mg of P per liter of soil (super simple – 18%

of P_2O_5, 16% of calcium (Ca) and 8% of sulfur (S)).

The soil water retention curve was obtained with non-deformed samples and adjusted by the Soil Water Retention Curve (SWRC) software [27], presenting the following parameters for the equation [28]: $\alpha = 1.3011$; $m = 0.2656$; $n = 1.8482$; $\theta R = 0.1700$ cm³ cm-³; $\theta S = 0.599$ cm³ cm-³; Ym = 0.181. The volumetric soil water content in the field capacity was associated with the soil water tension of 10 kPa, corresponding to 0.30 cm³cm-³ (Figure 3). [29] found soil moisture values in the field capacity varying between 0.29 to 0.35 cm³cm-³ for medium-textured soils.

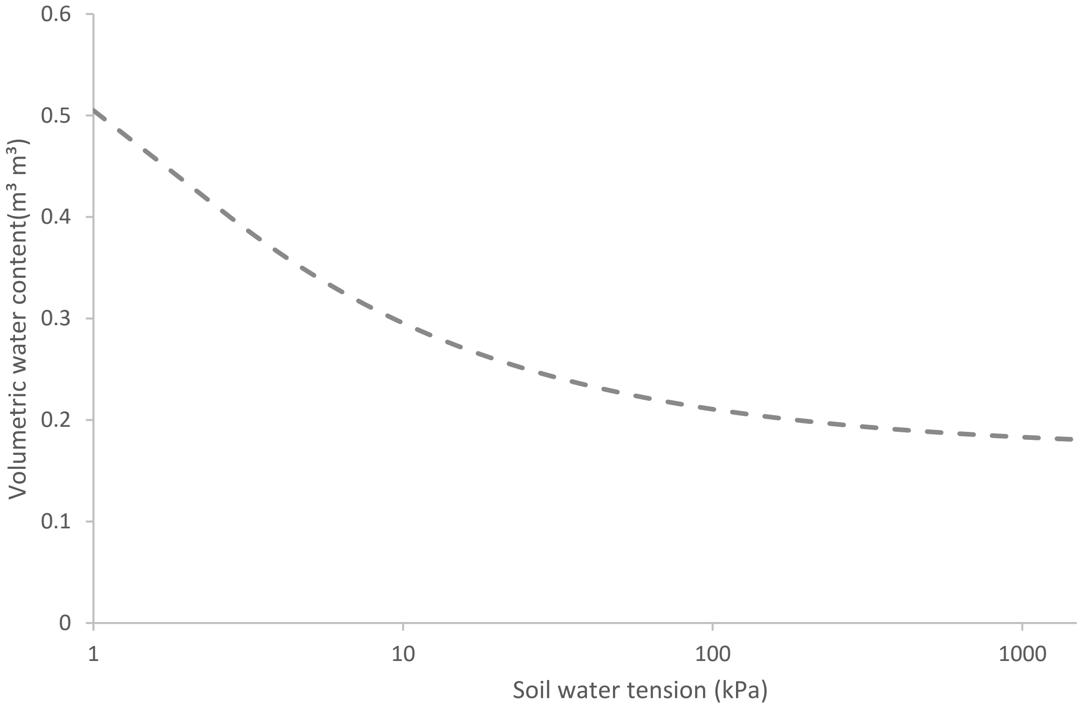

Figure 3 – Soil water retention curve.

2.6 Irrigation System

The basil plants were irrigated with a drip irrigation system, with one self-compensated dripper per pot, which applies a flow rate of 2 L h^{-1} in the pressure head range from 4 to 40 m.c.a. The service pressure for the system operation was 15 m.c.a., guaranteed by a pressure regulator in the pump output. A 4 mm microtube connected each dripper to a 16 mm lateral line, which in turn was supplied by a 25 mm manifold line. The system had a reservoir of 1000 L, and the motor pump used had a power of 0.5 HP regulated so that the operating pressure of the system operated at 0.147 MPa. For water filtration, 200-mesh disk filter was used to prevent the drippers from clogging.

The system uniformity test was performed on a test bench for drip line with the same dimensions of the system installed in the greenhouse and presented a Christiansen Uniformity Coefficient (CUC) of 98%.

2.7 Irrigation scheduling

The irrigation management was performed by tensiometry with four tensiometers per treatment, installed at 16 cm deep. For soil water tension readings, a digital tensiometer was adopted, with 0.1 kPa resolution, pre-calibrated in mercury column at 20, 30, and 40 cm. Irrigation occurred when at least three of the four tensiometers reached the preset irrigation tensions of 20, 30, 40, 50, and 60 kPa. The irrigation depth for each soil water tension (Table 3) was calculated based on the soil water retention curve, aiming to increase the soil moisture until the field capacity (corresponding to 10 kPa).

Table 3 – Irrigation depth and time for the evaluated soil water tensions.

	Soil water tension (kPa)				
	20	30	40	50	60
Irrigation depth (mL)	419	615	736	820	883
Irrigation time (min)	12.57	18.46	22.08	24.60	26.50

2.8 Evaluation of crop development

The crop development analyses were performed during harvest, starting from measuring the height of the plants from the soil base to the highest point. Then, these plants were cut close to the soil for measuring the diameter of the stem, separating and counting the number of inflorescences per plant and weighting in a precision scale (±0.1g), aiming to obtain the fresh mass of the plant and the inflorescences. The plants were placed in paper bags, and the drying process occurred at 40ºC until constant weight, in a greenhouse with forced air circulation. After drying, the dry matter mass and the essential oil content in the plant were determined.

2.9 Essential oil extraction and composition analysis

The essential oil extraction occurred in the aerial part of the plant, composed of stem, leaves, and inflorescences. The materials were chopped and weighed on a precision scale (±0,1g), put individually in 2 L volumetric balloons, and half-filled with deionized water. The hydrodistillation was performed in Clevenger type apparatus, for 2 hours. After the extraction of the essential oils, they were collected using a Pasteur glass pipette, stored individually in 2.5 mL amber-colored glass flasks, adequately identified, and weighted on a ±0,0001 g resolution/accuracy scale. The material was kept in a freezer at -4 ºC until the moment of the chemical composition analysis.

The essential oil content in percentage, which is the ratio between the mass of essential oil extracted and the dry matter mass, was calculated.

The chemical composition analyses of the essential oil were performed with three independent repetitions for each treatment, at Rutgers University, Department of Plant Biology and Plant Pathology. For gas chromatography, the essential oil was diluted in the proportion of 6 µL of essential oil in 1.5 mL of T-butyl methyl ether solvent. The analysis was performed in an Agilent 6890 Series FID chromatographer, GC System with fused-silica capillary column DB5 (5% phenyl / 95% dimethylpolysiloxane; 30 m x 0.25 mm i.d.). Helium gas was used as transporter gas, in a pressure column of 16.2 psi (0.112 MPa), with 99.99% purity.

The identification of the essential oil components was confirmed using GC Agilent 6890, and the conditions were attached to an Agacent 5973 selective network mass detector and split 25:1 and 20.1

$mL.min^{-1}$, with electrons impact value (EI = 70eV). The constitutive identifications were performed using retention times and co-injection with authentic patterns, whenever possible, and combining the mass spectra with the patterns from the MS compound libraries (Wiley 275.L). The retention rates (RR) for n-alkane series (8 to 20) were calculated to provide the identification of the substances and to compare with values from the literature [30].

The essential oil yield per plant was estimated by multiplying the total dry mass per plant by the essential oil content, required to calculate the activity's profitability.

2.10 Statistical analysis

The statistical analysis of the data considered the variance analysis, and the measures were compared by Tukey test at 5% probability.

3 RESULTS AND DISCUSSION

3.1 Growth variables

The Ocimum basilicum L. plants had development according to the expected during cultivation in the greenhouse, and there was no incidence of diseases during the crop cycle, regardless of the treatment used. The mean interval between two successive irrigations was 1.4 days for tension of 20 kPa, gradually increasing up to 3.7 days for 60 kPa (Figure 4).

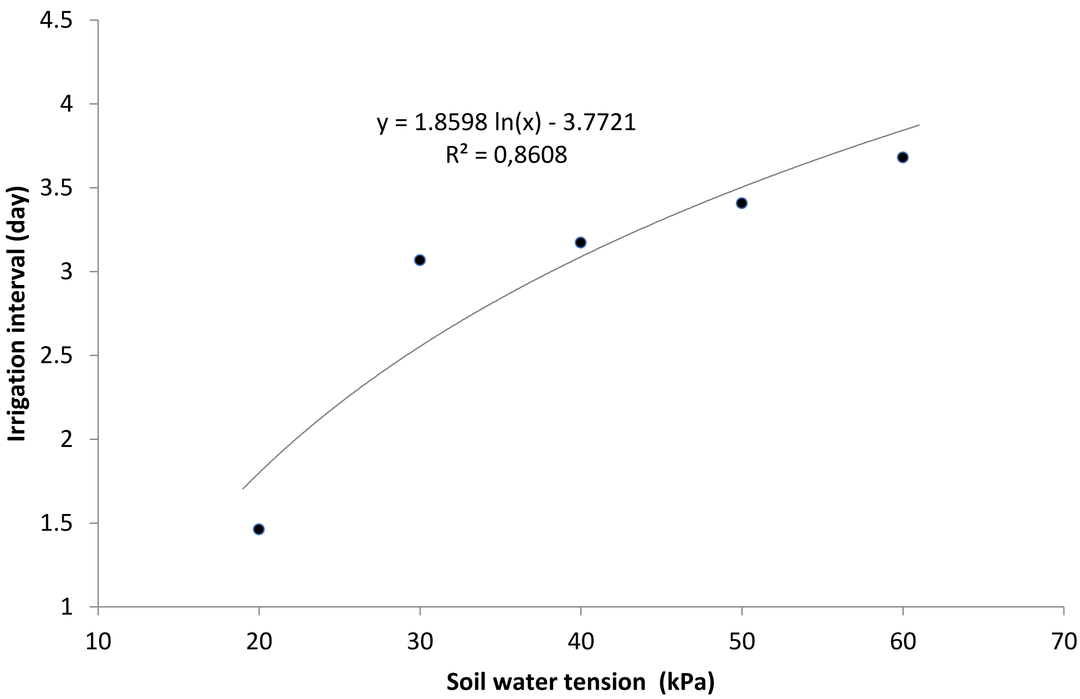

Figure 4 – Interval between irrigations in days for each soil water tension.

It was not observed statistical interaction between the analyzed variables, harvest stages, and soil water tensions. However, the growth variables (Table 4), total dry mass per plant (TDM), total inflorescence dry mass per plant (IDM), total fresh mass per plant (TFM), inflorescence fresh mass per plant (IFM) and the number of inflorescence per plant (NI), had significant differences for harvest stage, with a gradual increase from the beginning of flowering to end of flowering. These results are following [8], who, studying Ocimum basilicum plants during the beginning, full and end of flowering, reported a higher increase in mass during the final phase, with the formation of seeds.

For the plant height, there was an initial increase between BF and FF, stabilizing between FF and EF, which indicates that the plant practically stopped its vertical development during the EF phase. However, it maintained its lateral growth, that is, increased the number of branches and leaves, as observed by the increase in TDM and TFM. The stem diameter (SD) stayed practically the same during the analyzed harvest stages.

Table 4 – Plant growth variables in relation to flowering stages.

Harvest stage	TDM(g)	IDM(g)	TFM(g)	IFM(g)	PH(cm)	SD (mm)	NI
IF	50.15 C	11.80 C	86.08 C	23.21 C	66.53 B	6.76 A	25.36 C
F	75.74 B	24.64 B	119.06 B	41.95 B	71.96 A	6.46 A	62.71 B
FF	117.40 A	44.48 A	162.52 A	67.02 A	72.36 A	7.68 A	123.40 A

TDM – total dry mass per plant (g); IDM – total inflorescence dry mass per plant (g); TFM – total fresh mass per plant (g); IFM – total inflorescence fresh mass per plant (g); PH – plant height (cm); SD – stem diameter (mm); NI – number of inflorescences per plant; BF – beginning of flowering; FF – full flowering; EF – end of flowering. Capital letters must be analyzed in column.

The soil water tensions mainly affected the TDM and the TFM. The TDM presented the highest average value when irrigation occurred in soil water tension of 20 kPa, with 88.38 g, and the lowest value in tension of 60 kPa, with 72.42 g, that is, a reduction of more than 20% when the plants were irrigated in higher soil water tensions, passing through stress cycles before water replacement. The intermediary irrigation tensions of 30, 40, and 50 kPa presented TDM values that did not differ among themselves (Table 5).

Table 5 – Plant growth variables in relation to different irrigation tensions.

Soil water Tension (kPa)	TDM(g)	IDM(g)	TFM(g)	IFM(g)	PH (cm)	SD(mm)	NI
20	88.38 A	28.31 A	138.51 A	47.00 A	71.49 A	6.96 A	72.48 A
30	81.28 AB	28.30 A	126.78 AB	42.14 A	71.52 A	6.28 A	66.15 A
40	83.01 AB	27.43 A	123.69 AB	45.44 A	67.68 A	6.85 A	70.85 A
50	80.30 AB	25.41 A	115.43 B	44.69 A	71.32 A	6.79 A	75.04 A
60	72.42 B	25.50 A	108.73 B	41.29 A	69.79 A	7.94 A	67.93 A

TDM – total dry mass per plant (g); IDM – total inflorescence dry mass per plant (g); TFM – total fresh mass per plant (g); IFM – total inflorescence fresh mass per plant (g); PH – plant height (cm); SD – stem diameter (mm); NI – number of inflorescences per plant. Capital letters must be analyzed in column.

The TFM presented the highest value when the irrigation occurred in soil water tension of 20 kPa, with 138.51 g; it reached intermediary values in tensions of 30 and 40 kPa and the lowest values from the tension of 50 kPa on, which were maintained until the tension of 60 kPa.

Several studies reported a reduction in the dry and fresh mass of medicinal plants cultivated in hydric stress conditions [31]; [19]; [21].

The other growth variables, IDM, IFM, PH, SD and NI, did not show significant changes for the soil water tensions.

The results indicate that this basil variety generates higher TDM and IDM when irrigated when reaching soil water tension of 20 kPa. Otherwise, irrigation management with 60 kPa reduced the accumulation of fresh and dry mass of the plant as a result of the hydric deficit.

3.2 Essential oil content and yield

The content (in %) of essential oil present in the dry mass of the plants was affected by the harvest time as well as by the soil water tension. There was statistical interaction between these two variables, the essential oil content in the dry mass varying from 0.74% to a maximum value of 1.67%.

The irrigation tensions of 20, 30 and 40 kPa presented similar behavior for harvest times, with significant increase in the essential oil content between BF and FF, however, with no change between harvest at FF and EF (Table 6).

Table 6 – Essential oil content (%) present in the dry mass of plants in relation to harvest times and soil water tensions for irrigation.

Harvest stage	Soil water tension (kPa)				
	20	30	40	50	60
F	0.99 Ba	0.89 Ba	0.83 Ba	0.84 Ca	0.74 Ca
FF	1.57 Aa	1.50 Aab	1.30 Aab	1.22 Bab	1.12 Bb
EF	1.40 Aa	1.49 Aa	1.50 Aa	1.65 Aa	1.67 Aa

BF – beginning of flowering; FF – full flowering; EF – end of flowering. Capital letters must be analyzed in columns and miniscule letters, in lines.

For irrigation tensions of 50 and 60 kPa, the essential oil content in dry mass increased significantly among all analyzed harvest times, considering that, in the tension of 50 kPa, the essential oil content increased from 0.84% in BF to 1.65% in EF, while in the tension of 60 kPa, it went from 0.74% in BF to 1.67% in EF, that is, the essential oil content more than doubled between the BF and EF phases.

Considering the harvest stages in relation to the soil water tensions (Table 6), it was observed that, in BF, there was no differentiation. In the harvest at FF, the highest essential oil content in dry mass occurred in the tension of 20 kPa, with 1.57%, and decreased to 1.12%, in the tension of 60 kPa. For the harvest at EF, the different soil water tensions did not affect significantly the basil essential oil content.

The essential oil yield (g. plant^{-1}) was affected by harvest stages and soil water tensions (Table 7). The EF harvest was the one that presented the highest essential oil yield per plant, in all water regimes. However, for this harvest stage, no significant variation among the different soil water tensions was observed. The harvest should be carried out at EB, regardless of the soil water tension that determines the moment to irrigate, to obtain the highest essential oil yield.

[32] and [8] reported differences in essential oil yield depending on the variety used and the season of cultivation, with the highest values between full flowering and end of flowering.

The essential oil yield varies in relation to the mass of the aerial part of the varieties used, environmental factors that can promote physiological changes in the plant, and the extraction method used [7].

Only during harvest at B, significant variation among the different soil water tension for irrigation was observed, with 1.31g in the tension of 20 kPa and 0.76 g in the tension of 60 kPa.

Table 7 – Essential oil yield (g. plant-1) extracted from dry mass in relation to flowering stages and water regimes.

Harvest stage	Soil water tension (kPa)				
	20	30	40	50	60
BF	0.61 Ca	0.47 Ca	0.42 Ca	0.41 Ca	0.27 Ca
FF	1.31 Ba	1.13 Bab	0.90 Bab	1.01 Bab	0.76 Bb
EF	1.67 Aa	1.69 Aa	1.95 Aa	1.79 Aa	1.85 Aa

BF – beginning of flowering; FF – full flowering; EF – end of flowering. Capital letters must be analyzed in columns and miniscule letters, in lines.

3.3 Essential oil chemical composition

The essential oil extracted from basil presented, in its composition, 49 identified substances. The ones appearing in higher quantity (%) in all treatments, in decreasing order, are Linalool, 1,8-Cineol, Camphor, and Eugenol (Table 8). Linalool and 1.8-Cineol were already reported as being the components found in the highest quantities in the essential oil in several other studies [33]; [34]; [8]; [35]. This differentiation in the content is related to the variety used, geographical origin of the genetic material [32]; [36], and harvest stage [8], among other factors.

The harvest stage and soil water tension did not promote changes in the chemical components found in the basil essential oil; they only influenced the proportion of certain substances, some affected by harvest time, others by the water regime.

The harvest stages affected the major components found in the essential oil. Linalool, which was the substance found in the highest quantity in the essential oil, did not show significant differences in its amount between harvests at the beginning and end of flowering (Table 9). 1.8-Cineol and Camphor had a significant increase in their quantities between BF and EF, while Eugenol reduced between harvest at FF and EF. [8], working with Ocimum basilicum plants rich in Methylchavicol and Linalool, with the harvest at different flowering phases, observed difference in the proportion of these and other components in the essential oil between full flowering and end of flowering, when the plants were already presenting seeds.

Table 8 - Components found in essential oil.

P	Substance	(%)	P	Substance	(%)	P	Substance	(%)
1	α-Thujene	0.06	18	trans-Sabinenehydrate	0.16	35	α-Guaiene	0.11
2	α-Pinene	1.03	19	Fenchol	0.03	36	cis-Cadina -1(6),4-diene	0.04
3	Camphene	1.02	20	(E)-Epoxy-ocimene	0.05	37	α-Humulene	0.20
4	Sabinene	0.90	21	Camphor	15.15	38	Germacrene-D	0.09
5	β-Pinene	1.77	22	neo-Menthol	0.07	39	Valencene	1.41
6	Myrcene	0.77	23	δ-Terpineol	0.47	40	Germacrene B	0.15
7	α-Phellandrene	0.09	24	Terpinen-4-ol	0.69	41	α-Bulnesene	0.15
8	α-Terpinene	0.10	25	α-Terpineol	2.78	42	*Zonarene	0.39
9	o-Cymene	0.09	26	Octanolacetate	0.11	43	α-Cadinene	0.07
10	Limonene	2.01	27	Chavicol	0.04	44	cis-Muurol-5-em-4-β-ol	0.04
11	1,8-Cineole	20.74	28	Isobornylacetate	0.31	45	cis-Muurol-5-en-4-α-ol	0.05
12	(E)-β-Ocimene	0.28	29	Myrtenylacetate	0.08	46	Caryophyllene oxide	0.10
13	ɣ-Terpinene	0.20	30	Eugenol	5.27	47	1,-epi-Cubenol	0.30
14	n-Octanol	0.12	31	Copaene	0.06	48	Valerianol	1.87
15	cis-Sabinenehydrate	0.45	32	β-Bourbonene	0.20	49	Bergamotol	0.03
16	Fenchone	2.36	33	(E)-Caryophyllene	0.60	*	Total Substances (%)	96.46
17	Linalool	33.03	34	A-trans-Bergamotene	0.37			

P – Peaks in the order of analysis.

Table 9 – Substances (%) found in higher quantities in the basil essential oil, in the different flowering stages.

Substance	*BF	FF	EF
Linalool	31.58 a	34.37 a	33.13 a
1,8-Cineol	19.32 b	20.20 ab	22.70 a
Camphor	13.86 b	15.24 ab	16.35 a
α-Terpineol	0.41 b	0.50 a	0.50 a
Isobornyl acetate	0.21 c	0.31 b	0.42 a
Eugenol	5.48 a	6.09 a	4.23 b

BF – beginning of flowering; FF – full flowering; EF – end of flowering. Miniscule letters must be analyzed in line.

The water regimes only affected the Linalool and Isobornyl acetate. Linalool was found in higher quantity in tensions of 20 to 50 kPa, in quantities ranging from 35.03% to 34.27%, with significant reduction in the tension of 60 kPa, with 27.14%. Isobornyl acetate increased its proportion in the essential oil between the tensions of 20 and 60 kPa (Table 10).

Table 10 – Linalool and Isobornyl acetate (%) in different soil water tensions.

	Soil water tension (kPa)				
Substance	20	30	40	50	60
Linalool	35.03 a	34.84 a	33.85 a	34.27 a	27.14 b
Isobornyl acetate	0.261 b	0.32 ab	0.31 ab	0.33 ab	0.34 a

Miniscule letters must be analyzed in line.

The concentration of Linalool in the basil essential oil had different results in the literature. [37] and [38], working with hydric stress in Ocimum basilicum plants, observed a reduction in the proportion of Linalool with reduction water availability. On the other hand, [39] found variation in the Linalool quantity in different water regimes between 50 and 125% of field capacity. [21] reported an increase in the essential oil and Linalool content with the rise of hydric stress. [40] reported that, while other substances such as Methylchavicol and Methyleugenol were affected by the hydric stress, Linalool maintained the same proportion. This divergence of results shows that different varieties and origins can present distinct behaviors with essential oil content and composition.

4. Conclusions

Irrigation in the soil water tension of 60 kPa generated a reduction in the essential oils content and yield to the tension of 20 kPa, only in harvest stage FF. However, it did not change the essential oil composition.

Regardless of the soil water tension to determine irrigation, the highest essential oil content and yield were found in the harvest at the final stage of flowering.

Harvest stages did not alter the essential oil composition, nor the Linalool content. On the other hand, the contents of the Cineol, Camphor, ∝-Terpineol and Isobornyl acetate components increased with harvest time from BF to EF. Eugenol indicated an opposite tendency, with a content reduction from BF to EF.

The Linalool was the component found the highest proportion in the essential oil and had higher content in soil water tensions up to 50 kPa, decreasing only at 60 kPa.

In medium-textured soils, it is recommended, to basil producers that aim Linalool extraction to proceed with irrigation when the soil water tension reaches up to 50 kPa, with the harvest at any flowering stage.

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7. References

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