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# Nitrogen Fertilization in Two Varieties of Basil

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**Abstract**

The cultivation of basil is worth mentioning, because it is a very promising crop. The aim of this study was to evaluate the development of the Basil cultivation, cultivar Tuscan lettuce leaf and Alfavaca red basilican, submitted to different doses of nitrogen. The first factor was composed of six nitrogen doses and one control (0, 40, 80, 120, 160, 200, 240 kg ha$^{-1}$ of nitrogen), and the Second was composed of two cultivars (Alfavaca red basilican and Tuscan lettuce leaf) with four replicates. The basil Alfavaca red basilican cultivar overcame the cultivar Tuscan lettuce leaf in the plant height and diameter of the stem. In the leaf and shoot dry matter variables, the doses that resulted in the greatest increase of dry matter were 128 and 125.62 kg ha$^{-1}$ of nitrogen for the cultivar Tuscan of lettuce leaf. Both Alfavaca red basilican and Tuscan lettuce leaf were influenced by nitrogen fertilization and the dose of 120 kg ha$^{-1}$ of nitrogen has the highest potential in the developmental parameters.

**Keywords:** alfavaca red basilican, nitrogen, *Ocimum basilicum*, plant mineral nutrition, Tuscan lettuce leaf

## 1. Introduction

Originally from India, with wide application and use, ranging from cooking to alternative medicine, the Basil (*Ocimum basilicum)* deserves a prominent role among the numerous medicinal and flavor plants, for being cultivated in several regions around the world (Özcan & Chalchat, 2002). As a plant, it can be considered an annual (Saha, Monroe, & Day, 2016) or perennial crop, depending on the region, the place of cultivation and/or management used.

Despite the importance of basil culture, studies on the nutritional requirement of this species are still scarce (Veloso, Castro, Cardoso, Junior, & Chagas, 2014). Therefore, Luz et al. (2014) highlight the importance of fertilization because deficiency or excess nutrients can interfere with plant growth, biomass production and the amount of active principles and proteins (Nurzyńska-Wierdak, Rożek, & Borowski, 2011).

The use of nitrogen provides an increase in the productivity of several crops, such as annual crops, winter crops, vegetables and other crops. (Pepke, Cruz, Silva, Figueiredo, & Bicudo, 2013; Pietro-Souza, Bonfim-Silva, Schlichting, & Silva, 2013; Gomes, Silva, Gusmão, & Souza, 2012; Porto et al., 2012). However, production may be compromised due to lack of information about nitrogen fertilizer.

In studies by Biesiada and Kuś (2010), with the use of nitrogen in basil plants, the best results were encountered in 150-250 kg ha$^{-1}$ doses of nitrogen. Ferreira et al. (2015) observed that the highest yields of fresh and dry mass of the leaf were obtained with the doses between 90 and 135 kg ha$^{-1}$ of nitrogen, respectively, and the dose of 110 kg ha$^{-1}$ of nitrogen presented positive influence on crop growth and development during the spring periods. According Zheljazkov, Cantrell, Ebelhar, and Coker (2008) verified that largest yields of basil essential oil was encountered with nitrogen fertilization of 50 to 60 kg ha$^{-1}$.

While in studies by Ferreira, Bulegon, Yassue, and Echer (2016), there was no influence of nitrogen fertilization on the cultivation of Tuscan basil leaf lettuce cultivated in pots. The authors also note that the non-effect of nitrogen doses on the production characteristics may be related to the conduction adopted, which was based on only one cut, since the availability, absorption and use of nitrogen for the production of biomass have a tendency increase over time.

Based on the information cited, this work is based on the hypothesis that the growth and/or development of basil may be dependent on the nitrogen fertilization used.

Therefore, the objective of this study was to evaluate the development of the Basil cultivation, cultivar Tuscan lettuce leaf and Alfavaca red basilican, submitted to different doses of nitrogen.

## 2. Material and Methods

The experiment was conducted in a greenhouse. The site is located at 420 m altitude, 24°33′40″S and 54°04′12″W. It has a subtropical Cfa climate with annual rainfall averaging 1700 mm and a temperature ranging from 10 at 30 °C.

The design was completely randomized blocks, in a factorial scheme of type 7 × 2. The first factor consisted of six nitrogen doses and a control (0; 40; 80; 120; 160; 200; 240 of nitrogen); the second was composed of two cultivars (Alfavaca red basilican and Tuscan lettuce leaf), with four replicates. Each experimental unit consisted of two vessels with eight-$dm^{-3}$ containing Clayey oxisol with a basil plant in each vessel, totalizing two plants per experimental plot.

The soil chemical analysis showed the following characteristics: M.O. = 17.77 g $dm^{-3}$; pH = 4.67 ($CaCl_2$); P = 5.56 mg $dm^{-3}$; K = 0.13 $mmol_c$ $dm^{-3}$; Ca = 3.82 $mmol_c$ $dm^{-3}$; Mg = 1.03 $mmol_c$ $dm^{-3}$; H + Al = 3.44 $mmol_c$ $dm^{-3}$; CTC = 8.42 $mmol_c$ $dm^{-3}$; SB = 8.42 and V = 59.14%. The practices of soil fertilization and correction were carried out according to the soil analysis, based on the recommendations proposed by Biasi and Deschamps (2009), with 120 and 80 kg $ha^{-1}$ of $P_2O_5$ and $K_2O$, respectively, without nitrogen. Nitrogen doses were divided into four applications, 0, 7, 14, 21 days after transplantation (DAT). The urea was used as the source of nitrogen. For a better fertilization efficiency the urea was diluted in water, applying 200 ml of the solution per pot.

Basil seedlings were grown in 200-cell expanded polystyrene trays containing commercial substrate. Transplanting of seedlings was performed when the seedlings presented four definitive leaves, at 30 days after sowing. Irrigation and other cultural treatments were carried out according to the need of the crop.

The evaluations were performed when the plants showed the maximum vegetative growth, that is, at the beginning of flowering at 56 DAT. The variable plant height, stem diameter and canopy projection was evaluated with the aid of a graduated ruler and digital caliper.

The Chlorophyll Meter SPAD-502 Plus was used to determine the SPAD index. Four leaves per plant were evaluated, being one leaf located in the apical part, two in the middle third and one leaf base.

After the biometric evaluations, the plants were sectioned, duly identified all the parts and taken to the laboratory, for the leaf number and leaf area evaluations. Afterwards, they were packed in paper bags and placed in a forced circulation oven at 65 °C, for 72 hours. When they reached constant weight, the vegetable parts were weighed in a precision scale, to determine the dry masses.

After obtaining the data, the analysis of variance was performed. When significance was verified in the variables, models were adjusted according to the regression analysis (5% probability, by F test).

## 3. Results and Discussion

According to the results observed, basil Alfavaca red basilican cultivar overcame the Tuscan cultivar lettuce leaf in the plant height and diameter stem (Figures 1a and 1b).

For plant height, it was verified that basil Alfavaca was 24.7% larger than Tuscan at the peak of both growth. Likewise, the diameter of the stem was approximately 27% higher in basil Alfavaca, compared to Tuscan basil. However, the largest diameters were verified with 95 kg $ha^{-1}$ of nitrogen independent of the cultivar.

The results found in this work for the height of plants of the Tuscan leaf lettuce, corroborate with Ferreira et al. (2015) that found heights of this same cultivar, with approximately 30 cm.

For the stem diameter, Veloso et al. (2014) noted that the diameters ranged from 3.4-6.6 cm, depending on the cultivar. However, Araújo, Matsumoto, Santos, César, and Bonfim (2011), when studying the effect of nitrogen fertilization on the basil crop, did not observe differences for stem diameter. While, Matsumoto, Araújo, and Viana (2013), verified a larger diameter with 68.57 kg $ha^{-1}$ of nitrogen.

In this way, it can be concluded that stem diameter can be an intrinsic characteristic of the species itself, therefore, it has little influence. Moreover, it is worth mentioning that under field conditions, the larger the diameter of the stem has a direct influence on the quality of the product, since the vigorous stem can support the plants of greater height and mass of the aerial part, when these are reached by rain, wind or other inclement weather.

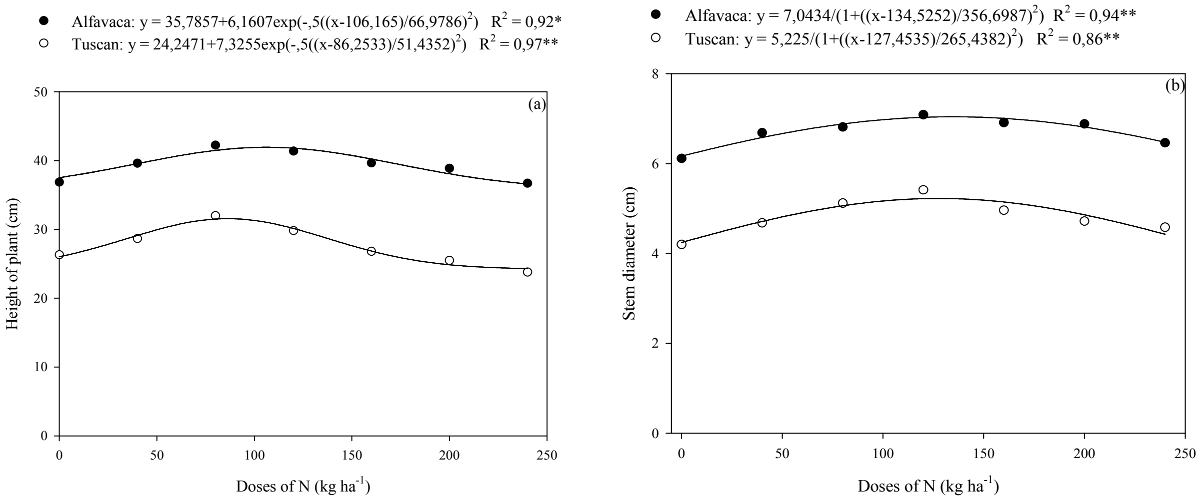


Figure 1. Height of plants (a) and stem diameter (b) of basil, Alfavaca basilican cultivar and Tuscan lettuce leaf in function of application of doses of Nitrogen

*Note*. * and ** significant at 1 and 5% probability by regression analysis of variance.

It was verified that the crown projection in the two basil cultivars was influenced by nitrogen fertilization, corroborating with plant height and stem diameter (Figure 2a). However, the projections of the Alfavaca cultivar were stagnant at the dose of 110 kg ha$^{-1}$ of nitrogen, and the cultivar Tuscan at the dose of 115 kg ha$^{-1}$ of nitrogen, from these doses there was decrease. Despite this, the cultivar Alfavaca surpassed the cultivar Tuscan in 30.8%.

The highest SPAD index were obtained with the dose of 203.25 kg ha$^{-1}$ of nitrogen in the cultivar Tuscan leaf lettuce and 168.87 kg ha$^{-1}$ in the Alfavaca red basilican cultivar (Figure 2b).

These results were superior to those obtained by Matsumoto et al. (2013), which, when subjecting basil to different doses of nitrogen, obtained the highest values in the SPAD index with a dose of 119.54 kg ha$^{-1}$ of nitrogen.

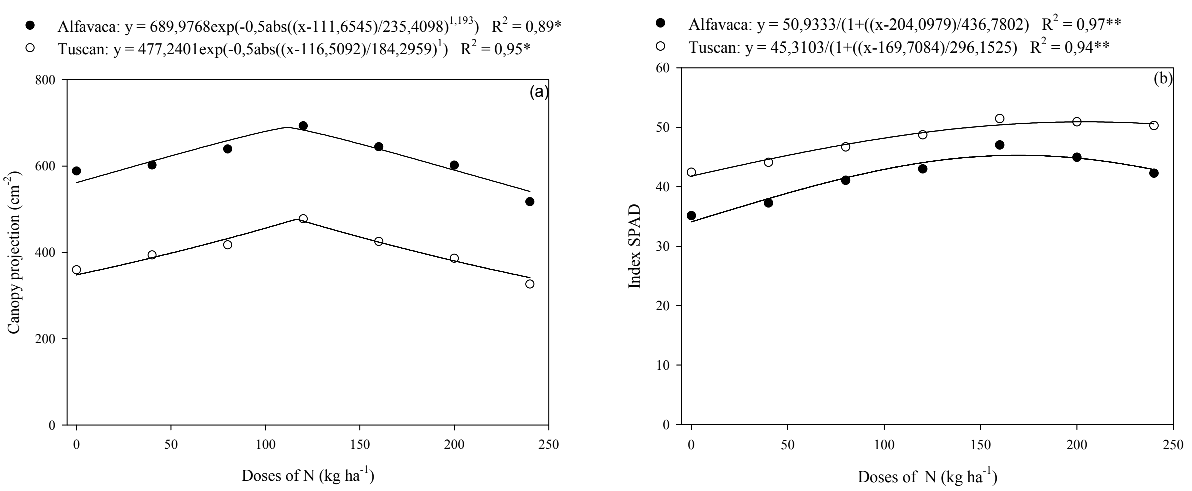


Figure 2. Projection of canopy (a) and SPAD index (b) of basil, Alfava red basilican cultivar and Tuscan lettuce leaf in function of application of doses of Nitrogen

*Note*. * and ** Significant at 1 and 5% probability by regression analysis of variance.

The importance of the SPAD index, according to Leonardo, Pererira, Silva, and Costa (2013), has been shown to be adequate to assist in the management of nitrogen fertilization. The authors observed a significant effect for the SPAD index, using two sources of nitrogen (urea and chicken litter).

Other authors found effects of nitrogen doses in the SPAD index, in crops such as orange (Souza, Salomão, Andrade, Boas, & Quaggio, 2011) and citrumelo swingle (Vale & Prado, 2009).

The highest number of leaves was observed in the Alfavaca cultivar, with approximately 44% more leaves than the Tuscan cultivar (Figure 3a). However, the maximum leaf area was verified in the cultivar Tuscan, with 552 $cm^{-2}$ $plant^{-1}$ leaf area at the estimated dose of 100 kg $ha^{-1}$ of nitrogen (Figure 3b). In the Alfavaca cultivar, the leaf area peak was verified with a dose of 80 kg $ha^{-1}$ of nitrogen, which represented 42% more leaf area than the control of this cultivar.

The results of the number of leaves of this experiment for the cultivar Tuscan, provided 53% less leaves than in the study conducted by Favorito et al. (2011) for the same cultivar. Luz et al. (2014) also found plant height results higher than that observed in this study.

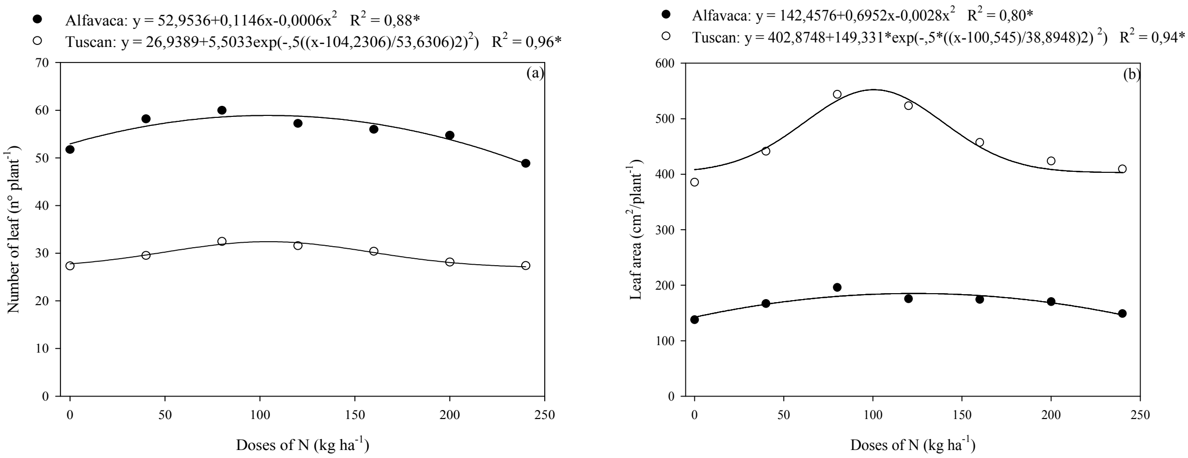


Figure 3. Number of leaves (a) and Leaf area (b) of basil, Alfava red basilican cultivar and Tuscan lettuce leaf in function of Nitrogen doses application

*Note*. * and ** Significant at 1 and 5% probability by regression analysis of variance.

Regarding the number of leaves, the studied cultivars have defined characteristics, and therefore these differences are observed so different. Although the Alfavaca cultivar has a larger number of leaves, this plant has low photosynthetic efficiency, because its leaves are small and purple.

Similarly, Veloso et al. (2014) in the studies with six accessions of basil, observed difference in the number of leaves, however, the red basil used in their study presented the second worst leaf production and also had small size.

The results observed in the leaf area of the Alfavaca cultivar of this experiment corroborate with those verified by Ferreira et al. (2016) that found a leaf area of approximately 140 $cm^2$ per plant. However, the maximum leaf area observed by Souza et al. (2011), was 73.19 $cm^2$.

In the leaf and shoot dry matter variables (Figures 4a and 4b), the doses that resulted in the highest dry matter increment were 128 and 125.62 kg $ha^{-1}$ of nitrogen for the Tuscan lettuce leaf and 63 and 103.3 kg $ha^{-1}$ of nitrogen for the Alfavaca red basilican cultivar.

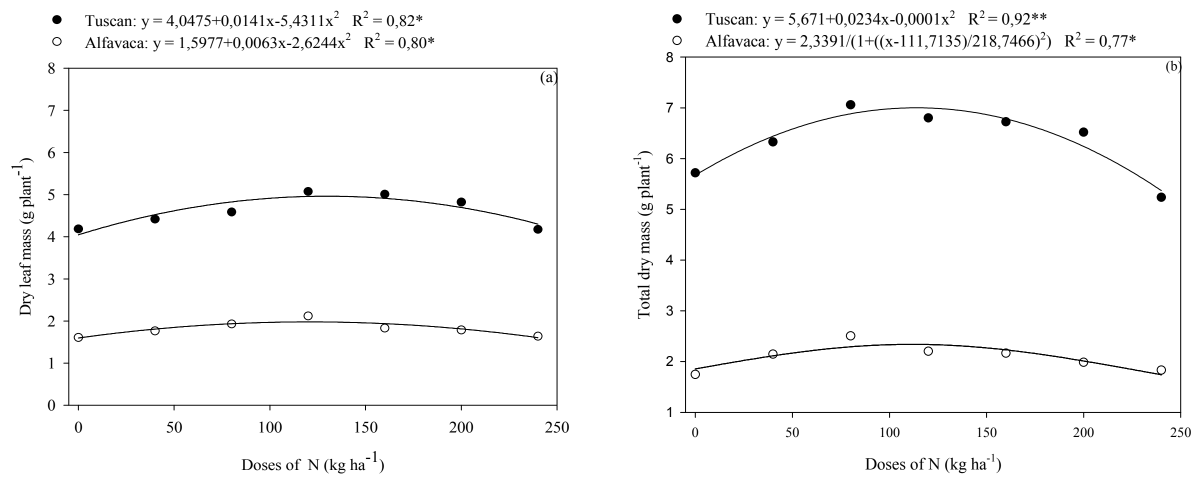


Figure 4. Dry leaf mass (a), total dry mass (b) of two cultivars of Basil, as a function of different doses of nitrogen

*Note*. * Significant at 5% probability, by regression analysis.

This increase in dry mass is also related to the greater efficiency of the plant to perform photosynthesis, consequently, a larger increase of fresh and dry mass will occur, a result justified by the SPAD index.

In the studies conducted by Bufalo et al. (2015), the dry matter weights also vary, so that, for nitrogen fertilization, the highest result observed by the authors was applied with 250 kg $ha^{-1}$ of nitrogen, and when organic fertilization was used, only 150 kg $ha^{-1}$ of nitrogen, to obtain the largest masses.

This research shows the need for more studies on nitrogen fertilization in the basil cultivars. For it is increasingly observed that development depends not only on fertilization, but also on the cultivar and the place of cultivation.

## 4. Conclusions

The cultivars of basil, Alfavaca red basilican and Tuscan leaf of lettuce were positively influenced by nitrogen fertilization, being tthat he dose of 120 kg $ha^{-1}$ of nitrogen has the best potential in the development parameters of both cultivars.

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