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COMPARATIVE STUDY REGARDING THE BEHAVIOR OF SOME VARIETIES OF BASIL CULTIVATED IN NFT SYSTEM (NUTRIENT FILM TECHNOLOGY)

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Abstract

The study was carried out in the greenhouses of the Research Center for the quality of Horticultural products, Hortinvest greenhouses but also the greenhouse in Nutrient Film Technology (NFT) system in the vertical greenhouse (Plant Factory) in the Greenhouses of the Faculty of Horticulture built through a project in collaboration with China. 2 varieties of basil were cultivated, Genovese and Aromat de Buzău. We found differences in vegetative mass between different crop varieties. The aim of the study was to analyze the behavior of these varieties in the unconventional culture system, on nutritive film (NFT)

Key words: *basil, cultivars, NFT, production.*

INTRODUCTION

Basil is native to India, China, Sri Lanka, where it has spread around the globe. It was introduced to Europe in the middle of the 16th century. As a spice plant, basil is grown in southern Ukraine, Armenia, Georgia and Central Asia, in many countries in Western Europe (France, Italy, Germany, etc.) and in North America (Ciofu, 2004).
The genus *Ocimum* belongs to the *Lamiaceace* family and includes about 50-150 species of plants and shrubs found in tropical regions of Asia, Africa, Central and South America. (Darrah, 1980; Tucker and DeBaggio, 2009) with a large number of varieties (Runyoro et al., 2010; Aligiannis et al., 2001). Types of this genus differ in their characteristics, leaf size, flower color, phenotypic characteristics and aroma. *O. gratissimum,* pink basil, *O. viride* dendritic, *Ocimum basilicum* basil, sweet americanus, tenuiflorum.
The name of the basil plant comes from the Latin basilisk or dragon; this etymological connection may explain the symbolic connection between basil and scorpions (Grieve, 1971; Stobart, 1982).
Basil is an annual plant, the stem has a height between 25-50 cm, and it is branched and bears elongated, fleshy leaves. It blooms from June to September and presents small, white or purple flowers. The fruits are small achenes, black in colour, 1.5-2 mm long and about 1 mm wide. The germination capacity is 60-80% and it is kept for 4-5 years. One gram contains 600-800 seeds.
Basil is grown mainly on lands with southern exposure, rich in humus and nutrients, with light or medium texture, flat, with a neutral reaction (pH between 6.5-7.5).
Temperature can affect plants in many different ways. Extremely low or high temperatures can influence the production and quality of basil Carvalho et al. (2002); Abbas (2014).
Increasing or decreasing differences between day and night air temperature ('DIF') may increase or decrease the elongation of the stem and the internode (Walters and Currey, 2016).
Basil, also called the king of herbs, is one of the species that behaves very well in the NFT culture system horizontally but also vertically, in floors. It can be grown all year round on a vertical farm where much higher yields can be obtained compared to the standard from greenhouse culture.

One of the advantages of NFT systems is the reduced volume of nutrient solution. This reduces the energy required to heat the nutrient solution in the winter months if desired (Thompson et al., 1998).
The troughs in NFT systems are usually placed at heights that are comfortable for greenhouse employees to access for transplanting and harvesting. (Walters and Currey, 2015; Enache et al., 2019).
It grows very well in moderate light conditions, but for better efficiency it can be grown in LED-lit areas, where and other growth factors, climate, CO_2, nutrients and substrates can positively influence the production of basil (Pennisi, 2019; Rahman et al., 2021).
Omer et al. show that the quantitative effects of temperature and light intensity on growth parameters have an influence on sweet basil plants grown in the greenhouse (*Ocimum basilicum* L., fam. *Lamiaceae*).
Increasing air temperature to 29°C resulted in an increase in fresh and dry weight accumulation, node number, per-cent of plants with visible flower buds or flowers, plant height, internode length, branch number, and chlorophyll fluorescence for all species and cultivars evaluated (Walters and Currey, 2019).
Basil contains antioxidants (Peirce, 1999) but also vitamins A and C that have made it useful for protecting cells against disease (Romesh et al., 1993) fever and headache (Ducke, 2002). It is also used to treat stomach pain, as an expectorant, diuretic (Nyarko et al., 2002), as well as insecticides (Gill and Randhawa, 2000) and scorpion repellent and snakes (Gill et al., 1992).
It is an important source of essential oil that is used in food, perfumery and cosmetics (Tutulescu et al., 2017), and some types of *Ocimum* are used as a folk remedy for some diseases, especially in Asian and African countries (Aldjwi, Ali, 1996).

MATERIALS AND METHODS

The experiments were carried out within USAMV Bucharest, Hortinvest greenhouses, Research Center for the Quality of Horticultural Products.
The biological material used in the experiment was represented by the 'Genovese' and 'Aromat de Buzău' varieties.
The 'Genovese' basil variety (*Ocimum basilicum*) is a variety with large, green leaves that can be grown in pots, the height of the plant can reach 50 cm.
The 'Aromat de Buzău' basil variety is a semi-late variety, being very well adapted to the existing environmental conditions in Romania. The leaves have a specific aroma and have the ability to retain their properties during the conservation period. The mature plant has the shape of a globular bush, slightly spread, having a height between 40-60 cm. The average production of shoots is 12.4 t / ha.
The EC was maintained in the first week after planting at 1.6 ppm, then it was raised to 2.2 ppm. The nutrient solution had a constant pH of 6. We performed determinations on the percentage of seeds grown in the case of the analysed varieties, as well as measurements on plant height, number of leaves per plant, number of stems formed. We also performed determinations on plant mass. The duration of keeping the plants in culture was of 26 days.

RESULTS AND DISCUSSIONS

The percentage of sprouted seeds was 97% for the 'Genovese' variety and 98% for 'Aromat de Buzău' (Figure 1).

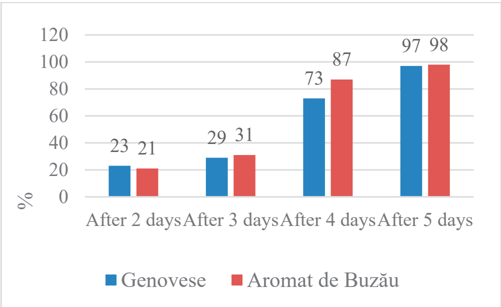

Figure 1. Percentage of sprouted seeds for the analysed varieties

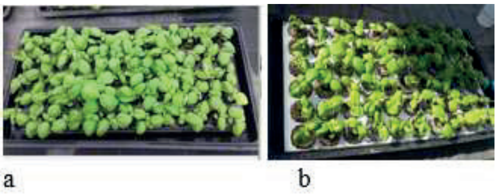

Figure 2. Basil seedlings: 'Genovese' variety (a) and 'Aromat de Buzău' (b)

We found that in the case of the 'Genovese' variety, the highest height was recorded in variant 2, grown in NFT system, with LED lighting, it was 32.0 cm, with a significance, statistically, distinctly very significant compared to the control. In the case of the variant grown in peat pots (V3), the height of the plants was 19.75 cm. From a statistical point of view, there were distinctly significant positive meanings at V1 and V2 (Table 1).

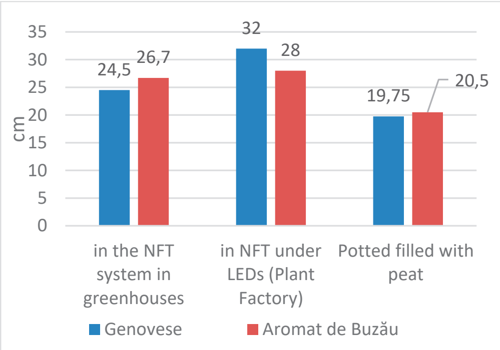

Figure 3. Plant height after 26 days after planting

Table 1. Influence of growing conditions on the height of basil plants - 'Genovese' variety

Variants	Height (cm)	Difference (cm)	Difference (%)	Significance
V(0) average	25.42	5.67	128.69	***
V(1)	24.50	4.75	124.05	***
V(2)	32.00	12.25	162.03	***
V(3)	19.75	0.00	100.00	Ct

DL5% = 1.420 DL5% in % = 7.1899
DL1% = 2.360 DL1% in % = 11.9494
DL01% = 4.420 DL01% in %= 22.3797

In the case of the 'Aromat de Buzău' variety, we found that the height of the plants was influenced by the growing conditions. In the case of variant 1, plants grown in the greenhouse in natural light conditions, the height of the plants was 26.7 cm by 6.2% above the average experience. The best variant regarding the height was registered at V2, plants cultivated in LED lighting conditions. From a statistical point of view, there were distinctly significant positive differences for all variants grown in the NFT system (Table 2).

Table 2. Influence of cultivation conditions on the height of basil plants 'Aromat de Buzău' variety

Variants	Height (cm)	Difference (cm)	Difference (%)	Significance
V(0) average	25.07	4.57	122.28	***
V(1)	26.70	6.20	130.24	***
V(2)	28.00	7.50	136.59	***
V(3)	20.50	0.00	100.00	Mt

DL5% = 0.910 DL5% in % = 4.4390
DL1% = 1.510 DL1% in % = 7.3659
DL01% = 2.840 DL01% in %=13.8537

Figure 4. Aspect of basil plants cultivated in NFT system and in potted

a. b.

Figure 5. Appearance of the greenhouse illuminated with LED (Plant Factory): a. 'Genovese' variety; b. 'Aromat de Buzău' variety

Figure 6. Plant appearance a. In NFT - natural light and b. In NFT LED lighting

Regarding the number of leaves on plant, we found that the best results were recorded for the variant grown under LED lighting (Figure 7).

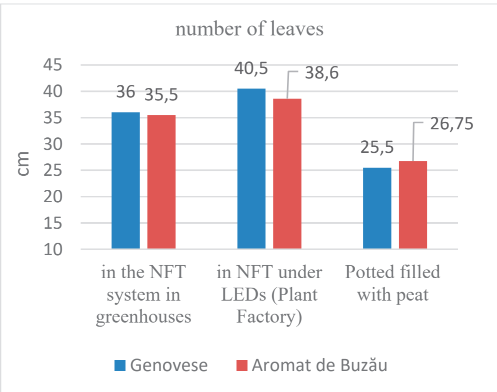

Figure 7. Number of leaves on plant

From a statistical point of view, there was a statistically significant difference in V2, where the difference regarding in the number of leaves per plant was with 15 leaves, over the control variant (V3), Table 3.

Table 3. Influence of temperature and lighting conditions on the number of leaves on plant in the 'Genovese' variety

Variants	Number of leaves (cm)	Difference (cm)	(%)	Significance
V(0) average	34.00	8.50	133.33	N
V(1)	36.00	10.50	141.18	N
V(2)	40.50	15.00	158.82	*
V(3)	25.50	0.00	100.00	Control

DL5% = 13.440 DL5% in % = 52.7059
DL1% = 22.240 DL1% in % = 87.2157
DL01% = 41.630 DL01% in %= 163.2549

In the case of the 'Aromat de Buzău' variety, the number of leaves per plant was 35.5 at V1 and 38.6 at V2. The lowest number of leaves was recorded at V2 (control). From a statistical point of view we found very distinctly significant positive differences at V1 and V2 (Table 4).

Table 4. Influence of temperature conditions on the number of leaves on plant in the 'Aromat de Buzău' variety

Variants	leafes Number (no)	Difference (no)	(%)	Significance
V(0) average	33.62	6.87	125.67	***
V(1)	35.50	8.75	132.71	***
V(2)	38.60	11.85	144.30	***
V(3)	26.75	0.00	100.00	Control

DL5% = 1.540 DL5% in % = 5.7570
DL1% = 2.560 DL1% in % = 9.5701
DL01% = 4.790 DL01% in %= 17.9065

Regarding the number of branches formed on the plant, we found that there were no significant differences between the variants (Tables 5 and 6).

Table 5. Number of branches formed on plants of the 'Genovese' variety

Variants	number (no)	Difference (no)	(%)	Significance
V(0) average	3.33	0.33	111.11	N
V(1)	3.50	0.50	116.67	N
V(2)	3.50	0.50	116.67	N
V(3)	3.00	0.00	100.00	Ct

DL5% = 0.650 DL5% in % = 21.6667
DL1% = 1.080 DL1% in % = 36.0000
DL01% = 2.020 DL01% in %= 67.3333

Table 6. Number of branches formed on plants in the 'Aromat de Buzău' variety

Variants	Number (no)	Difference (no)	(%)	Significance
V(0) average	3.57	0.07	101.90	N
V(1)	3.70	0.20	105.71	N
V(2)	3.50	0.00	100.00	N
V(3)	3.50	0.00	100.00	Mt

DL5% =	3.180	DL5% in % =	90.8571
DL1% =	5.260	DL1% in % =	150.2857
DL01% =	9.850	DL01% in %=	281.4286

In the experiment, the total mass of plants harvested was for the Genovese variety between 93.81 g at V3 and 168.75 g at V2. From a statistical point of view, we found positive differences in this variety, distinctly significant compared to variant 3 control. In the case of the 'Aromat de Buzău' variety, average masses of 97.53 g/plant were recorded at control V3 and 157.23 g / plant at V2 (Tables 7 and 8).

Table 7. Total mass of the plant in the 'Genovese' variety

Variants	Mass (g)	Diference (g)	(%)	Significance
V(0) average	138.76	44.95	147.92	***
V(1)	153.73	59.92	163.87	***
V(2)	168.75	74.94	179.88	***
V(3)	93.81	0.00	100.00	Ct

DL5% =	12.510	DL5% in % =	13.3355
DL1% =	20.710	DL1% in % =	22.0765
DL01% =	38.770	DL01% in %=	41.3282

Table 8. Total mass of the plant in the 'Aromat de Buzau' variety

Variants	Mass (g)	Diference (g)	(%)	Significance
V(0) average	132.82	35.29	136.18	***
V(1)	143.70	46.17	147.34	***
V(2)	157.23	59.70	161.21	***
V(3)	97.53	0.00	100.00	Ct

DL5% =	4.220	DL5% in % =	4.3269
DL1% =	6.990	DL1% in % =	7.1670
DL01% =	13.080	DL01% in %=	13.4113

In the case of the 'Genovese' variety, we found that the mass percentage of leaves obtained on a plant was higher in the variant cultivated under LED lighting conditions compared to the rest of the variants (Figure 8).

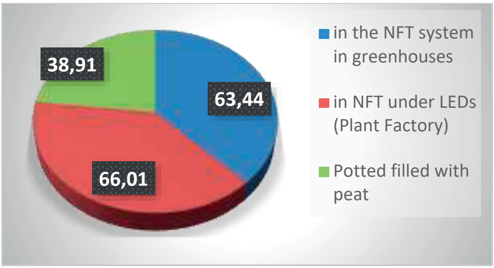

Figure 8. Percentage of average leaf mass reported to total mass of plant - 'Genovese' cultivar

Figure 9 shows that the percentage of average mass of the stems was lower in the LED lighting variant compared to the rest of the variants.

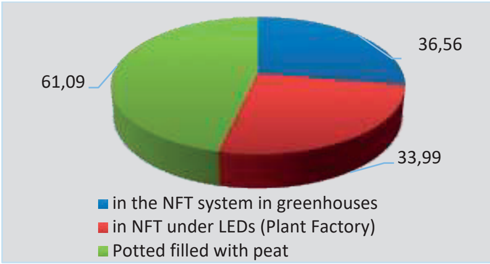

Figure 9. Percentage of the average mass of the stem reported to total mass of plant - 'Genovese' cultivar

In the case of the 'Aromat de Buzău' variety, the highest percentage of the average leaf mass was also registered for the variant cultivated in constant LED lighting conditions, the percentage being 61.17% leaf mass of the total plant (Figure 10).

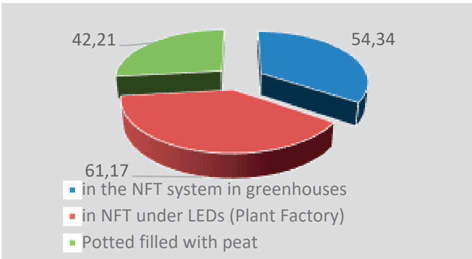

Figure 10. Percentage of average leaf mass reported to total mass of plant - 'Aromat de Buzău' cultivar

Also, in the case of the 'Aromat de Buzău' variety, the highest percentage to be registered at the mass of the stem was in the variant cultivated in pots (57.79%) (Figure 11).

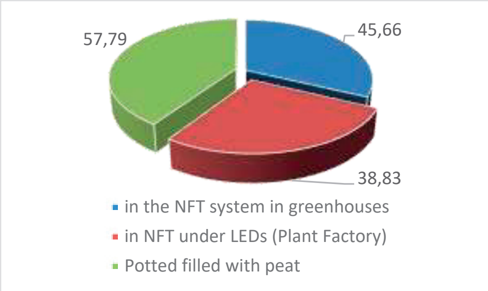

Figure 11. Percentage of the average mass of the stem reported to total mass of plant 'Aromat de Buzău' cultivar

CONCLUSIONS

In this study we cultivated two varieties of basil, Genovese and 'Aromat de Buzău' in 3 systems of growing: in NFT system in greenhouse with natural lighting conditions, in NFT system in conditions of permanent lighting with LEDs (10 hours/day) similar greenhouse conditions. As a control variant, we used the culture on peat substrate, in 10/10 cm pots.

We found that in the conditions of growing under LED lighting, plant height, number of leaves per plant and plant mass were higher compared to the control variant (in pots), but these results also appeared in greenhouse in NFT system.

Also, the leaf yield was higher under NFT growing conditions for both varieties.

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