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STUDY ON THE INFLUENCE OF NUTRIENT CONDITIONS ON THE PRODUCTION AND QUALITY OF LETTUCE GROWN ON PERLIT SUBSTRATE

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Abstract

The study was carried out in the research greenhouse, within the Horticultural Products Quality Research Center in 2022. A variety of oak leaf lettuce, Kineta, was grown on the mattresses filled with perlite. The nutrient solution was administered in 3 concentrations (EC), namely 1.5 mS/cm^2, 2.5 mS/cm^2 and 3.5 mS/cm^2. Three pH levels were used for each EC type. Differences were found between the experimental variants regarding the variety's reaction to these treatments. The aim of the study was to see the influence of the nutrient solution concentration on some production and quality parameters of lettuce grown on perlite substrate.

Key words*: lettuce; soilless; perlite; substrate.*

INTRODUCTION

Lactuca sativa L. is one of the vegetable species cultivated on large areas, in all cropping systems, being consumed all year round. The salad assortment is quite varied from head salad to leaf salad. Within the assortment, the color varieties are diverse, from light green to dark red. In greenhouse conditions various cultivation methods have been adopted from soil cultivation practiced especially in solar conditions, spring or autumn sometimes and winter. Since the time to obtain the edible part is longer under the conditions of soil cultivation and the fact that the humidity of the soil cannot be controlled permanently, but also due to the pests that may appear in the soil in the last period, I resorted to the application of different methods of cultivating lettuce in an unconventional system. A frequently encountered method is the cultivation of lettuce on different types of substrates or under culture conditions in a nutrient film technology system. These methods lead to better control of the culture substrate, better monitoring of the nutrient solution, and finally to obtaining a well-controlled product from the point of view of the nitrate content. Different researchers have applied the cultivation system to substrates with very good results, thus being able to recommend the best variants in terms of nutrient solution concentration (Al-Kinani & Draghici, 2009). Simultaneously with the application of the non-conventional system on the culture substrate, organic fertilizers can also be applied, fertilizers that have a positive effect on the chemical composition of lettuce plants (Drăghici et al., 2016; Nicola et al., 2020) but also on the growth of lettuce plants (Enache et al., 2019; Zienab et al., 2021).

Nerlich & Dannehl (2020), in the research undertaken, showed that environmental conditions, fertilization, and the culture substrate can influence both the characteristics of lettuce plants and their average mass.

Melad and Fahima (2018), based on some studies, showed that there were differences between the use of chemical and organic fertilizers, with the data obtained showing that in the case of organic fertilization, the average mass of lettuce heads was higher compared to the organically fertilized ones, studies were also carried out by Asmaa et al. (2021) and Micu et al. (2022).

Ayşe et al. (2005) analyzed the influence of substrates composed of zeolite and perlite as well as the nutrient solution on the growth of lettuce plants and found that the use of zeolite increased the nitrogen and potassium content.

The study conducted showed that the use of the biochar product as a growth substrate in lettuce culture led to an increase in production and quality performance (Singh et al., 2012; Smider, 2014; Noor et al., 2023).

MATERIALS AND METHODS

The study was carried out in the research greenhouses belonging to the Center for the Study of the Quality of Agro-Food Products within USAMV of Bucharest. The seedlings were produced in the greenhouse, and at planting, they were 27 days old, presenting an average of 3.3 true leaves. Planting was done on mats filled with perlite with a grain size of 4 mm, the mats having a size of 1 m long and a capacity of 10 L. The experimental variants consisted of the application of the nutrient solution with concentrations of 1.5 mS, 2.5 mS, and 3.5 mS. In the case of each variant of EC, three pH values were used, namely nutrient solutions with pH 5, 6 and 7 (Table 1).

Table 1. The experimental variants

	EC mS/cm^2		
	1.5	2.5.	3.5
pH	5	5	5
pH	6	6	6
pH	7	7	7

During the growth of the plants, the temperature, light, and CO_2 content in the culture space were constantly monitored. The growth of the plants in height, the formation of the number of leaves, and the diameter of the lettuce plants were monitored dynamically, and at the end of the culture, after 32 days from planting, the mass of the plants and the root volume were determined. Also, at the end of the culture, we recorded the values for each plant and interpreted how the pH of the solution, in accordance with the concentration of the nutrient solution, influenced the height growth of the lettuce plants, the number of leaves formed per plant, the diameter of the plants, the mass of the plants, and nitrate content. Influence of nutrient solution concentration on height growth of lettuce plants. All recorded parameters were analyzed using Two ways ANOVA, Statistical software version 10, Turkey test was proceeded to differentiate between the treatments at $p<0.05$.

RESULTS AND DISCUSSIONS

The temperatures recorded in the greenhouse were appropriate for the species, being between 19°C and 24.67°C with an average during the growth period of 22.3°C.

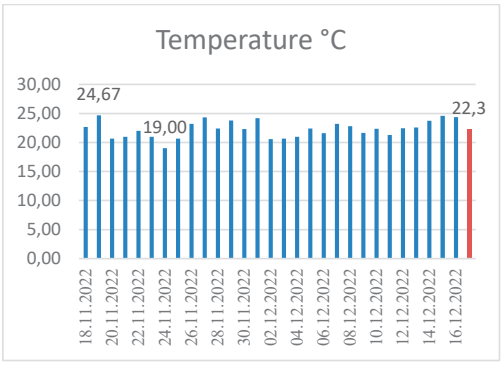


Figure 1. Temperature values recorded in the greenhouse during the culture period

The carbon dioxide concentration was on average 396.78 ppm, the maximum values recorded were 468.39 ppm and the minimum 337.85 ppm (Figure 2).

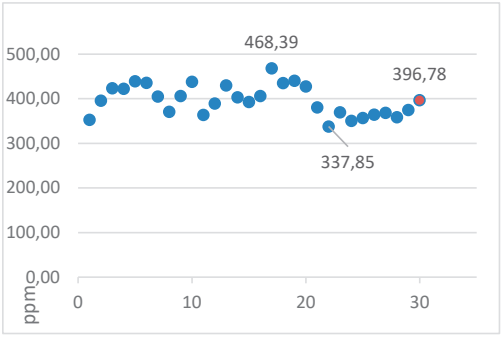


Figure 2. Carbon dioxide content recorded in the evening during the cultivation period

Figure 3. Appearance of the experiment in the greenhouse

From figure 4, it can be seen that at a pH of 5, in the case of all EC variants, the lowest plant height was obtained. In the case of the pH of 6 at the EC value of 1.5 mS/cm^2, the highest plant height (cm) was obtained, and in the case of using EC of 3.5 mS/cm^2, the plant height was also lower compared to the rest of the variants. The highest plant height values were recorded at pH 7, with plant height being the highest for all EC values.

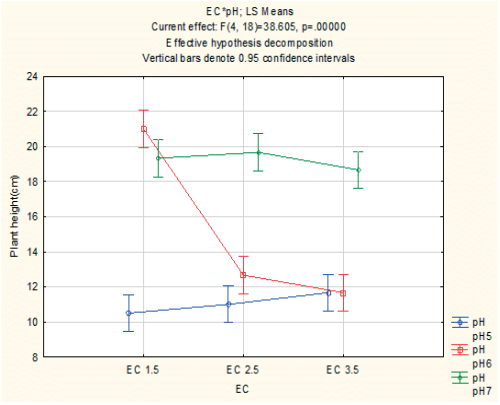


Figure 4 Influence of EC and pH on plant height

The number of leaves per plant recorded the highest values when using an EC of 1.5 mS/cm^2. Increasing the EC value to 2.5 and 3.5 mS/cm^2, respectively, did not lead to the formation of a large number of plant leaves, except for the use of EC 2.5 and at a pH of 7 (50.33 leaves/plant). The interaction between the EC used and the pH led to obtaining a lower number of leaves per plant in the case of a pH of 5 (Figure 5).

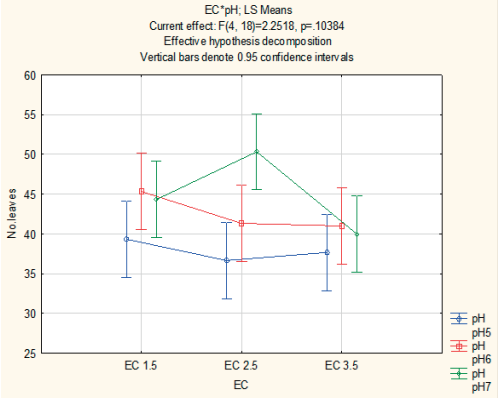


Figure 5 Influence of EC and pH on the number of leaves per plant

In the case of the interaction between EC and pH, a very significant influence was found on the growth in diameter of lettuce plants. The largest diameter of the plants was recorded when a pH of 7 was used. The smallest diameter of the plants was recorded when a pH of 5 was used. In the case of using a pH of 6, it was found that the largest diameter was obtained in the plants where the EC was 1.5 mS/cm^2 and the lowest in plants with an EC of 2.5 mS/cm^2 (Figure 6).

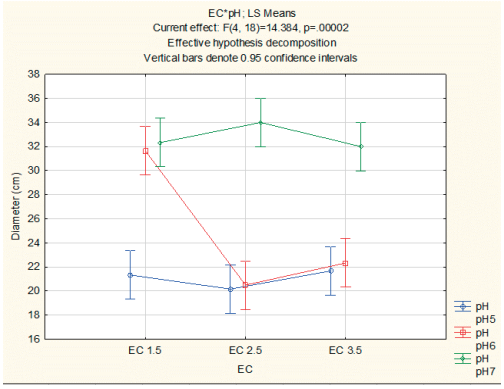


Figure 6. Interaction between EC and pH on diameter growth of lettuce plants

Based on the data analysis, we could find that in the case of using a pH value of 5, the average plant mass recorded the lowest values. In the case of all EC nutrient solution concentrations: 1.5 2.5 and 3.5 mS/cm^2) registering a very significant influence ($p = 0.0000$). In the case of using pH 7, it was found that the plant mass was the highest compared to the rest of the variants (Figure 7).

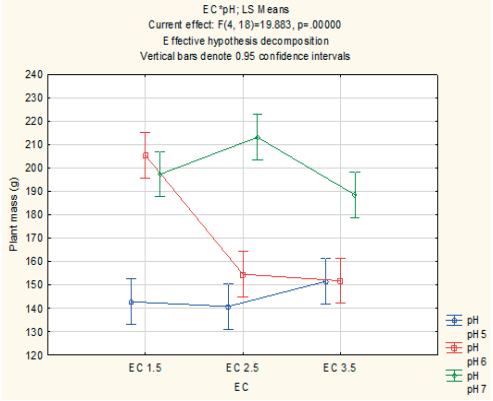


Figure 7. Interaction between EC and pH on plant mass

Analyzing the interaction between EC and pH values on the volume of the root system, it was found that there were no significant differences between its size (Figure 8).

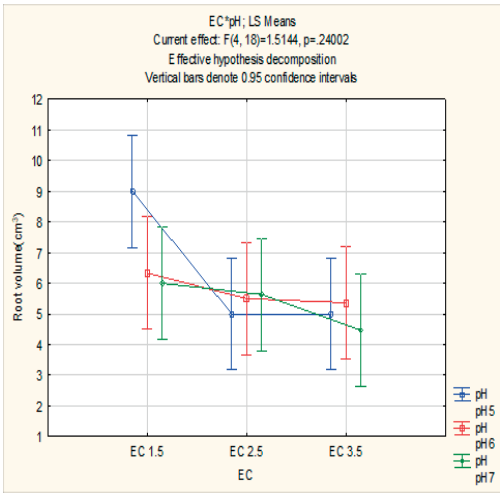


Figure 8. The interaction between EC and pH on root volume size

The correlation carried out to see the influence of the EC of 1.5 on the plant mass found a significant relationship (R^2 = 0.6406) which indicates that, in this situation, at a pH of 6 and 7 respectively, the plant mass increased (Figure 9).

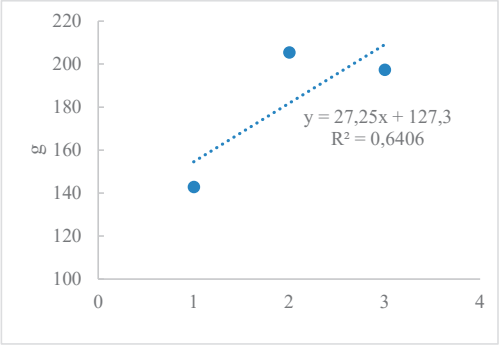


Figure 9. Relationship between EC of 1.5 mS/cm^2 and pH on plant mass

In the case of the EC of 2.5 mS/cm^2, a very significant correlation was also found in relation to the pH of the nutrient solution (R^2 = 0.8869). Also, and in the case of EC of 3.5 mS/cm^2 the relationship was significant (R^2 = 0.7551) (Figures 10 and 11).

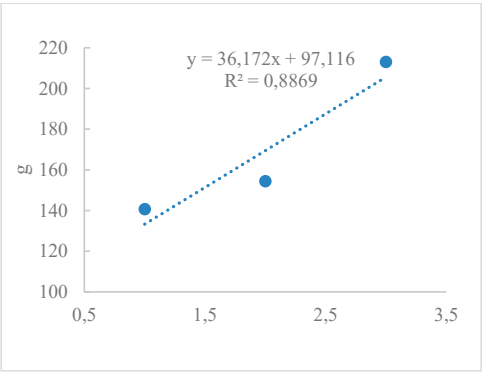


Figure 10. Relationship between EC of 2.5 and pH on plant mass

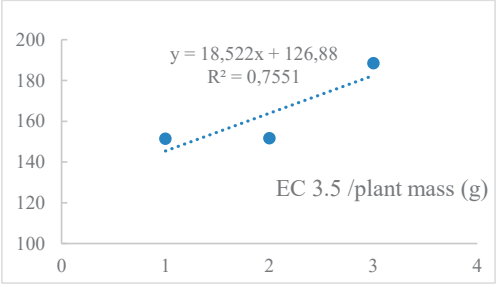


Figure 11. Relationship between EC of 3.5 mS/cm^2 and pH on mass of lettuce plants

Analyzing the influence of the pH, depending on the concentration of the nutrient solution (EC), it is noted that, in the case of using a pH of 5 and an EC with a value of 3.5 mS/cm^2, the mass of the plants was greater, which also emerges from the correlation performed (R^2 = 0.5833) (Figure 12).

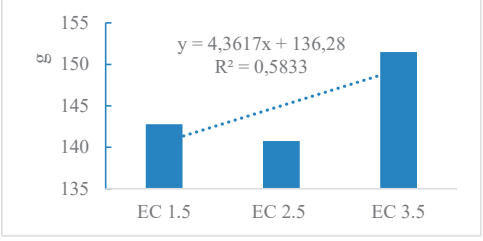


Figure 12. Correlation carried out at the pH 5 variant and EC values of the nutrient solution on plant mass

In the case of using a pH of 6, it was found that, using an EC of 1.5 mS/cm^2 led to a higher average mass, the correlation performed was negatively significant (R^2 = 0.789) as the EC increased (Figure 13).

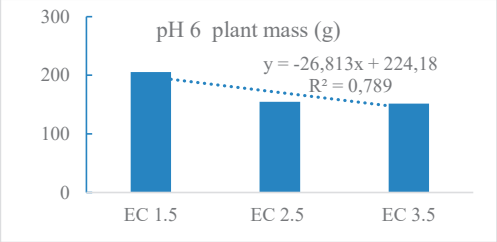


Figure 13. Correlation carried out at the pH 6 variant and the different EC values of the nutrient solution on plant mass

The correlation performed when using a pH of 7 led to the need to increase the EC to 2.5 mS/cm^2 to achieve a higher average plant mass. An EC of 3.5 mS/cm^2 and at a pH of 7 does not lead to an increase in production (R^2 = 0.1231) (Figure 14).

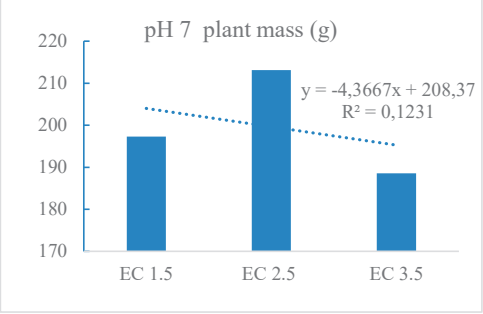
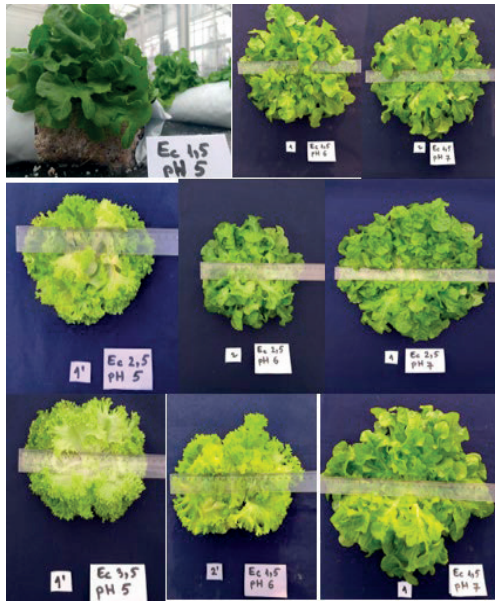


Figure 14. Correlation carried out for the variant of pH 7 and the EC of the nutrient solution on plant mass

Figure 15 shows an aspect from the moment of carrying out the determinations in the greenhouse.

Figure 15. Aspect from the time of carrying out the determinations in the greenhouse



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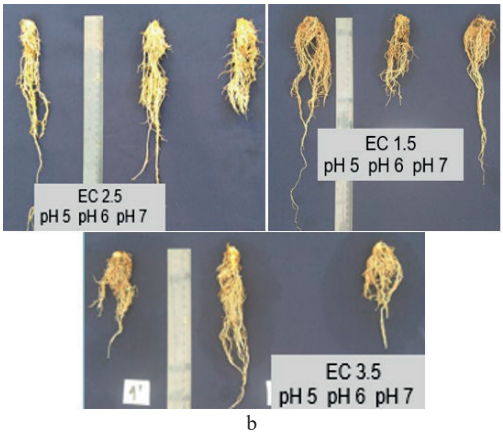

b

Figure 16. Appearance of lettuce plants (a) and appearance of roots (b) on experimental variants

In summary, in Table 2 it is noted that the highest average plant mass was recorded at an EC of 1.5, as well as plant height, number of leaves, plant diameter and root volume. A very significant influence of the EC nutrient solution concentration and even of the pH is noted.

From the interaction of EC and pH, very significant differences were noted regarding the mass, height and diameter of the plants and insignificant differences between the number of leaves and root volume (Table 2, Figure 16).

Table 2. The influence of EC and pH on the analyzed parameters

	Plant mass(g/plant)	Plant height(cm)	No.leaves	Diameter(cm)	Root volume(cm3)
EC 1.5	181.8 ± 10.1a	16.9 ± 1.6a	43.0 ± 1.4a	28.4 ± 1.8a	7.1 ± 0.8a
EC 2.5	169.5 ± 11.2b	14.4 ± 1.4b	42.8 ± 2.5a	24.9 ± 2.4b	5.4 ± 0.3b
EC 3.5	163.9 ± 6.7b	14.0 ± 1.2b	39.6 ± 0.7a	25.3 ± 1.7b	4.9 ± 0.3b
EC	***	***	ns	***	*
pH 5	145.0 ± 2.7c	11.1 ± 0.2c	37.9 ± 1.5b	21.1 ± 0.6c	6.3 ± 0.9a
pH 6	170.5 ± 9.2b	15.1 ± 1.5b	42.6 ± 0.9a	24.8 ± 1.8b	5.7 ± 0.3a
pH7	199.6 ± 4.1a	19.2 ± 0.3a	44.9 ± 1.9a	32.8 ± 0.5a	5.4 ± 0.3a
pH	***	***	**	***	ns
EC x pH	***	***	ns	***	ns

CONCLUSIONS

Temperature and atmospheric humidity conditions in the greenhouse were the factors ~~those~~ corresponding to the species throughout the experiment.

The height of the plant was influenced by the value of the EC, but also by the pH, as result indicated that the height of the plants maximized at pH 1.5 and with pH 7.

The lowest plant heights were recorded when a pH of 5 was used.

The number of leaves was also influenced by the pH not only by EC, but the greatest variations being also recorded at a pH of 7.

The diameter of the plants was also influenced by the highest pH values, being recorded at a pH of 7. In the case of the concentration of the EC nutrient solution had an influence on the growth in diameter of the lettuce plants, and the plant responded well to EC 1.5 mS/cm^2. The mass of the plants was influenced by both the pH value and the EC value. The highest values were recorded under the conditions of using a pH of 7 and an EC of 1.5 mS/cm^2.

The root volume was influenced to a lesser extent by the pH value, as here too, but the largest root volume of the roots was recorded in the case of using an EC of 1.5 mS/cm^2.

The correlations performed indicated significant values in the case of the interaction between EC and pH.

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