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## CROP PRODUCTION

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### INTERVARIETAL DIFFERENCES OF BIOMETRIC INDICATORS AND PRODUCTIVITY OF LETTUCE (*LACTUCA SATIVA* L.) DEPENDING ON DENSITY OF THE PLANT GROWTH IN HYDROPONIC SYSTEMS

Research article

#### Abstract

The article discusses conditions for growing varieties of lettuce in closed photoculture using hydroponic method. The purpose of the study was an agrobiological assessment and development of individual elements of the technology for growing Dutch lettuce varieties Caipira, Crispinet, Almadraba, Azirka, Cristabel, Ezrilla and Ovired in a hydroponic flooded system. We studied two options for the density of plants on the pallets of a hydroponic unit, which provide different crop production efficiencies.

**Keywords:** lettuce, hydroponics, productivity, biometric indicators.

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### МЕЖСОРТОВЫЕ ОТЛИЧИЯ В БИОМЕТРИЧЕСКИХ ПОКАЗАТЕЛЯХ И ПРОДУКТИВНОСТИ САЛАТА ПОСЕВНОГО (*LACTUCA SATIVA* L.) В ЗАВИСИМОСТИ ОТ ПЛОТНОСТИ РАЗМЕЩЕНИЯ РАСТЕНИЙ ПРИ ВЫРАЩИВАНИИ НА ГИДРОПОНИКЕ

Научная статья

#### Аннотация

В статье рассматриваются условия выращивания сортов салата посевного в закрытой светокультуре методом гидропонии. Цель исследования заключалась в агrobiологической оценке и разработке отдельных элементов технологии выращивания голландских сортов салата Caipira, Crispinet, Almadraba, Azirka, Cristabel, Ezrilla и Ovired на гидропонной системе типа подстопления. Исследовались два варианта плотности размещения растений на поддонах гидропонной установки, которые дают различную эффективность получения урожая.

**Ключевые слова:** салат посевной, гидропоника, урожайность, биометрические показатели.

#### 1. Introduction

Lettuce is a very popular green crop in the world, characterized by early maturity, good taste and the content of essential vitamins and minerals. Recently, the cultivation of this culture is carried out mainly in protected ground using hydroponic methods. Hydroponics ensures year-round stable crop and saves a significant amount of resources, this is especially true in areas of the Far North and alike. Therefore, the work studying basic agrotechnical methods for growing green crops in hydroponic farms in closed systems remains relevant to this day.

The study of the technology for growing lettuce in closed systems and protected soil has been developed in works of Russian scientists [2], [5], [6], as well as foreign scientists [10], [11]. The dependence of yield on lighting conditions, microclimatic conditions, agricultural practices and varietal characteristics of the culture is a well-known fact [3], [4], [7], [8], [9]. Study of growing conditions and their impact on the productivity and biochemical composition of plants are relevant and in demand due to the growing request for fresh and high-quality vegetable products.

The aim of the research was to assess the inter-varietal differences of the main biometric indicators and the productivity of 7 varieties of lettuce depending on the density of plants in hydroponic units.

Based on the goals, the following tasks were solved:

1. To study the biological characteristics of 7 varieties of lettuce in low-volume hydroponics in a closed light culture.
2. Survey the dynamics of growth indicators of 7 varieties of lettuce in conditions of different density on a pallet.
3. Set the optimum density of lettuce on a pallet in a hydroponic unit, which increases the yield of the product.

## **2. Methods**

The object of the study were 7 varieties of lettuce (*Lactuca sativa* L.): Caipira, Crispinet, Almadraba, Azirka, Cristabel, Ezrilla, Ovired (manufacturer Enza Zaden Seed Operations BV, Netherlands). Survey was carried out at the Department of Biology and Biotechnology of Surgut State University in 2018–2019 as part of a research topic on the study of plant growing conditions by the method of low-volume hydroponics in a closed photoculture. During the experiment was carried out an agrobiological assessment and development of individual elements of the hydroponic growing technology for 7 varieties of lettuce. The laboratory is equipped with hydroponic unit with a flooding system (tidal Ebb and Flow). Mineral wool cubes 75 mm long, 75 mm wide and 65 mm high with two grooves along the cube were used as a substrate for this type of hydroponic unit. The advantage of such a system is that the cubes are flooded 1–2 times a day, then the solution is drained, and lowering the water level provides fresh air to the roots for better breathing.

Seeds sowing was carried out by 3 seeds into a mineral wool cube, impregnated with a nutrient solution, to a depth of 0.3 cm, placing seeds evenly over the entire area of the cube. Germination was carried out in the dark, at an air temperature of +24 °C and a relative humidity of 85–90 %. On the third day, seedlings were placed on pallets of a hydroponic unit, 130 × 50 cm in size and were grown until the plants fully ripened (obtaining finished products).

To prepare the nutrient solution, water treatment was carried out and FERTICARE™ HYDRO complex water-soluble fertilizer was used with microelements and low chlorine content, as well as calcium nitrate; electrical conductivity 1.6–1.8 mS/cm; pH 5,8–6,1. Watering was carried out once a day per within 15 minutes.

The experiment was conducted indoors without sunlight, shelves were illuminated with white LED lamps with a full spectrum, luminous flux of about 8000 lm. Duration of lighting – 13 hours a day. Daytime air humidity was maintained in the range of 45–55 %, air temperature +22–24 °C, nutrient solution temperature +21–22 °C.

Variable parameters in the experiment: the density of plants on the pallets of the hydroponic unit. The first option: 50 cubes (5 rows of 10 pieces) were placed on a pallet, the distance between the cubes was 10 × 8 cm. The second option: 40 cubes (4 rows of 10 pieces) were placed on a pallet, the distance between the cubes was 12 × 12 cm.

Biometric indicators were taken at the beginning of growth then 4 days after, then after 5–6 days, and also at the end of the experiment the mass was determined after cutting the plants. We used plants from the central part of the pallet with the best lighting conditions. Wet weight of all plants in the cube, weight of one plant in the cube, height of the plant, number of leaves, leaf size (length and width) were registered according to B. A. Dospelkov [1].

Statistical processing of experimental data was carried out by the method of analysis of variance (the significance of the difference between the means was carried out according to least significant difference (LSD<sub>0.05</sub>), using the Microsoft Excel package.

## **3. Results**

Currently, there are many varieties of lettuce of different type and color, as well as taste. The Dutch varieties of lettuce that we are studying are not yet very popular in Russia, and the agrotechnical methods of their cultivation in hydroponic plants with a flooding system have not been sufficiently studied. The results of phenological observations showed that the onset of technical ripeness (8–10 leaves) for different varieties of lettuce is somewhat different. So lettuces of Almadraba, Ezrilla and Ovired varieties turned out to be ripening faster – 38 days. For the rest of the varieties, the onset of technical maturity reached at 43–45 days.

Differences in biometric parameters were also observed. The studied varieties of lettuce formed medium height (18.6–22.9 cm) rosettes, the exception were Azirka, Cristabel and Crispinet varieties, in which rosettes had a height in the range of 13.3–16.5 cm.

The number of leaves in lettuce determines the yield. Ezrilla and Almadraba varieties (16–17 leaves) turned out to be many-leaved, Azirka and Cristabel (8–10 leaves) were few-leaved.

Observation of biometric indicators in 2 experiments, differing in the density of arrangement of mineral wool cubes on pallets of a hydroponic unit, showed that the height of the sockets at the initial stages of growth did not differ significantly (Figure 1). Differences became more noticeable at later stages (29, 36 days), plants of 3 varieties in option 2 were characterized by a higher height (Caipira, Azirka, Almadraba), compared with option 1. There were no significant differences in the varieties Cristabel, Crispinet, Ezrilla and Ovired.

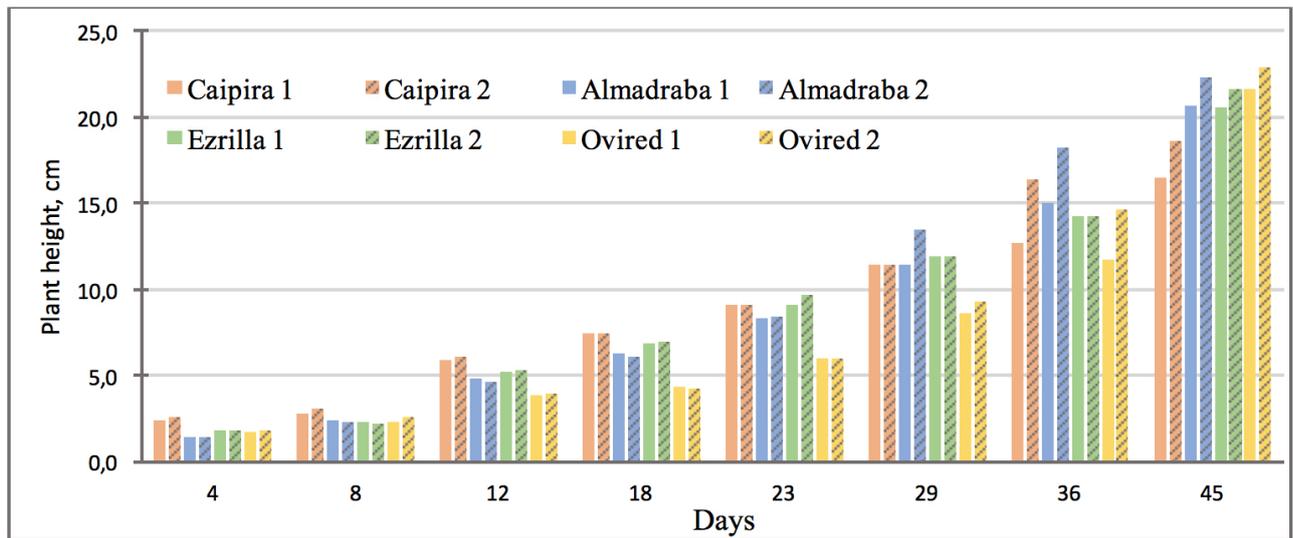


Figure 1 – Height of 4 lettuce varieties (Caipira, Almadraba, Ezrilla, Ovired) at different stages of development in two options of placement on the pallets:

1 – 50 pieces on a pallet, 2 (shown by hatching) – 40 pieces on a pallet. The abscissus axis shows the number of days from the sowing commencement

According to the number of leaves in rosettes, it is noted that in the second options 5 varieties have a significant excess of the number of leaves compared to the first option. These are lettuce varieties: Caipira, Crispinet, Azirka, Cristabel and Ovired (Figure 2). The other two varieties do not have reliable differences for this indicator.

Another biometric parameter, such as leaf length, shows a true difference in the second option of the three varieties of Caipira, Crispinet and Azirka lettuces, exceeding that value in option 1. The remaining 4 varieties do not show reliable differences (Figure 3). The width of the leaf is reliably higher in Caipira, Crispinet, Azirka, Cristabel and Ezrilla varieties.

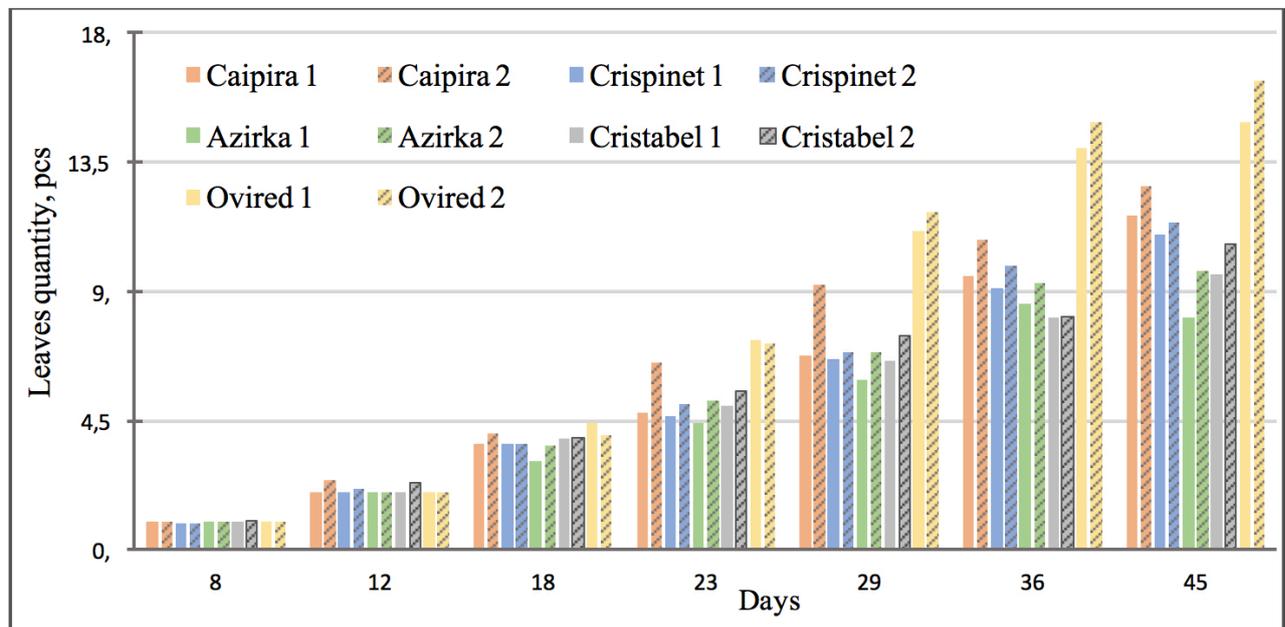


Figure 2 – Leaves quantity of 5 lettuce varieties (Caipira, Crispinet, Azirka, Cristabel, Ovired) at different stages of development in two options of placement on the pallets:

1 – 50 pieces on a pallet, 2 (shown by hatching) – 40 pieces on a pallet. The abscissus axis shows the number of days from the sowing commencement

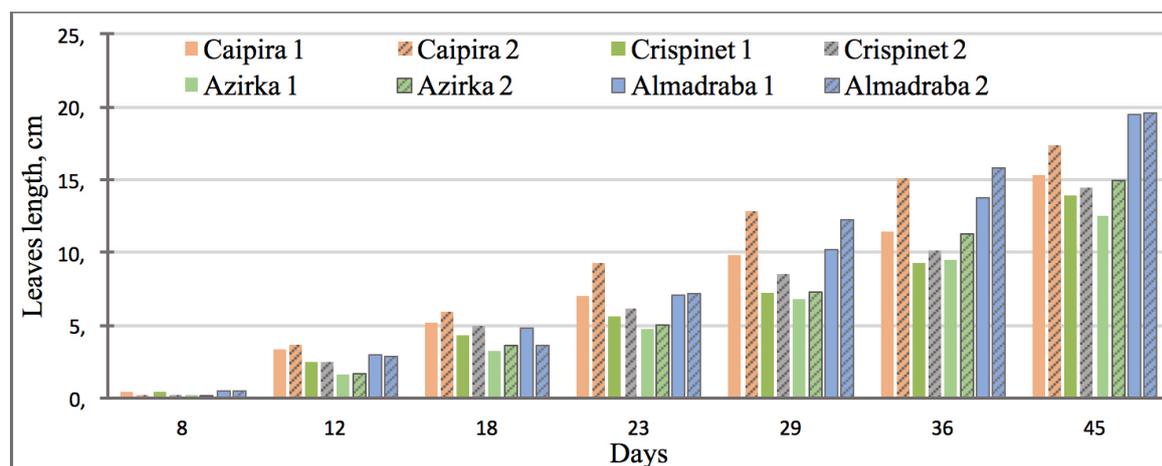


Figure 3 – Leaves length of 4 lettuce varieties (Caipira, Crispinet, Azirka, Almadraba) at different stages of development in two options of placement on the pallets:  
 1 – 50 pieces on a pallet, 2 (shown by hatching) – 40 pieces on a pallet. The abscissus axis shows the number of days from the sowing commencement

When comparing yields in the two described options of plant placement on the pallets, a significant increase in yield in the second option of the experiment was revealed for 5 lettuce varieties: Caipira, Crispinet, Azirka, Cristabel and Ezrilla. The highest increase in biomass was observed in the varieties of Caipira (83 %), Cristabel (128 %) and Ezrilla (71 %) (Table).

Table 1 – Yield of lettuce depending on the placement density on the pallet of the hydroponic unit, the average value

Variety of lettuce (figure shows experiment option)	Average mass of 1 plant, g	Average mass of 3 plants in a cube, g	Yields, kg/m <sup>2</sup>	Sx (experiment error), g
Caipira 1	16.28	48.84	3.00	2.12
Caipira 2	29.84	73.83	4.54	2.09
LSD <sub>0.05</sub>	5.53			
Crispinet 1	9.36	22.41	1.38	1.37
Crispinet 2	14.37	34.81	2.14	1.10
LSD <sub>0.05</sub>	3.64			
Almadraba 1	33.02	71.76	4.41	4.39
Almadraba 2	35.23	86.29	5.30	2.51
LSD <sub>0.05</sub>	Not significant			
Azirka 1	7.69	17.60	1.08	1.11
Azirka 2	13.36	34.52	2.12	1.06
LSD <sub>0.05</sub>	3.45			
Cristabel 1	13.24	34.93	2.15	1.81
Cristabel 2	30.22	70.70	4.08	2.02
LSD <sub>0.05</sub>	6.00			
Ezrilla 1	22.72	52.86	3.25	4.61
Ezrilla 2	38.93	90.01	5.54	2.61
LSD <sub>0.05</sub>	10.85			
Ovired 1	16.73	46.17	2.84	0.68
Ovired 2	20.44	47.78	2.94	1.80
LSD <sub>0.05</sub>	Not significant			

As a result of the survey, it was found that the change in the density of lettuces on the pallet of the hydroponic unit has an impact, but not for all the varieties of lettuces. The varieties of Caipira, Crispinet, Azirka, Cristabel and Ezrilla lettuces were positively reacting to the decrease in the placement density. However, not all biometric parameters had reliable differences. The most significant parameter is the yield, and all these 5 varieties significantly increased the yield in the second option. On the other hand, lettuce varieties that did not change the values of mass in the second option – Ovired and Almadraba, are also promising for cultivation, as they can be placed on the pallet denser, and thus it is possible to increase the yield per square meter of area.

**Conflict of Interest**

None declared.

**Конфликт интересов**

Не указан.

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