Variety testing of new head lettuce hybrids

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Abstract. The growing demand of the country's population for head lettuce is met, according to various authors' estimates, by no more than 30-35%. The main suppliers from Iran, Israel, and Uzbekistan are actively involved in the import of green crops in Russian Federation. One of the existing levers of increasing the production of head lettuce is the introduction of new high-yielding and complex-resistant hybrids into production and the development of varietal agricultural techniques for their cultivation. The article presents an agro-technology evaluation of new hybrids of head lettuce F1 Serena and F1 LE 10585 of the company "Sakata" according to the main economically valuable indications (productivity, yield, biochemical analysis) in the conditions of the Anapa-Taman zone.

1. Introduction

Lettuce (Lactuca sativa var. capitata) belongs to the genus Lactuca, family Asteraceae. This is a cold-resistant, precocious, low-calorie vegetable crop. Head lettuce is a natural antioxidant that accumulates vitamins C, PP, E, and the content of beta-carotene reaches up to 6.1 mg% against 1.2 mg% of white cabbage. The content of vitamin C ranges from 2 - 2.5 mg%. Lettuce leaves contain a large amount of folic and organic acids (65 mg% malic acid, 48 mg% citric acid and 11 mg% oxalic acid). When using nitrate forms of nitrogen in the period of unfavorable conditions, a residual amount of nitrates can accumulate in the lettuce, which can lead to a decrease in the quality of products [1, 11].

The study of the agro-technology plasticity of new hybrids of head lettuce in the conditions of is of undoubted interest for several reasons:

Firstly, the cultivation of lettuce by individual entrepreneurs and owners of small businesses should be considered as a profitable commercial solution.

Secondly, the precocity, cold-resistance, and suitability for the cassette technology allow us to grow lettuce in a conveyor culture in 4-5 terms.

Thirdly, there is an unlimited demand for Iceberg lettuce from processors (for example, the daily demand for head lettuce from one company "Belaya Dacha" is 50-60 tons).

Insignificant labor and material costs, as well as the extended period of cultivation, with profitability in all periods of production, make the crop attractive for small businesses forms. The hampering of the further development of production is observed due to the lack of technological support from the originators of varieties and hybrids and the lack of varietal agricultural technics for various soil and climatic zones of the region.

2. Problem Statement

The main task of vegetable growing is to provide the population with all vegetable products consistently throughout the year and in accordance with the physiological norms of consumption. Vegetables that are
consumed fresh are of particular value, which allows us to use the mineral salts and vitamins contained in them in an unchanged state. Green crops, which are mainly used in fresh form, play an important role [2, 9]. As of 2020, about 415 varieties and hybrids of lettuce have been included in the State Register of Varieties of Russia for use in agricultural production [3]. In our opinion, the main task of selection and varietal agrotechnics is to resolve the bottlenecks, namely, the slow differentiation of growth processes in the first half of the growing season, the low resistance of plants to leaf necrosis and the increase in the mass of heads (54-56% of the total plant phytomass). New varieties must be resistant to biotic and abiotic environmental factors, and have high environmental plasticity.

3. Research Questions

3.1 Research objects

The objects of research were hybrids of the Sakata breeding and seed company F1 Serena and F1 LE 10585. These samples are being tested for the first time in the conditions of the south of Russia, they are not included in the State Register of Breeding Achievements approved for use in the Russian Federation.

3.2 Subject of research

The study of new hybrids of the Sakata breeding company in the vegetable crop rotation. The experiments were laid in the Temryuksky district of the Krasnodar Krai. The researchs were carried out according to the generally accepted methods.

Vegetable pepper was the predecessor. The system of soil preparation was carried out according to the type of semi-steam with background fertilization. In the pre-sowing processing, the field was leveled with the achievement of a fine-lumpy structure by using light harrows [4, 6]. The scheme of planting seedlings (90+50) x 30 cm. Planting of seedlings for the spring growing period was carried out in the decade of May 2020. The area of the experimental plot is 12 square meters, the area of the accounting plot is 10 square meters. The repetition in the experiments is fourfold. The number of registered plants in each repetition is 60 pieces.

Weather conditions were close to the long-term average annual. However, during the growing season, there were sharp temperature changes, which could affect the tying of the head.

The planting of seedlings of the culture began after warming up the soil and increasing its temperature to 15.0-16.5°C at a depth of 6-8 cm. Precipitation fell in the form of short-term rain: for the first decade of May it was 29 %, and in the third – of a torrential nature - it was 192 % of the norm. The amount of precipitation is not a limiting factor, since the plantings were on drip irrigation. The temperature started to rise sharply in June. In July, the average decadal temperature varied from 24.1°C to 26.9 °C, the maximum was 30 °C, the difference between day and night temperatures was 2-3 °C.

4. Purpose of the Study

The purpose of our work is to establish the potential yield and environmental plasticity of new head lettuce hybrids of the "Sakata" company in the conditions of the Краснодарском крае for their subsequent introduction into production. To achieve this goal, the following tasks were solved:

The features of the formation of morphological indications of head lettuce plants were studied.

We have established the dynamics of the formation of the crop and the receipt of products.

Based on the obtained results and observations a conclusion about the possibility of zoning the studied samples in the conditions of the Krasnodar Krai was issued.

5. Research Methods

We used field and statistical methods of research. Sowing of head lettuce seeds was carried out on March 30 to obtain seedlings and further field researchs.

Seedlings of the studied hybrids were planted on May 8, 2020 in the 3-4-leaf phase.

In the course of the research, the following accounts and observations were made:

1. Determination of laboratory germination of seeds.
2. Determination of the degree of plant survival and the percentage of falls.
3. Phenological observations (date of sowing seeds, planting seedlings in the open ground, formation of the head, the onset of technical maturity, the date of harvesting).
4. Dynamics of phytomass growth.

6. Results
The experiments were laid out according to the planting scheme (90+50) x 30 cm, which provided a density of standing plants of 47.6 thousand plants/hectare. The landing was carried out by a seedling machine. Post-planting control established 100% survival rate of plants.

On 5-6 days, the seedlings adapted to the weather conditions of the open ground and before harvesting the heads there were no falls in any repetition.

On the 10th day of the growing season, the hybrids had 5-7 leaves, 7-8 cm long and 5-6 cm wide. The dynamics of the growth of phytomass is reflected in Table 1.

**Table 1. Phenological data on head lettuce, 2020.**

| Under research hybrids | Date of planting seedling | Date of appearance of mass shoots | Date of planting seedling | Date of 3-4 leaves | Date of 5-7 leaves | Date of formation of the head | Date of mass harvesting |
|------------------------|---------------------------|----------------------------------|---------------------------|-------------------|-------------------|-----------------------------|-----------------------|
| F1 Serena              | 30.03                     | 04.04                            | 08.05                     | 22.05             | 04.06             | 10.06                      | 20.06                 |
| FILE 10585             | 30.03                     | 04.04                            | 08.05                     | 22.05             | 04.06             | 11.06                      | 20.06                 |

The is a slow growth of head lettuce plants in the first month of the growing season. The 22 of May, single plants, which passed to the formation of the head were observed. During the next 10 days, 85-90% of the plants clearly showed the contours of the formed heads. We draw the attention of producers to the indication. The formation and ripening of the head at the same time go with a delay. The above and other photographic materials the tolerance of hybrids to leaf necrosis, bacteriosis, and false powdery mildew, which affect head lettuce hybrids, can be seen.

The shape, color, and position of the leaf blade for head lettuce are not so important at first glance, because the producer is interested in the head, but these indicators affect the aesthetic perception of the culture, and the formation and structure of the head [10] (Table 2).

**Table 2. Dynamics of lettuce phytomass growth, 2020.**

| Hybrid       | Indicator  | Phytomass of lettuce after planting seedlings |
|--------------|------------|---------------------------------------------|
|              | 5th day    | 10th day | 20th day | 30th day | 40th day |
| F1 Serena    | Leaf weight| 3.07     | 10.06    | 39.48    | 185.0    | 310.67   |
|              | Weight of roots | 0.73   | 1.57     | 2.14     | 10.21    | 15.22    |
|              | Head weight | –       | –        | –        | 230.64   | 390.14   |
|              | ∑           | 3.77     | 10.78    | 40.82    | 415.97   | 716.03   |
| F1 LE 10585  | Leaf weight| 2.86     | 9.02     | 44.43    | 185.34   | 221.47   |
|              | Weight of roots | 0.63 | 1.23     | 1.36     | 10.82    | 14.53    |
|              | Head weight | –       | –        | –        | 199.17   | 385.86   |
|              | ∑           | 3.49     | 10.25    | 45.79    | 395.33   | 621.86   |

The position of the leaf in the studied hybrids is semi-erect or closer to erect. Starting from the phase of 3-4 leaves, the plant begins to lift the leaves by 10-15 °C to the top, freeing up space for the newly laid leaves. The leaf blade is whole, light green in color with a slight serration.
In the structure of plants, the mass of leaves in the F1 Serena hybrid in the first 20 days after planting seedlings is from 81.4 to 96.6%. In the F1 LE 10585 – 81.9-96.7% (Table 3).

Table 3. Growth of phytomass of head lettuce (% of the total mass of plants), 2020.

| Indicator          | F1 Serena |          |          |          |          |          | FILE 10585 |
|--------------------|-----------|----------|----------|----------|----------|----------|------------|
|                    | 5th day   | 10th day | 20th day | 30th day | 40th day |          |            |
| Leaf weight        | 81.4      | 93.3     | 96.7     | 44.5     | 43.4     | 71.9     | 81.9       |
| Weight of roots    | 18.6      | 6.7      | 3.3      | 1.1      | 2.1      | 63.9     | 18.1       |
| Head weight        |           |          |          |          |          | 54.4     | 50.3       |
| Weight of total    |           |          |          |          |          | 54.4     |            |
| plant, g           | 100       | 100      | 100      | 100      | 100      | –        |            |

The analysis of Table 3 shows the different intensity of the growth of the head weight during the growing season of plants. It is noted that it goes in the last 10-12 days, just before harvesting.

The average indicator of the percentage expression of the weight of organs is also not sufficiently informative. However, in the total phytomass of plants, heads account for 54.4-56.2% of the weight of the studied hybrids. There is a need for further study of possible methods of increasing the weight of the food organ through crop selection and the development of appropriate agricultural practices.

It is known that both for sowing lettuce seeds and for planting seedlings, excellent soil preparation is required, starting with the structure of the surface layer (it should be finely lumpy, and the surface should be leveled), since the root system is tender, lightweight, with a weak location of the surface roots, which caused a positive regeneration of the roots.

We want to pay attention to the preservation of the stability of the roots in the arable layer, where easily decomposing organic substances (after the introduction of poorly matured manure) can cause the development of mushrooms that cause rot. The necessary organic matter for the soil, which improves the structure, should slowly decompose and, if possible, preserve the structure. For this reason, pepper was chosen as a precursor, under which 40 tons/hectare of compost was added.

The root system of head lettuce grows very slowly. On the 5th day, the roots weighed 0.10-0.15 g. Despite the irrigation with perviku and the timely deployment of the drip irrigation system, the plants lost turgor. The mass of the roots after 5 days added a little more than 1 g, and on the 10th day it was 1.17 g for F1Serena, and 1.27 g for F1LE 10585 (Fig. 1, 2). The dynamics of root growth is shown in Table 3.

The shape of the head on the vegetating plant F1Serena (Fig. 3, 4) is perceived visually as rounded. In a long cross-section, the shape of the head is more expressive, and it is closer to the round-oval. In the F1 LE 10585 hybrid, is more elongated (Fig. 5).

According to the size of the heads, in our opinion, the most possible to consider (medium, large, very large) are medium-long between large and medium.

In terms of density, the heads are of medium density, as it should be in a head lettuce.

Dense and very friable heads are rare, but the friable ones that were left for a week to mature are 7-11%. The heads are closed for harvesting (Fig. 6).
The system of plant protection in the economy was conducted with elements of organic farming without the use of herbicides [5, 7].

The control of the manifestation of diseases on the registered plants showed that none of them showed indications of diseases, which indicates their high tolerance (Table 4).
Table 4. Control of tolerance of the studied samples of head lettuce, 2020.

| Test sample   | on the 5th day | on the 10th day | on the 20th day | on the 30th day | on the 40th day |
|---------------|---------------|----------------|----------------|----------------|----------------|
| F1 Serena     | no indications| no indications | no indications | no indications | no indications |
| FILE 10585    | no indications| no indications | no indications | no indications | no indications |

The economic significance of the studied hybrids for possible cultivation in small businesses forms is quite high, as indicated by the figures given in Table 5.

Table 5. Economy of head lettuce production, 2020.

| Technology Area | Yield, kg/ha | Revenue, rub | Expenses, rub | Profit, rub | Average price, rub/kg | Cost price, rub/ha | Profitability, % |
|-----------------|--------------|--------------|---------------|-------------|-----------------------|-------------------|------------------|
| ground per 1 ha | 18125        | 596375       | 217875        | 378500      | 32.9                  | 12.0              | 174%             |
| total ha        | 0.008        | 145          | 4771          | 1743        | 3028                  |                   |                  |

Regarding the yield, it should be said that it was actually at the level of indicators of advanced farms.

The commercial attractiveness of the culture in the Kuban has not lost, which we see in terms of cost price and profitability.

7. Conclusion
The market demand for head lettuce in the south of Russia remains unsatisfied for 5-6 years, despite the excellent conditions for its cultivation in the region. The problem is the lack of in-depth logistics and marketing research covering the range of products grown, time frames, volumes, forms of delivery, etc. The market requires early, high-yielding hybrids, with a high alignment of the heads by weight, density, having an intense light green color of the leaves, with a white, grayish-white, yellowish-greenish color inside the head. In the context of such requirements, a research on the growth processes, productivity and product quality of new head lettuce hybrids was constructed, which allowed us to establish the following:

1. Hybrids F1 Serena and F1 LE 10585 should be attributed to early maturing, which from the planting of seedlings to the maturation of the heads takes 45-50 days.

2. In the structure of costs in the production of lettuce, the largest costs (48 %) fell on seeds, care work for vegetative plants (12%), plant protection system (12%), irrigation with fertigation, which shows the possibility of growing lettuce in large quantities in farms.

3. A comprehensive evaluation of vegetation conditions, varietal specificities of F1 Serena and F1 LE 10585 hybrids allow us to conclude that it is possible to grow hybrids in 3-4 terms:
   A) III decade of March – I decade of April.
   B) II-III decade of April.
   C) I decade of May.
   D) III decade of July – I decade of August.

References
[1] Wahid F, Baig S, Arshad M 2020 Growth responses and rubisco activity influenced by antibiotics and organic amendments used for stress alleviation in Lactuca sativa Chemosphere 264 128433
[2] Varela A, Sandoval-Albán A, Combariza G 2021 Evaluation of green roof structures and substrates for Lactuca sativa L. in tropical conditions Urban Forestry & Urban Greening Available 127063

[3] State Register for Selection Achievements Admitted for Usage (National List) 2019 Plant varieties (official publication) (Moscow: FGBNU Rosinformagrotekh) 516 pp. Retrieved from: https://gossortrf.ru/wp-content/uploads/2019/07/REESTR_2019-3.pdf

[4] Abedin T, Yamamoto A, Hosokawa M 2020 Drip fertigation enhances the growth of hydroponic lettuce (Lactuca sativa) using polyester fiber substrate Scientia Horticulturae 276 109604

[5] Lúcia D R, Santos H M L M, Delerue-Matos C 2016 Ecotoxicological impact of two soil remediation treatments in Lactuca sativa seeds Chemosphere 159 193-198

[6] Verwaaijen B, Wiberg D, Schlüter A 2017 Assembly of the Lactuca sativa, L. cv. Tizian draft genome sequence reveals differences within major resistance complex 1 as compared to the cv. Salinas reference genome Journal of Biotechnology 267 12-18

[7] Azzi V, Kanso A, Samrani A El 2017 Lactuca sativa growth in compacted and non-compacted semi-arid alkaline soil under phosphate fertilizer treatment and cadmium contamination Soil and Tillage Research 165 1-10

[8] Baslam M, Morales F, Goicoechea N 2013 Nutritional quality of outer and inner leaves of green and red pigmented lettuces (Lactuca sativa L.) consumed as salads Scientia Horticulturae 151 103-111

[9] Teng Z, Luo Ya, Trouth F 2019 Identification of romaine lettuce (Lactuca sativa var. longifolia) Cultivars with reduced browning discoloration for fresh-cut processing Postharvest Biology and Technology 110931

[10] Witkowska I M and Woltering E J 2014 Storage of intact heads prior to processing limits the shelf-life of fresh-cut Lactuca sativa L. Postharvest Biology and Technology 91 25-31. DOI: https://doi.org/10.1016/j.postharvbio.2013.12.011

[11] Rana M K 2016 Salad Crops: Dietary Importance, in: Encyclopedia of Food and Health pp 665-672