Assessment of collection samples of leeks for cultivation and breeding in the North-Western region of the Russian Federation

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Abstract. 21 collection samples of leek were assessed to identify appreciable varieties for breeding and cultivation in the conditions of the North-Western region of Russia. The study was performed in 2015-2019 at the experimental field of the Pushkin laboratories of the Department of Genetic Resources of Vegetable Crops of N.I.Vavilov Institute of Plant Genetic Resources. We have found varietal differentiation in terms of growth, yield and biochemistry of the studied leek samples. The dynamics of leek growth identified an advantage in the number of leaves, the sheath diameter and the increase in plant mass in the Anika, Lincoln and Banditd samples in 2015-2016 and in the Gayia, Elefant and Malabare samples in 2018-2019, which provided a heavy yield.

1. Introduction
A promising vegetable crop in the North-Western region of the Russian Federation is leek. It is distinguished by high productivity, winter hardiness, versatility, valuable dietary properties, environmental plasticity and high adaptability to growing conditions [1].

Leeks are not widely used in Russia today. According to its qualities, it belongs to the most valuable types of onions. The content of proteins, fats and carbohydrates in the false blanched stem varies: 1.8-2.2%, 0.2%, 7.3-11.2%, respectively. Leek is rich in organic acids and vitamins (ascorbic acid, B vitamins), mineral salts and trace elements [2]. The green leaves of any stage of development are used for food.

10 kg of leek per capita is made annually in European countries [3].

One of the most essential components of the technology is the variety. The yield, adaptability to industrial technology, the provision period and the quality of vegetable products depend on it [4].

The presence of a well-studied parent material with a complex of valuable economic features is of great significance in the selection of leeks [5]. The study of the leek gene pool to select the original forms for breeding is of great practical value. The studies by scholars are performed on winter hardiness, productivity, resistance to diseases and pests, as well as adaptability. This gives the opportunity to create varieties and hybrids suitable for cultivation in the North-Western region of Russia, as well as to increase the production of leeks [6].

Today, 31 varieties of leek are registered in the State Register of Selection Achievements Authorized for Use for Production Purposes of the Russian Federation in 2021 [7].

The creation of new varieties and hybrids by selecting the parent material and assessment for cultivation and selection is a relevant direction.
Therefore, in the period from 2015 to 2019, studies were performed on the examination and assessment of 21 samples of leeks of domestic and foreign selection. The evaluation was made according to the main economically valuable features of plants to identify the most promising conditions for breeding and growing in the North-West of Russia.

The following research objectives are to study the peculiarities of growth, development and formation of the crop, as well as to identify the biochemistry of the studied leek samples.

2. Materials and methods

The research objects were samples of leeks of the European subspecies. The soils of the experimental field of the Pushkin laboratories of the Department of Genetic Resources of Vegetable Crops of N.I.Vavilov Institute of Plant Genetic Resources are sod-podzolic, light loamy with a pH of 6.5, the availability of mobile forms of phosphorus and potassium is average.

The registration plot area is 2.0 m², the replication in the experiments is 4-fold. The placement of plots in the experiment is randomized.

The scheme of experience consists of the following samples of the world collection of N.I.Vavilov Institute of Plant Genetic Resources: Pandora (K-2546), Bandit (K-2542), Anica (K-2577), Zhiraf (K-2586), Premyer (K-2561), Kamus (K-2573), King (K-2499), Longina (K-2496), Lincoln (K-2544), Mestny Burundi (K-2486), Mestnny Jamaica (K-2555), De Carentan (K-2519), Elefant (K-2199), American flag (K-2456), Malabare (K-2485), Pras (K-2038), Gayia (K-2539), Lavi (K-2526), Bulga (K-2516), Long meries (K-2131), Renova (K-2517).

The records and observations were performed according to the methodology of N.I.Vavilov Institute of Plant Genetic Resources aimed at the study of the collection material of onion crops [8].

In the course of the experimental work, phenological, biometric observations, analysis of plants for biochemical composition were performed. The yield record was performed by weighing the total and marketable products according to the accounting plots. The data obtained was processed by the statistical method [9].

Leek was grown in seed culture. The transplant seedlings (age 60 days) underwent open-ground planting in the 2nd decade of May. Planting scheme (60+10)/2 × 15 cm.

3. Results and discussion

The significant differences in agro-climatic conditions were noted during the years of research. In 2015, the most favorable conditions for leeks were formed: the optimal amount of precipitation, the air temperature in the long autumn period exceeded the long-term average by 3-4 °C. In 2019, there were favorable conditions for culture. The growing season of 2016 and 2018 was marked by insufficient or superfluous humidification conditions and considerable temperature fluctuations.

The following plant characteristics were studied: height, length and diameter of the sheath, number and width of leaves. The biometric observations were performed in dynamics on 10 plants from the variant 40 and 70 days after open-ground planting and before harvesting.

The leek crop formation is considerably influenced by the photosynthetic potential, which depends on the leaf area and narrow habit. The height of leek plants belongs to varietal features. The highest plants were observed in the Kamus samples – 105.1 cm and Lincoln – 101.1 cm, and the lowest in the Premyera sample - 78.7 cm (Table 1).

| Sample name, origin | Plant height, cm | Yield, kg /m² | Plant weight, g | Diameter of the sheath, cm | Length of sheath, cm | Number of leaves, pcs | Middle leaf width, cm |
|---------------------|-----------------|---------------|-----------------|---------------------------|---------------------|----------------------|-----------------------|
| Anica (Netherlands) | 99.2            | 5.03          | 386.7           | 4.4                       | 23.2                | 9.3                  | 6.6                   |
| Sample name, origin | Plant height, cm | Yield, kg/m² | Plant weight, g | Diameter of the sheath, cm | Length of sheath, cm | Number of leaves, pcs | Middle leaf width, cm |
|--------------------|-----------------|--------------|----------------|--------------------------|---------------------|----------------------|----------------------|
| American flag (India) | 95.6            | 2.63         | 202.8          | 3.3                      | 24.2                | 8.0                  | 4.3                  |
| Bulga (Sweden)      | 98.1            | 2.91         | 207.6          | 3.4                      | 23.9                | 9.0                  | 5.0                  |
| De Carentan (Argentina) | 85.1           | 2.77         | 205.4          | 3.3                      | 23.6                | 8.4                  | 5.1                  |
| Elefant (Canada)    | 96.2            | 3.58         | 255.4          | 4.2                      | 21.2                | 10.0                 | 5.4                  |
| Gayia (Netherlands) | 97.2            | 3.66         | 261.8          | 3.8                      | 26.3                | 10.0                 | 58                   |
| Lavi (Denmark)      | 99.8            | 2.80         | 203.6          | 3.4                      | 34.7                | 8.4                  | 4.3                  |
Long meries (Canada)          107.8  2.37  197.2  3.3  30.2  7.8  4.1
Malabare (France)            88.4   3.48  248.8  4.0  22.2  9.6  5.6
Renova (Sweden)              93.4   2.50  191.2  3.3  25.2  8.8  4.1
Pras (Russia)                85.6   3.21  229.4  3.7  19.2  9.6  5.2

The most valuable part of the leek is believed to be the blanched part of the sheath. The sheath length is an essential indicator of the cash crop of the leek. The dynamics of the increase in the length of the cash crop showed an advantage in this indicator during all monitoring periods and by harvesting was the greatest in the Zhiraf samples -32.3 cm, King -31.7 cm, Lavi and Long meries - 34.7 cm and 30.2 cm (tables 1, 2). The length increase of the sheath in the experimental samples Malabare, Bulga and the control De Carentan had a common pattern. In all periods of observations, their indicators were almost the same and by the time of harvesting amounted to 22.2 - 23.9 cm. The smallest length of the sheath during harvesting were Premyer, Lincoln, Longina, Bandit, Pras and Elefant from 19.1 cm to 21.2 cm.

The findings showed that the plants of medium-ripened leek samples (Kamus, King, Zhiraf) were high, had a long sheath and narrow light green leaves (table 1).

The sheath diameter depends on the standard of the product part of the leek. The largest diameter of the sheath was distinguished by plants of samples from the Netherlands (Pandora, Lincoln, Anika) - 4.2-4.4 cm, as well as samples of Elefant and Malabare - 4.2 cm and 4.0 cm.

“Late-maturing leek samples were distinguished by slow plant growth and a long growing season. They have a shorter sheath (19.1-23.2 cm), often thickened at the bottom. The leaf rosette is fanshaped; the phylotaxy is dense. They are distinguished by broad leaves of green and dull green color, often with a waxiness” (tables 1, 2) [1].

The formation of a leek crop depends on the number of leaves, their length and width. It is defined by the plant weight. The largest plant weight during harvesting ensured the highest yield of the samples: Anica – 5.03kg/m², Lincoln – 4.86 kg/m², Bandit – 4.09kg/m² (tabl.1).

During harvesting, the following samples: Gayia – 261.8 g, Elefant – 255.4 g and Malabare – 248.8 g had the largest plant weight. The largest plant weight of the Gayia sample provided the highest yield, which amounted to 3.66 kg/m², exceeding the control sample De Carentan by 33% (table 2).

The high yield of leeks was observed in Elefant - 3.58 kg/m² and Malabare - 3.48 kg/m², which was 26-29% higher than the control sample De Carentan. The marketability in total productivity reached 83.7 – 87.8 %.

One of the goals of the research work was to identify the biochemistry of the sheath and leaves of leeks by the experimental variants.

In the studied samples, the highest dry matter content was in the sheath, which ranged from 14.48% to 21.87%, and in the leaves from 10.09% to 13.39%. It was the highest in the Gayia sample. All the studied samples were distinguished by a considerable accumulation of sugars in the sheath from 8.3% to 11.4%, which was the greatest in Gayia. The value of leeks is that the sheath contains a considerable amount of ascorbic acid from 20.1 to 30.0 mg/100g, which was the largest in the samples of Lincoln and Long meries, and the smallest in Lavi. It should be mentioned that in the leek leaves, according to the variants of the experiment, a considerable excess of ascorbic acid by 1.4-2.4 times was observed in comparison with the sheath.

The leek has a low ability to collect nitrates. As a rule, the accumulation of nitrates in the sheath is higher than in the leaves. By the results obtained, the nitrate content in the sheath had values from 51 to 269 mg/kg and was the lowest in Kamus and Pras samples. They also had the lowest nitrate content in the leaves of 41-43 mg/kg of green weight. The indicators for the nitrate content of the studied samples were within the LOC.
4. Conclusions
1. In the conditions of the Leningrad region, the studied leek samples proved to be average-late.
2. The varietal differentiation in growth, yield and biochemistry of leek samples has been established.
3. The dynamics of leek growth showed an advantage in the number of leaves, the diameter of sheath and the increase in plant mass in Anika, Lincoln and Bandit samples in 2015-2016, and in Gayia, Elefant and Malabare samples in 2018-2019, which ensured the highest yield.
4. It is reasonable to use the most productive leek samples in further breeding work.

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