Comparative assessment of soybean varieties in the taiga zone of the West Siberian region

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Abstract. The studies on the comparative assessment of soybean varieties of Siberian breeding performed in 2017-2019 in the sub-taiga zone of the West Siberian region showed that the duration of the growing season of soybeans depended on the biological characteristics of the variety and weather conditions. SibNIIK 315 variety was characterized by the shortest growing season – 96 days, while Cheremshanka variety had the longest – 108 days. Sibiryachka and Eldorado soybean varieties were the second in terms of early ripening (102-103 days). In wet 2017 and 2018, the growing season of the studied varieties was delayed by 9-15 days compared to warm and drier 2019. The yield of soybean grain was influenced by the characteristics of the variety and weather. On average, for three years of study, the highest grain yield – 2.65 tons/ha was obtained from Sibiryachka variety. SibNIIK 315 took the second place in terms of yield. In terms of grain quality, Zolotistaya and SibNIIK 315 with protein content of 32.6 and 32.2%, respectively, were the best. The protein content of Sibiryachka variety was less – 31.5%, but higher compared to Eldorado and Cheremshanka varieties.

1. Introduction
The problem of increasing protein production is one of the most important and relevant in Russia, including in Western Siberia [1, 2]. The solution to this problem is possible by increasing the planting acreage and increasing the yield of high-protein leguminous crops, in particular soybeans. Soybean is gradually gaining its popularity in the world among grain legumes and oilseeds. Its successful promotion is driven by enormous opportunities in the food industry, agronomic and even ecological advantages compared to other crops [3].

2. Problem statement
An important factor in the guaranteed production of crops is a variety adapted to specific soil and climatic conditions. A comparative variety test of the world collection of the All-Union Research Institute of Plant Breeding, including from Russia, the USA, Canada, Belarus, Ukraine, showed that soybean varieties were created in the Siberian Agricultural Research Institute of the Russian Academy of Agricultural Sciences that ensured high yield of certified seeds with an average growing season of...
not more than 100 days. Among the collection material there are no varieties that can compete in speed with the varieties of Omsk selection [4].

Previously included in the State Register and recommended for use in Western Siberia, SibNIIK 315, Omskaya 4, Altom, SibNIISHoz 6 have a high productivity potential of 2.5-3.0 t/ha, which is the biological basis for obtaining high yields in various soil and climatic zones of the region [5]. The results of ecological variety testing conducted in the laboratory of selection of leguminous crops of the Siberian Agricultural Research Institute in 2000-2004 showed that the average yield of soybean grain was 2.32 t/ha, the average maximum – 2.81 t/ha [6].

A soybean variety testing conducted in 2004-2010 with previously created varieties zoned in Omsk Region showed that on average in terms of early ripening, which is extremely important in the conditions of the sub-taiga zone of Western Siberia, yield and protein collection per hectare the following varieties were the most prominent: SibNIIK 315 and Dina with a growing period of 99 and 95 days and protein collection from 1 ha – 541.2 and 545.2 kg/ha, respectively [7]. Currently, the study of new varieties of soybeans of Siberian breeding in the Non-Chernozem Zone of Western Siberia is quite relevant.

The purpose of the study is to give a comparative assessment of soybean varieties by the yield and quality of soybean grains in the sub-taiga zone of the West Siberian region.

3. Materials and methods

The object of the study was soybean varieties included in the State Register and recommended for use in Western Siberia: Sibiryachka (taken for control), SibNIIK 315, Zolotistaya, Eldorado and Cheremshanka.

The studies were carried out in the sub-taiga zone on gray forest medium-loamy soil in 2017-2019. The weather conditions of 2017 and 2018 for the period from May to September were characterized by a higher average daily air temperature (13.9 and 13.6 °C) compared to the average long-term data with high rainfall: 407.2 and 410 mm, respectively. 2019 was warm with an average daily air temperature of 14.8 °C and precipitation of 303.3 mm, which is 13.3 mm more than the average long-term norm [8–12]. The weather features of the research years affected the duration of the growing season, the yield and grain quality of soybean varieties.

Experimental agricultural methods: Predecessor – wheat. In autumn – underwinter plowing to a depth of 20-22 cm. In spring when the soil reaches physical ripeness – early-spring harrowing. Pre-sowing cultivation to a depth of 7-8 cm. Planting in rows with a sowing coefficient of 1.0 million germinating seeds per hectare to a depth of 5-6 cm. Crop tending began with compaction carried out after sowing, and included weeding. Harvesting of grain was carried out at its complete ripeness.

Plot allocation in the experiment is randomized. Repetition – 4 times. Accounting and observations were carried out according to the method of state variety testing [13]. The protein content in the grain was determined at the Tarskaya agrochemical service station according to GOST 10846-91. The obtained data were processed using the STATIST computer program.

4. Results and discussion

The results of the studies showed that the duration of the growing season of soybean varieties was influenced by their biological characteristics and weather conditions. SibNIIK 315 variety was characterized by the shortest growing season – 96 days, while Cheremshanka variety had the longest – 108 days (Table 1). Sibiryachka and Eldorado soybean varieties were the second in terms of early ripening with a growing season of an average of 102 and 103 days, respectively, over three years. In wet 2017 and 2018, the growing season of the studied varieties was longer by 9-15 days compared to warm and drier 2019.

The analysis of the crop structure showed that all varieties had the largest number of beans – from 13.6-13.9 pcs. Eldorado and Zolotistaya – up to 19.7 pcs. The Sibiryachka plant was formed in wet season, with warm June, July and August 2017. The smallest number, with the exception of Eldorado, was observed in drier 2019. Eldorado had a smaller number of beans in 2018 – 8.0 pcs. On average,
over the years of research, the largest number of beans – 13.6 pcs – was typical for Sibiryachka variety, slightly less – 12.8 – SibNIIK 315 variety (Table 2). In the future, this contributed to the formation of a higher grain yield compared to other varieties. A thousand-kernel weight was also the largest in 2017, less in 2018-2019. On average, the largest grain with a thousand-kernel weight of 170.2 g was formed in Cheremshanka variety, the smallest, with a weight of 157.1 g – in Eldorado.

On average, the largest number of grains in a bean over three years was 1.99, 1.98 and 1.96 pieces in Zolotistaya, Sibiryachka and Eldorado varieties, the smallest – 1.69 – SibNIIK 315.

Table 01. Length of the growing season of soybean varieties, days

| Variety          | 2017  | 2018  | 2019  | On average |
|------------------|-------|-------|-------|------------|
| Sibiryachka (control) | 105   | 106   | 94    | 102        |
| SibNIIK 315      | 99    | 99    | 90    | 96         |
| Zolotistaya      | 109   | 107   | 98    | 105        |
| Eldorado         | 109   | 107   | 94    | 103        |
| Cheremshanka     | 113   | 112   | 100   | 108        |

Table 02. Structure of soybean crop

| Variety            | Number of beans, pcs/plant | Number of grains in a bean, pcs | Thousand-kernel weight, g |
|--------------------|----------------------------|---------------------------------|---------------------------|
| Sibiryachka (control) | 13.6                        | 1.98                            | 159.4                     |
| SibNIIK 315        | 12.8                        | 1.69                            | 163.9                     |
| Zolotistaya        | 10.1                        | 1.99                            | 159.6                     |
| Eldorado           | 10.1                        | 1.96                            | 157.1                     |
| Cheremshanka       | 10.7                        | 1.79                            | 170.2                     |

The yield of soybean grain also depended on the biological characteristics of the variety and weather. A large grain yield of all varieties was formed in wet season, with warm June, July and August 2017. The highest – 3.99 t/ha was in the control variety Sibiryachka (Table 3). In terms of this indicator Sibiryachka significantly exceeded other soybean varieties. A similar pattern was observed in 2018. In the same year, SibNIIK 315 variety with a yield of 2.16 t/ha had a significant advantage compared to Zolotistaya, Eldorado and Cheremshanka varieties, and the Cheremshanka variety exceeded the Eldorado variety.

In dry weather conditions of the second half of 2019, the drought-resistant Zolotistaya and Eldorado varieties had the highest grain yield – 1.57 and 1.53 t/ha, while other soybean varieties did not exceed 1.36-1.39 t/ha [14].

Table 03. Grain yield of soybean varieties, t/ha

| Variety            | 2017  | 2018  | 2019  | On average t/ha | %  |
|--------------------|-------|-------|-------|-----------------|----|
| Sibiryachka (control) | 3.99  | 2.56  | 1.39  | 2.65            | 100.0 |
| SibNIIK 315        | 3.19  | 2.16  | 1.36  | 2.24            | 84.5  |
| Zolotistaya        | 3.31  | 1.31  | 1.57  | 2.06            | 77.7  |
| Eldorado           | 3.29  | 1.20  | 1.53  | 2.01            | 75.8  |
| Cheremshanka       | 3.40  | 1.46  | 1.38  | 2.08            | 78.5  |
| LSD<sub>05</sub>   | 0.61  | 0.185 | 0.097 |                 |      |

On average, over 3 years of research, the highest grain yield – 2.65 t/ha was given by Sibiryachka variety, the lowest 2.01 t/ha – by Eldorado. In second place in this indicator was SibNIIK 315, which provides yields at the level of 84.5% compared to Sibiryachka variety.

In terms of grain quality, on average over three years of research, Zolotistaya and SibNIIK 315 with a protein content of 32.6 and 32.2%, respectively, were the most prominent. The protein content
of Sibiryachka variety was less – 31.5%, but higher compared to Eldorado and Cheremshanka varieties. In the latter variety, the protein content was the lowest and was only 28.2%.

A very important indicator for soybean is the attachment height of lower beans, which determines the quality of harvesting. If the plants of Zolotistaya (72.2 cm), Sibiryachka (71.1 cm), Cheremshanka (70.3 cm) were the highest, then the highest attachment height of lower beans – 18.3 cm was distinguished by Cheremshanka variety (Fig. 1). Then, in a descending order there is Eldorado (17.6 cm) and Zolotistaya (17.1 cm), Sibiryachka (15.4 cm), SibNIK 315 (12.7 cm), which was characterized by the lowest attachment of the first beans.

![Height of plants of soybean varieties and attachment of lower beans, cm](image)

**Figure 01.** Height of plants of soybean varieties and attachment of lower beans, cm

5. **Conclusion**

1. The duration of the growing season and the yield of soybean grains depend on their biological characteristics and weather conditions. SibNIK 315 variety was characterized by the shortest growing season – 96 days, while Cheremshanka variety had the longest – 108 days. Sibiryachka and Eldorado soybean varieties were the second (102-103 days). In wet years, the growing season of soybean varieties is delayed by 9-15 days.

2. The increased yield of soybean grains was formed in wet years, with warm June – August. Under these conditions, the control variety Sibiryachka had the highest grain yield – 3.99 t/ha, reliably exceeding other varieties in this indicator. In the years (2019) with drier weather in the second half of the vegetation, the drought-resistant varieties Zolotistaya and Eldorado had increased grain yields (1.57 and 1.53 t/ha). On average, over three years of research, the highest grain yield – 2.65 t/ha was given by Sibiryachka variety, in second place – SibNIK 315 variety.

3. In terms of the grain quality, on average over three years of research, Zolotistaya and SibNIK 315 with a protein content of 32.6 and 32.2%, respectively, were distinguished. The protein content of Sibiryachka variety is less – 31.5%, but higher compared Eldorado and Cheremshanka varieties.

4. In terms of height, the lower beans are most technologically advanced for mechanized harvesting of Cheremshanka (18.3 cm), Eldorado and Zolotistaya (17.6-17.1 cm), Sibiryachka (15.4 cm). SibNIK 315 has low attachment of the first beans – 12.7 cm.
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