



НОВЫЙ СОРТ СОИ ГОРИНСКАЯ

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Представлены результаты исследований по созданию нового сорта сои Горинская с использованием методов гибридизации и индивидуального отбора. В качестве исходного материала использованы сорта сои СибНИИК-315 (материнская форма) и Fiskebi V (отцовская). Исследования проведены в лесостепной зоне Западной Сибири (Новосибирская область). Соя Горинская относится к маньчжурскому подвиду. Растения имеют светло-коричневое (рыжеватое) опушение стебля, листьев, бобов. Характер роста и тип верхушки промежуточный, число ветвей – 1–3, угол отхождения ветвей – 20–30 град., куст сжатый. Высота до первого разветвления составляет 6–10 см, высота прикрепления нижнего боба 10–13 см. Бобы расположены равномерно по всему растению. Длина стебля равна 55–75 см, число междоузлий на стебле – 12–15. Соцветие представляет малоцветковую кисть из 3–5 цветков. Венчик имеет фиолетовую окраску. Бобы слабо изогнутые с заостренным кончиком, при созревании приобретают бурую окраску. Семена удлинено-овальной формы, зеленовато-желтого цвета, без пигментации. Рубчик семени коричневый. Сорт зернового направления использования. Урожайность в конкурсном сортоиспытании достигала 29,4 ц/га. Масса семян с одного растения составляет 10–12 г, масса 1000 семян – 150–160 г. Число семян в бобе 2–3, среднее число бобов на один продуктивный узел – 2–3. Содержание белка в семенах составляет 35–38%, жира – 17–19%. Продолжительность вегетационного периода равна 100–105 дней. Сорт среднеустойчив к болезням, холоду, засухе, засолению почвы. В 2018 г. сорт сои Горинская включен в Государственный реестр селекционных достижений, допущенных к использованию в Российской Федерации по Восточно-Сибирскому региону.

Ключевые слова: соя Горинская, селекция, сорт, гибридизация, отбор

NEW CULTIVAR OF SOYBEAN GORINSKAYA

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The paper presents results of research into breeding of the new soybean cultivar Gorinskaya by the methods of hybridization and individual selection. Soybean varieties SibNIK-315 (female parent) and Fiskebi V (male parent) were used as a starting material. The studies were carried out in the forest-steppe zone of the Western Siberia (Novosibirsk region). Soybean Gorinskaya belongs to the Manchu subspecies. The plants have a light brown (reddish) pubescence of the stem, leaves, beans. The growth pattern and the type of apex is intermediate, the number of branches is 1–3, the angle of branching is 20–30 degrees, the bush is compressed. The height to the first branch is 6–10 cm, the attachment height of the lower pod is 10–13 cm. The beans are distributed evenly throughout the plant. The length of the stem is 55–75 cm, the number of internodes on the stem is 12–15. The

inflorescence is a small-flowered raceme of 3-5 flowers. The corolla is purple in color. The pods are slightly curved with a pointed tip; when ripe, they acquire a brown color. The seeds are elongated-oval, greenish-yellow in color, without pigmentation. The seed hilum is brown. The cultivar is the grain variety for use. The yield in the competitive variety testing reached 29.4 c / ha. The mass of seeds per plant is 10–12 g, the mass of 1000 seeds is 150–160 g. The number of seeds per pod is 2-3; the average number of pods per 1 productive node is 2-3. The protein content in seeds is 35-38, fat – 17-19%. Duration of the vegetative period is 100-105 days. The cultivar is medium resistant to diseases, cold, drought, and soil salinity. In 2018, the Gorinskaya soybean variety was included in the State Register of Breeding Achievements Approved for Use in the Russian Federation for the East Siberian region.

Keywords: Gorinskaya soybean, breeding, cultivar, hybridization, selection

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Конфликт интересов

Авторы заявляют об отсутствии конфликта интересов.

Conflict of interest

The authors declare no conflict of interest.

INTRODUCTION

Soybean (*Glycine max* (L.) Merr.) is the most common legume crop in the world, grown in more than 90 countries. It is an important source of protein and oil for food, feed and technical purposes and is therefore used in various industries [1-4]. The leaders in soybean production are the United States and Brazil, which grow two thirds of the world's soybean production [5].

At present, Russia's soybean production is clearly insufficient, as evidenced by the steady increase in soybean imports: from 65,000 tons in 2000 to 2.05 million tons in 2015. The reserves available in Russia are sufficient to increase the cultivated area to 5-6 million hectares, which will provide up to 7 million tons of commercial raw materials [6]. In the forest-steppe zone of Western Siberia, soybean can be cultivated on an area of about 250,000 ha and receive a guaranteed yield of 15 c/ha¹ [7-10]. As of 2020, 257 soybean varieties are registered in the State Register of Varieties of the Russian Federation, 13 of which are of Siberian selection. However, the current varieties do not fully meet the modern requirements of the

agro-industrial complex. Growth of soybean production in Russia can be achieved not only by expanding the area under this crop, but also by creating new high-yield varieties.

Soybean varieties adapted to growing in the forest-steppe zone of Western Siberia are determined by the biological characteristics of the crop: requirements for thermal conditions, moisture supply, light, mineral nutrition. In addition, soil and climatic conditions are important for this crop. The forest-steppe zone of the West Siberian region is characterized by a short frostless period, a long duration (up to 17 hours) of the summer day, under which many soybean varieties significantly outgrow their generative development and lengthen the growing season, not having time to form a yield of mature seeds. Favorable average daily temperatures for germination of soybean seeds in the soil, emergence and growth of seedlings, budding and flowering, formation of beans and seeds, and maturation are provided in this region during the beginning of the third decade of May and the second decade of September. The duration of this period is about 115 days, the sum of temperatures above 10 °C is not less than 1800 °C., i.e. the growing period from sowing to ripen-

¹Kashevarov N.I., Gorin V.E., Polyudina R.I. et al. Cultivation of soybean in Western Siberia: recommendations. Novosibirsk, 1999. 74 p.

ing should not exceed 115 days. Varieties that do not reach full maturity before the onset of low positive average daily temperatures will be severely reduced or fail to yield mature seeds when regular frosts occur.

The main methods of variety development are intra-specific and distant hybridization and individual selection² [11–13].

The purpose of the research is to create a new high-yielding variety of soybean adapted to Siberian conditions.

MATERIAL AND METHODS

The research was conducted at the central experimental base of the Siberian Research Institute of Fodder Crops, SFSCA RAS, located in the forest-steppe zone of the Novosibirsk Region (Krasnoobsk settlement).

The soil of the experimental plots is medium-loamy leached chernozem, pH 6.6. The content of humus in the soil is 5.2%, easily hydrolysable nitrogen - 7.7 mg/100g soil, mobile phosphorus - 15.0, potassium - 16.0 mg/100g soil.

SibNIK-315 and Fiskebi V soybean varieties were used as starting material. The main methods of creating promising breeding material were hybridization and individual selection.

Nurseries were planted according to generally accepted methods. In the hybrid and breeding nursery, the plants were sown and harvested manually and the number of plants per plot was counted.

In the control nurseries and competitive varietal trials, the plot area was 25 m², the arrangement was systematic, the repetition was four times. Sowing was carried out with a seeder CH-16. We sowed 700 thousand germinated seeds per 1 hectare by wide-row method. Plants were harvested by Sampo (Rostov) combine. Before harvesting, sheaf samples from 1 m² were taken from the trial sites. Seed productivity and its elements from each plant were determined. The standard was the variety SibNIK-315.

Phytopathological surveys were carried out by the plant immunity group. Snedecor application software package was used for statistical data processing.

RESULTS AND DISCUSSION

Intraspecific hybridization of soybean to expand the genetic variability available for selection is an effective method in breeding this crop (see footnote 2) [11]. The study of flowering biology and improvement of hybridization technique allowed the use of this method of breeding to significantly expand the genotypic diversity of soybean breeding material by involving geographically distant forms in crosses. When selecting pairs for crossing, it should be taken into account that hybrids whose parental forms differ significantly in the maximum number of plant productivity elements give the highest rates of seed mass transgression from one plant³.

According to the classification adopted in Europe and the USA, soybean varieties are divided into 10 groups according to the length of the growing season. When breeding soybeans for Western Siberia conditions, varieties with high adaptability and a vegetation period of no more than 110 days are of particular interest.

The duration of the germination-to-ripening period is determined to a large extent by the length of the germination-to-flowering period and to a lesser extent by the length of the flowering-to-ripening phase. The period from germination to flowering is noticeably longer with decreasing temperature sum, increasing relative humidity, increasing nitrogen nutrition, growing on a long bed and increasing the feeding area. In general, the phenotypic expression of the growing season size is 70% determined by hereditary characteristics of the variety and only 30% by all other factors⁴. According to G. Johnson and R. Bernard (cited in footnote 2), genetic and phenotypic correlations between growing season length and seed yield have a significant positive relationship.

²Enken V.B. Soybean. Moscow: Selkhozgiz, 1959. 619 p.

³Vashchenko A.P., Mudrik N.V., Fisenko P.P., Zaostrovnykh V.I. Soybean breeding in Primorye. Breeding and agrotechnics of field crops in Primurye: Collection of scientific works. Novosibirsk, 1987 pp. 45-47.

⁴Korsakov N.I. Soybean (systematics and basics of breeding): thesis of Doctor of Science in Agriculture. L.: VIR, 1973. 44 p.

In order to create promising source material for breeding, crosses were carried out in 1994 where the best registered variety SibNIIK-315 was used as the female parent. The male component was represented by the variety Fiskebi V. Among the soybean varieties studied in the collection nursery, this variety was selected due to its high seed productivity and its constituent elements [14].

The first elite plants of this combination were isolated in a hybrid nursery in 1997. In 1998-2001, their study was continued in breeding nurseries. Selections were carried out in the field and laboratory conditions on the complex of traits: seed productivity and its constituent elements, the duration of the growing season, resistance to adverse environmental factors. Much attention was paid to the traits determining the manufacturability of soybean cultivation: the height of the bottom bean, resistance to bean bursting, lodging of plants, etc. Then, the study of the line named SNK-147 was continued in the control and competition nurseries, where it also showed high indicators of economically useful and morphobiological traits and properties (see Table 1).

Grain yields in 2010-2020 ranged from 16.0 to 29.4 c/ha, consistently exceeding the standard by 7-26%. The duration of the growing season ranged from 88 to 120 days, exceeding the standard by 5-17 days. On average, this line matured in 107 days during the 11 years of study, thus falling into the early maturing group (see the figure).

Increasing the protein and oil content of soybean seeds is one of the main focuses of breeding programs. Due to the quality and quantity of proteins, their balance in amino acids, high digestibility, and low cost of production, soybean ranks among the world's top protein-oil crops in terms of seed production. Soybean oil is similar in nutritional value to sunflower oil, but slightly inferior to cow's oil. The line we have created exceeds the standard in protein and fat production by 0.9 and 0.6 c/ha, respectively, or 14 and 17% (see Table 1).

Diseases are a major detriment to soybean yields. Only highly resistant varieties can ensure low disease incidence and a natural increase in soybean productivity. Infestation of soybean plants with downy mildew (peronosporosis) can reduce seed yields by up to 50%. This disease was first detected in the fields of the Siberian Research Institute of Fodder Crops in 2004. The reduction in soybean grain yield when affected by pustular bacteriosis reaches 22%, and by bacterial spot 27%⁵.

A phytopathological study of the variety SNK-147 in the nurseries of competitive variety trials showed that it was more resistant to major fungal and bacterial diseases compared with the standard (see Table 2).

Thus, the use of individual selection in splitting generations has proven effective in creating high-yielding soybean varieties that meet modern cultivation technology requirements.

In 2013, the SNK-147 soybean line was submitted to state variety testing under the name

Табл. 1. Параметры нового сорта сои Горинская (2010–2012 гг.)

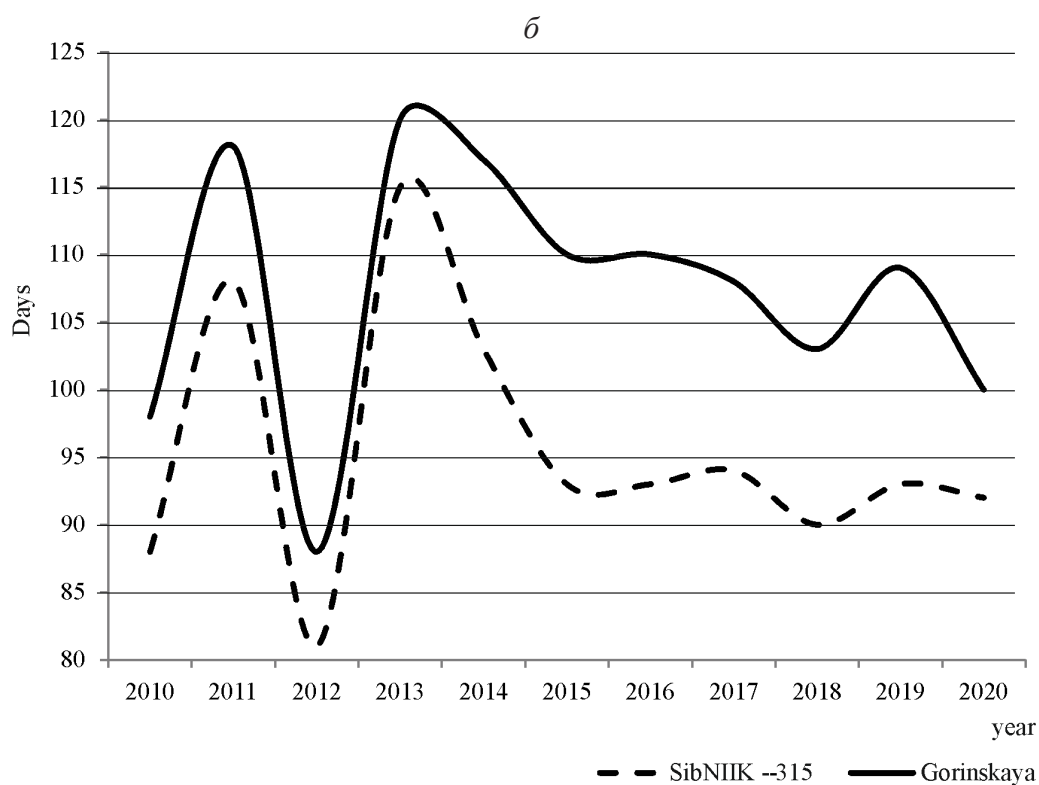
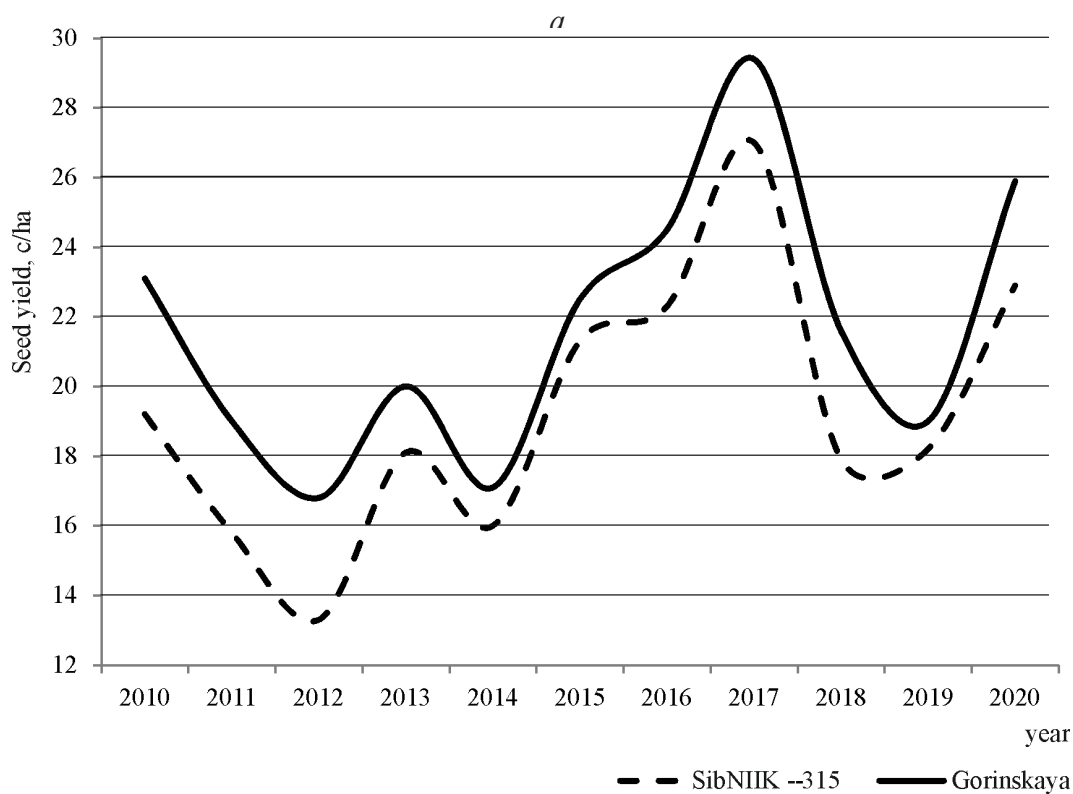
Table 1. Parameters of new soybean cultivar Gorinskaya (2010–2012)

Feature	Gorinskaya (SNK-147)	SibNIIK-315 (standard)	± to the standard, %
Grain yield, c/ha **	21,6 ± 1,3	18,9 ± 1,4	114*
Vegetation period, days	101 ± 8	92 ± 8	9*
Weight of 1000 seeds, g	133,1 ± 3,0	147,2 ± 5,7	90*
Crude protein content, %	36,4 ± 0,2	36,5 ± 0,1	100
Crude protein yield, c/ha	7,8 ± 0,7	6,9 ± 0,6	114*
Fat content, %	18,8 ± 0,4	18,2 ± 0,2	103
Fat yield, c/ha	4,1 ± 0,6	3,5 ± 0,4	117*

* Reliable at the 5% level.

** Grain yield given for 2010-2020

⁵ Ashmarina L.F., Gorobei I.M., Konyaeva N.M., Agarkova Z.V. Atlas of diseases of fodder crops in Western Siberia. Novosibirsk: Siberian Research Institute of Fodder Crops, 2010. 180 p.



Урожайность семян (*a*) и продолжительность вегетационного периода (*b*) нового сорта сои Горинская

Seed yield and maturity of new cultivar of soybean Gorinskaya

Gorinskaya. In 2018, the variety was included in the State Register of Breeding Achievements Approved for Use in the Russian Federation for the East Siberian region. The certificate of authorship No. 71916 dated 05.06.2018 and patent No. 9653 dated 05.06.2018b were obtained. The authors of the variety are: N.V. Balykina, A.V. Zheleznov, N.I. Kashevarov, N.N. Kashevarova, A.A. Polishchuk.

Gorinskaya soybean variety is for grain use. The yield in competitive variety trials in the forest-steppe zone of Western Siberia reached 29.4 c/ha. According to the State Variety Commission the average grain yield in the East Siberian region was 28.6 c/ha. The maximum yield (31.2 c/ha) was obtained at the Krasnoturansky State Crop Testing Site (SCTS) in the Krasnoyarsk Territory in 2016. Seed weight per plant is 10-12 g, weight of 1000 seeds - 150-160 g. The number of seeds in a pod is mainly 2-3, the average number of beans per productive node is 2-3, the maximum - 4-5. Seeds have 35-38% protein content and 17-19% fat content. Sprouting and flowering lasts 30 to 32 days; sprouting and maturation last 100 to 105 days. The variety is moderately tolerant to cold, drought, soil salinity.

Morphologically, Gorinskaya soybean belongs to the Manchurian subspecies (ssp. *manshurica* (Enken) Zel. et Koch.). The plants have light brown (reddish) pubescence on the stem, leaves and beans. The character of growth and the type of apex are intermediate, the number of branches 1-3, the angle of branching 20-30 degrees, the bush is compressed. The height to the first branching is 6-10 cm, the attachment height of the lower legume is 10-13 cm. The beans are evenly spaced throughout the plant.

The stem is 55-75 cm long, with 12-15 internodes on the stem. The type of seed germination is hypogeic (the seedpods reach the ground). Because of the presence of anthocyanin, the coloring of the sub-cotyledon during germination is purple. The primordial leaves are broadly ovate. The leaves are ternate, with the middle leaflets oval-oblong and slightly pointed. Leaf coloring is green. The inflorescence is a low-flowered cluster of 3 to 5 flowers. The corolla is purple. Pods slightly curved with a pointed tip, turning brown when mature. Seeds oblong-oval, greenish-yellow, without pigmentation. The seed ridge is brown.

CONCLUSIONS

1. Using hybridization and individual selection methods, a new variety of soybean, Gorinskaya, was created.

2. The average grain yield of the variety Gorinskaya in the West Siberian region is 21.6 c/ha (114% of the standard), the maximum yield is 29.4 c/ha, raw protein yield is 7.8 c/ha, fat yield is 4.1 c/ha, which is 14 and 17% higher than the standard, respectively. The maximum grain yield in the East Siberian region was 31.2 c/ha.

3. In 2018, the variety was included in the State Register of Breeding Achievements Approved for Use in the Russian Federation for the East Siberian region.

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Табл. 2. Поражение болезнями нового сорта сои Горинская (2010–2012 гг.), %

Table 2. Diseases of new soybean cultivar Gorinskaya (2010–2012), %

Feature	Gorinskaya (SNK-147)		SibNIIK-315 (standard)		± to the standard, %
	Average	Limits	Average	Limits	
Pustular bacteriosis	2,9	0–5,9	3,0	0,4–5,6	–0,1
Downy mildew	3,5	0,1–7,0	18,5	0,0–37,0	–15,0
Bacterial spot	4,0	0,0–8,1	8,3	0,4–16,2	–4,3

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