The study of bioresource collection of potato (*Solanum Tuberosum l.*) in the conditions of Primorsky Krai

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Abstract. The bioresource collection of potato of the Common Use Center of the FSBSI “FSC of Agricultural Biotechnology of the Far east named after A. K. Chaika” was studied. Source varieties of various origins were selected. The objects of research were 300 varieties and hybrids of domestic and foreign selection. The purpose of the research was to identify valuable source material for breeding in the conditions of Primorsky Krai basing on a comprehensive study of the collection of potato varieties and hybrids. Blakhit, Vulkan, Debryansk, Emelya, Zhavoronok, Zarevo, Krasavitsa Bryanschina, Lakomka, Mustang, Rosinka, Serpanok and Fermer were selected as the most efficient male parent forms. Variety sources that have economically valuable traits were included in targeted breeding. Promising hybrids were selected: Pri-11-31-24 Debryansk x Krasavitsa Bryanschina, Pri-17-18-7 Lakomka x Fermer, Pri-08-11-1 Rosinka x Zhavoronok, Pri-12-4-11 Emelya x Krasavitsa Bryanschina, Pri-12-35-4 Debryansk x Mustang, Pri-12-43-13 Blakhit x Mustang, Pri-11-12-5 Blakhit x Zarevo, Pri-11-14-25 Blakhit x Vulkan, Pri-12-47-15 Serpanok x Vulkan.

1. Introduction

Due to methodological revolution in genome decoding and studies of the molecular level of living systems organization, technologically developed countries have been rapidly introducing new genetic and breeding technologies into the practice of agriculture in recent years. At the same time, one of the most important areas of practical application of the results of fundamental genetic research in the developed world is genetics and plant breeding [1].

Challenges that potato selection is facing include creation of new varieties of early and mid-early maturity groups that have a set of economically useful traits. By many indicators, potatoes have a heterozygote effect. The indicator values depend on heterozygosity of traits control, which in turn is determined by the breadth of the genetic basis of the initial selection material [2, 3]. At the present stage, breeders should have databases that include not only the results of phenotyping of breeding material, but also information about the presence of DNA markers associated with genes and QTL that determine economically valuable traits. Over the past two decades, numerous DNA markers have been developed for potatoes that allow marker-assisted selection (MAS) of promising genotypes [4, 5] and are widely used in molecular screening by researchers from different countries [6]. Manifestation of selection-valuable traits directly depends on climatic characteristics of varieties cultivation [7, 8]. Varieties with different maturation periods, resistant to fungal and viral diseases, and suitable for industrial processing are extremely necessary for Primorsky Krai monsoon climate [9].
Work on the formation, preservation and study of the bioresource collection was being conducted on the basis of the Common Use Center “Bioresource collection of the FSBSI “FSC of Agricultural Biotechnology of the Far east named after A. K. Chaika”. The collection is unique for including samples from different ecological and geographical groups. Genetic diversity allows plant selection breeders to identify sources and donors of the following characteristics - disease resistance, high productivity, early maturity, starchiness, and protein content [10].

The purpose of the research was to identify valuable source material for selection based on a comprehensive study of the bioresource collection of potato varieties and hybrids of various origins.

2. Materials and methods

Cultivation tests and field studies were conducted in 2015-2019 in the experimental fields of the bioresource collection. The objects of research were 300 varieties of domestic and foreign selection, obtained from the All-Russian Institute of Plant Industry named after N. I. Vavilov and the Lorch Potato Research Institute.

The varieties and tuberous reproductions of seedlings were studied in the field according to the complete scheme of the selection process. The degree of damage of potato varieties and hybrids made by fungal and viral diseases were determined by phenological observations during the growth season. The account of the harvest was taken by weighing the tubers from the plots. The tasting evaluation of varieties and hybrids, and a biochemical analysis of tubers (dry matter, content of starch, protein, vitamin C, and reducing sugars) were conducted under laboratory conditions. During the storage period of varieties and hybrids (October-June), the tubers keeping ability was evaluated.

When testing the material, the methods of the All-Russian Institute of Plant Industry named after N. I. Vavilov [11] and the Lorch Potato Research Institute [12] were used as a basis. To prove the presence of significant differences between the mean values, we used one-way analysis of variance followed by multiple comparisons of the Fischer means (LSD method).

3. Results and Discussion

Evaluation of parental forms by a set of economically valuable traits depending on the growing conditions is significant in potato selection. Annual study of the source material allows identifying source varieties with a set of useful features and involving them in the breeding process.

About 300 potato varieties from around the world are studied annually in the collection nursery (Russia, Republic of Belarus, Germany, Netherlands, etc.) (figure 1).

The varieties of Russian origin are 38.7% of the Bioresource Collection. Those of foreign origin: German - 29.3%, Netherlandish - 18.8 %, Belarussian - 7.4%, and 5.8% are the varieties of other countries.

Analysis of varietal samples by the main selection-valuable traits showed that starch content in foreign varieties is higher by 1.4% than that of domestic ones. The amount of reducing sugars in many Russian samples exceeded the norm required for the processing industry (no more than 0.4%), and averaged in 0.73 % (table 1.).
Table 1. Selection-valuable traits of Russian and foreign potato varieties.

| Varieties | Productivity, g/bush | Marketable value, % | Mass of commercial tuber, % | Content, % of starch | Content, % of reducing sugars | Number of varieties with good and specific flavor, % | Number of varieties resistant to, % |
|-----------|----------------------|---------------------|-----------------------------|---------------------|-------------------------------|------------------------------------------|-----------------------------------|
| Russian, average | 805 | 83.7 | 95 | 14.2 | 0.73 | 77.8 | 35.7 | 85.7 |
| minimum- maximum limits | 110-1200 | 52.6-95.3 | 30-120 | 70.3-17.3 | 0.41-1.3 | - | - | - |
| Foreign, average | 750 | 73.2 | 90 | 15.6 | 0.42 | 63.0 | 26.7 | 53.3 |
| minimum- maximum limits | 55-1010 | 35.2-84.3 | 20-120 | 8.6-20.3 | 0.1-0.63 | - | - | - |

Foreign selection is focused on processing potatoes into semi-finished products. In this regard, the amount of sugars in tubers of foreign varieties was within 0.42%, which meets the requirements for the preparation of chips and French fries.

It was noted after the tasting test evaluation that there were more Russian varieties with good and specific flavor than foreign varieties - 77.8% and 63.0%, respectively.

The evaluation of the material for field resistance to fungal and viral diseases showed that the number of domestic selection varieties resistant to pathogens is much higher than the number of the foreign ones. It is known that foreign breeders are insufficiently focused on resistance to pathogens, since pesticides are actively used for growing potatoes.

The goal of hybrids and potato varieties of various origins study is to define their environmental adaptability to the conditions of Primorsky Krai and to select sources for different directions of potato breeding. As a result of the evaluation of the bioresource collection, varieties with valuable characteristics were identified:

- *high productivity* (900-1280 g/bush) – Avrora, Belaya noch, Vdokhnoveniye, Debryansk, Dubrava, Evgeniya, Zhukovsky ranny, Zagadka Pitera, Zarevo, Zolksy, Krasivitsa Bryanschina, Ketsy, Kolobok, Krepys, Ladozhsky, Lina, Lykovsky, Manifest, Nesterovsky, Nida, Ocharovaniye, Pogarsky, Pribrezhny, Ragneda, Ramzay, Rosinka, Rucheyk, Ryabinushka, Skarb, Tarasov, Udacha, (Russia), Izrail (Israel), Uldar (Republic of Belarus), Kholmogorsky, Chervona ruta, Schedrik (Ukraine), Anosta, Fregara (Poland), Valisa, Romanze (Germany), Impala (Netherlands), Sierra, Winola (Scotland);

- *early maturation (productivity 500-560 g/bush on the 60th day of planting)* – Avrora, Debryansk, Lider, Ognivo, Odyssey, Ryabinushka, Khozyayushka, Kholmogorsky, Effekt (Russia) Arosa, Astar, Bete, Karatop (Germany), Benimaru (Japan), Fabula (Netherlands);

- *high content of starch* (17.3-20.5 %) – Baron, Bryansk krasny, Vesnyanka, Evgeniya, Zhivitsa, Zhuravinka, Mustang, Pogarsky, SinteZ, Sotochka, Khozyayushka (Russia), Vytk, Vektor belorusssky, Zdabytok, Zorochka (Republic of Belarus), Darnitsa, Padarunak (Ukraine), Bonus, Ikar (Germany);

- *stable content of ascorbic acid 10.0-14.4 mg/100 g – Vulkan, Dachny, Evgeniya, Ilyinsky, Irbitny, Kortni, Nevsky, Tarasov, Fermer, Khidas, Charodey, Yugana (Russia) Colette, Fritella, Hermes, Gala (Germany);*

- *low content of reducing sugars* (0.4 % and less) – Atlant, Bashkirsky, Briz, Donetsky, Nevsky, Neptun, Pamyati Rogachova, Rozhdestvensky, Sarme, Fermer (Russia), Bonus, Fritella, Vitesse (Germany);

- *high eating qualities* (7.5-8.0 points) – Baltiysky, Vesnyanka, Donetsky, Zolksy, Liga,
Khozyayushka (Russia), Gala, Mariella, Vitesse (Germany);
- good keeping ability of tubers (total weight loss during long-term storage within 6.6-9.1 %) – Amur, Bashkirsky, Bryansk krasny, Vesna belaya, Zhivitsa, Krasavchik, Lena, Meteor, Nakra, Olilem, Rosinka, Russkaya krassvitsa, Sirenevy tuman, Skarb, Sudarynya, Yubilyar (Russia), Izrail (Israel), Argos, Fregata, Mariella (Germany);
- field plant resistance to late blight (7.0-9.0 points) – Blakhit, Evgeniya, Ketsy, Kuznechanka, Mars, Matushka, Pamjati Kulakova, Sudarynya, Suzorye, Chervona ruta, Yantar (Russia), Vytk (Republic of Belarus), Valisa (Germany);
- field plant resistance to viruses (7.0-9.0 points) – Akrosiya, Alaya roza, Bravo, Bryansk delikates, Vesna belaya, Zhukovsky ranny, Irbitsky, Kamensky, Lomonosovsky, Matushka, Chaika, Charodey (Russia);
- economically valuable traits – Avrora, Bashkirsky, Blakhit, Bryansk delikates, Bryansk krasny, Vesnyanka, Garant, Debryansk, Donetsky, Evgeniya, Zhivitsa, Zhukovsky ranny, Zolsky, Ketsy, Lileya, Nesterovsky, Ognivo, Pogarsky, Pribrezhny, Rosinka, Russkaya krassvitsa, Rucheyek, Ryabinushka, Saprykinsky, Sudarynya, Tarasov, Uladar, Khozyayushka, Kholmoogorsky, Fermer, Schedrik, Chervona ruta, Yantar (Russia), Vytk, Serpanok, Skarb (Republic of Belarus), Izrail (Israel), Argos, Bonus, Fregata, Fritella, Gala, Vitesse (Germany).

All varieties selected in the conditions of Primorsky Krai have flowering capacity.

Many of them participated in the hybridization process for several years, which allowed to determine their biological suitability as components of interbreeding, to form parent pairs and to conduct interbreeding. 2000-2500 flowers are pollinated, 1200-1700 berries are obtained, 50-70 hybrid combinations are formed annually.

An analysis of the results of artificial pollination allowed us to identify the most effective paternal forms in terms of fertilization ability (more than 90%) – Blakhit, Vulkan, Debrynaks, Emelya, Zhavoronok, Zarevo, Krassvitsa Bryanschina, Lakomka, Mustang, Rosinka, Serpanok, Fermer. Hybrids, which are currently being studied in a competitive test, have been obtained with the participation of source varieties (table 2.).

### Table 2. Characteristics of potato hybrids from the nursery of competitive variety tests.

| Hybrid | Yield, t/ha | Resistance to late blight | Dry matter content, % |
|--------|-------------|---------------------------|-----------------------|
| Yantar, st | 39.8 | 7.0 | 18.0 |
| Sante, st | 36.3 | 7.0 | 20.1 |
| Pri-11-31-24 Debrysansk x Krasavitsa Bryanschina | 37.8 | 9.0 | 25.4 |
| Pri-12-18-7 Lakomka x Ferm | 46.4 | 9.0 | 22.3 |
| Pri -08-11-1 Rosinka x Zhavoronok | 36.5 | 7.0 | 20.4 |
| Pri -12-4-11 Emelya x Krasavitsa Bryanschina | 36.4 | 6.0 | 21.0 |
| Pri -12-35-4 Debrysansk x Mustang | 39.1 | 7.0 | 24.5 |
| Pri -12-43-13 Blakhit x Mustang | 40.2 | 5.0 | 23.2 |
| Pri -11-12-5 Blakhit x Zarevo | 37.0 | 6.0 | 21.5 |
| Pri -11-14-25 Blakhit x Vulcan | 38.2 | 7.0 | 25.1 |
| Pri -12-47-15 Serpanok x Vulcan | 36.5 | 5.0 | 23.1 |
| LSD<sub>0.05</sub> | 3.2 | | |

A promising way to create long-term protection of potatoes against late blight is the presence of resistance to this pathogen at the genetic level [13]. The intensive development of late blight (3.0-7.0 points) was observed in all hybrids. However, samples with high resistance (9.0 points) were selected: Pri-11-31-24 Debrays x Krasavitsa Bryanschina, Pri-12-18-7 Lakomka x Ferm.
Hybrid Pri-12-18-7 Lakomka x Rermer showed the best yield result - 46.4 t/ha. 61.1% of the studied numbers reached bulking till harvest (30.8-36.5 t/ha).

According to the data of the biochemical analysis of the samples in the nursery, the following hybrids showed excessive dry matter content (20.5-25.4%): Pri-12-18-7 Lakomka x Fermer, Pri-12-35-4 Debryansk x Mustang, Pri-12-43-13 Blakhit x Mustang, Pri-11-14-25 Blakhit x Vulkan.

4. Conclusion
As a result of the research, 43 source varieties with economically valuable traits were selected. They are recommended to be used in various areas of potato breeding. 13 varieties were distinguished as excellent parental forms, with high pollen fertility and berry-forming ability. Hybrids with a set of economically valuable traits were identified (increased productivity, resistance to fungal and viral diseases, excellent palatability, good preservation of tubers during long-term storage): Pri-11-31-24 Debryansk x Krasavitsa Bryanschiny, Pri-17-18-7 Lakomka x Fermer, Pri-08-11-1 Rosinka x Zhavoronok, Pri-12-4-11 Emelya x Krasavitsa Bryanschiny, Pri-12-35-4 Debryansk x Mustang, Pri-12-43-13 Blakhit x Mustang, Pri-11-12-5 Blakhit x Zarevo, Pri-11-14-25 Blakhit x Vulkan, Pri-12-47-15 Serpanok x Vulkan.

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