Prospects of application in the breeding Fragaria Orientalis Los. in the conditions of permafrost

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Abstract. This article discusses the issue of interspecific hybridization in the genus Fragaria L. under the conditions of Yakutia. The species of oriental strawberry - Fragaria Orientalis Los., which formed under severe natural selection conditions and possessed high ecological adaptability to local natural and climatic conditions, was used as the main form. Revealed high frost resistance, immunity, productivity, unpretentiousness, excellent taste, and aroma of fruits of the species of interest for breeding in extreme conditions. The purpose of the research is to create local varieties of strawberries that combine a high level of productivity and quality indicators with adaptability to a complex of biotic and abiotic environmental factors. The result of interspecific hybridization of strawberries was the creation of varieties with a complex of economically valuable traits: Sadovo-Spasskaya, Bersenevskaya, Vladyka Zosima. The high stability and productivity of the variety Sadovo-Spasskaya were noted. Early ripening, high winter hardiness, and high taste are characteristic of the Bersenevskaya variety. The Vladyka Zosima variety is distinguished by an early ripening period, high productivity in the year of planting, and a long fruiting period. The result of research from 1999 to 2020. the creation of diverse seedlings with different types and periods of fruiting, yield, and weight of fruits, varied in shape and taste, runners-forming with high winter hardiness began.

1. Introduction

The gene pool of the genus Fragaria L. consists of more than a dozen species, subspecies, as well as a large number of varieties. East Asia is considered to be the center of origin and initial development of the genus [1-3]. Wild species of the genus Fragaria L. are significantly superior to F. × ananassa Duch varieties in winter hardiness, but most of them, being sources of important properties and economically valuable traits, are not used in strawberry breeding due to poor knowledge of phenotypic advantages and genetic potential [3, 13]. Fragaria Orientalis Los., Which has evolved under the harsh conditions of natural selection and has high ecological adaptability to the harsh local conditions, is not sufficiently studied in the conditions of Yakutia. It is ubiquitous in Central Yakutia. High frost resistance, immunity, productivity, unpretentiousness, excellent taste, and aroma of fruits - the main advantages of this species are of undoubted interest for breeding in extreme conditions. Back in the early twentieth century, I.V. Michurin recommended breeders introduce oriental strawberries into the culture and use them as a component for crosses. Academician M.A. Lisavenko also believed that for Eastern Siberia it is...
necessary to create its varieties of strawberries, using, first of all, Eastern strawberries for breeding, looking for its best forms in the most severe regions in terms of climate [4]. Eastern strawberry - a species of Fragaria Orientalis Los., In a wild state, is distributed in the Asian territory of Russia, where the western border of the range passes through the Irkutsk region, extends to Buryatia (Lake Baikal), to Yakutia up to 64 degrees North, to Altai and the Far East. It grows in Mongolia, the northeastern provinces of China (Manchuria), and North Korea. It is endemic to the relict mesophilic flora of the northeastern part of China [5]. In the flora of Yakutia, it is distributed along the banks of the Olenek River. The life form of strawberries is rosette hemicyrphyte. The plant is spring-summer-green by phenorhythmtype. Blossoms in the third decade of June, ripening of fruits in mid-July. No harmful objects were noted [6-8]. Scientific research on the introduction and breeding of strawberries in the Yakutsk Research Institute of Agriculture named after M.G. Safronov began in the 90s under the scientific guidance of Professor V. N. Sorokopudov [6].

2. Materials and methods
The work was carried out in the laboratory of fodder production and fruit and berry crops of the Yakutsk Scientific Research Institute of Agriculture named after M.G. Safronov in the fruit and berry nursery of the breeding station (Pokrovsk). The climatic conditions of Central Yakutia are the least favorable for the cultivation of garden strawberries. During the study period, the winter period was characterized by extreme temperatures and little snow cover. Typical aridity was observed in the summer period with high temperatures and sharp alternating fluctuations, very often strong winds were observed. The differences in the annual temperature along the absolute and maximum minima reached 102 °C. The average temperature in July was 18.7, the maximum was 38.0 °C, in January the average temperature was -43.3, the minimum was -64 °C. The annual amount of precipitation was 247 mm [9]. The material for the research was the species of strawberries: F. Orientalis Los. and F. × ananassa Duch., which were studied in the field conditions of a fruit and berry nursery. The counts and observations were carried out according to the program and methodology for the various study of berry crops [10, 14].

3. Results and discussion
The rational direction of using eastern strawberries seems to be its hybridization with the most promising varieties of garden strawberries, combining a complex of economically valuable traits of both species. When looking for parents, serious attention was paid to the components of winter hardiness that the eastern strawberry Fragaria Orientalis Los possesses. Its involvement in interspecific hybridization has shown very high results [11-12]. In 1999-2020 the brightest extremes of air temperature -52 – 55 °C and soil, at a depth (0-20 cm), -25.6 °C were identified, and the height of the snow cover was 22 cm. In summer, the duration of sunshine in June in Central Yakutia is 19 hours. An extended photoperiod has a strong effect on the shape, size, and taste of the fruits of introduced cultivars of garden strawberries. Introduced wild forms are undersized (no more than 15 cm), squat, little leafy, with intense shoot formation, with strongly colored anthocyanin coloration of shoots, peduncles, and petioles. Long and thin whiskers form rosettes of more than 5 orders of magnitude. The leaf is medium in size, thin, slightly ribbed, slightly wrinkled, medium glossy, light green in color, the petiole is densely pubescent. Small peduncles (2-3) above the leaves, inflorescences are spreading, few-flowered (7-9), bisexual flowers of small diameter (2.5 cm), consist of 5 white-colored rounded petals. The berries are very small (0.4-0.6 g), unevenly red, with a low sheen; yellow-red achenes are located on the skin. The shape of the berries is unusually diverse: from cylindrical, ovoid, heart-shaped, to round. The cavity in the berries is absent or insignificant. The pulp is juicy, whitish in color, tender, very soft. The taste is harmonious with a pronounced nutmeg aroma. The start time of berry ripening is mid-early (July 10-15). The fruiting type is non-repairable (2-3 weeks).

Outside the ecological range of the original forms, when transferred from the local flora, under the conditions of a collection nursery, oriental strawberry acclimatizes very quickly, within 2 years, and in its development, it significantly surpasses the wild one. In cultivated forms, the bush of the second year of fruiting is powerful (up to 35 cm and more), densely leafy, vertical habit. The beginning of ripening
is July 1-3, which is 10-14 days ahead of the wild-growing forms. The average yield per bush is 165.8 g, the maximum is more than 200 g, the number of peduncles is 54.7 pcs., Of generative organs - 324.8 pcs., Whiskers - 112.5 pcs. The mass of berries at the first harvest exceeds the wild ones by more than 8 times (2.5-3.5 g), and the number of ripe berries is higher and can reach from 150 to 220 pcs. on the bush. The aroma and taste are preserved, but to an insignificant extent, they are inferior to the wild ones. The shape of the berries, the color of berries, leaves, petioles, shoots, and other morphological signs are preserved. Intensive mustache growth is observed from the end of May to 20 August. A change in leaf color to yellow-green and yellow-red is observed with the termination of the growing season, after September 20, with the onset of night frosts below 8-10 °C.

Over a long period of study, the selected forms of eastern strawberries did not show a strong defeat by spot and powdery mildew. The Yakut populations of eastern strawberries showed a fairly high level of productivity, immunity, and adaptability using the example of selected forms.

The introduction of oriental strawberries and varieties of garden strawberries of domestic and foreign selection in Central Yakutia revealed the high adaptability of eastern strawberries to the conditions of Yakutsk, the advantage of all cultivars of garden strawberries. It was found that the selective forms of F.orientalis Los. are of great value for breeding, due to the presence of a complex of traits, which significantly increases the efficiency of the breeding process when crossing strawberry species with F. × ananassa Duch. The efficiency of selection of combinations of interspecific crosses F. × ananassa Duch. × F.orientalis is given in table 1, where the characteristics of unique strawberry varieties for Yakutia are given, which are obtained from interspecific crosses.

**Table 1. Characteristics of varieties from interspecific crosses of strawberries.**

| Crossing combinations, grade | Selective number | Temperature minimum °C, depth 20 cm | Productivity, c/ha | Weight berry, gr | vitamin content.C, mg% | Tasting scorepoint |
|-----------------------------|------------------|-------------------------------------|--------------------|------------------|------------------------|------------------|
| 1. Naydena Dobraya × F.orientalis Los. Bersenevskaya 2. Tanusha × F.orientalis Los. Sadovospasskaya 3. Bogema × F.orientalis Los. Vladyka Zosima | 16-03 2-07 24-08 | -55.0 -53.3 | 71.7 94.9 79.8 | 5.6 8.2 15.4 | 105.5 109.8 124.5 | 5.0 5.0 4.9 |
| | | air soil | | med. max. | | |

As a result of the research carried out, we give the characteristics of new varieties of strawberries for the harsh conditions of Yakutia:

Sadovospasskaya (Tanyusha × Fragaria orientalis Los.). A variety of medium ripening, universal use. The bush is vigorous, upright, the leaves are dark green, large in size, with a strong shine. The whiskers are numerous, medium-thick, medium anthocyanin color. The intensive growth of the mustache does not stop until the end of the growing season. The flowers are bisexual, medium-sized, white, rounded petals. Inflorescences with a small number of flowers, located below the level of the leaves. The berries are blunt-conical, the neck is absent, the surface is unaligned, bright red. The average weight of the first harvest is 8-10 g (maximum 26.7 g). Achenes are yellow, located above the skin, the area without achenes is narrow. The pulp is red; the cavity is narrow. It contains sugars - 10.3%, acids - 1.3%, ascorbic acid - 94.2 mg%. The taste is harmonious, with a pronounced nutmeg aroma. Tasting score 5.0. Productivity 9.5 - 15 t/ha. The variety is non-repairable, self-fertile. Winter hardiness is high. Resistant to harmful organisms. Intensive mustache growth is noted at the end of June. The growing season ends in early October. Bersenevskaya (Found good × Fragaria orientalis Los.). A variety of early ripening, universal use. The bush is medium-sized, spreading, the leaves are green, medium-sized. Whiskers of medium thickness, strong anthocyanin coloration, the number of whiskers are average. The
The growth of the mustache does not stop until the end of the growing season. The flowers are bisexual, medium-sized, white, rounded petals. Inflorescences with a small number of flowers, located at the same level as the leaves. The fruits are cordate, the neck is absent, the surface is even, of uniform red color with shine. Fruit weight from 4.5 g to 11.2 g. Achenes are yellow, located on the skin. The pulp is orange-red; the cavity is medium. It contains sugars - 9.8%, acids ~ 1.2%, vitamin C - 75.6 mg/100 g. The taste is pleasant with a strong nutmeg aroma. Tasting score 5.0. Productivity is 9.5 t/ha, with high agricultural technology of more than 10 t/ha. Winter hardness is high. Resistant to harmful organisms. The variety is non-repairable, self-fertile. Intensive growth of decease is noted at the end of June.

The growing season ends in early October. Vladyka Zosima (Bohemia × Fragaria orientalis Los.). Early ripening variety. The variety is not of a remontant type, self-fertile, versatile for its intended purpose. The bushes are vigorous; the leaves are green with a bluish tinge. Weed thick, medium anthocyanin coloration, a lot is formed. The leaf is large; the color of the upper side is blue-green. The flowers are bisexual, of medium size, collected in compact inflorescences, the petals are white, round in size. The peduncles are powerful, long, and thick, located at the level of the leaves, and lie on the soil under the weight of the harvest. The berries are large, red-colored, broadly conical, without a neck, with shiny skin, weighing 15.4 - 52.3 g. by the end of the season the berries become smaller up to 10 g. Achenes are yellow, numerous, located on the skin. The content of sugars - 10.0%, acids - 2.2%, vitamin C - 124.5 mg/100 g. The taste of berries is sweet and sour, with a harmonious nutmeg aroma. The pulp is red, juicy, tender, there is no cavity. The tasting score is 4.9 points. Average yield 8.0 - 15 t/ha. Winter hardiness and drought resistance are high. Resistance to harmful objects. The color of the leaves remains unchanged until the end of the growing season in the first decade of October, with the onset of stable soil freezing (table 2).

Table 2. The main characteristics of the original forms and varieties of strawberries in various environmental conditions.

| Characteristic | Variety | AYANISH varieties in nursery conditions |
|---------------|---------|----------------------------------------|
| Frost resistance | Sadovospasskaya | The highest |
| Productivity, c/ha | Very high | 150.0 |
| Berry weight g, average-maximum | 10.5 | 8.2 |
| Fruit shape | 20.0 | 26.7 |
| Vitamin C, mg% | blunt-conical | blunt-conical 109.8 |
| Degust. score, point | Naydena Dobraya | 5.0 |
| Frost resistance | Satisfying | Bersenevskaya |
| Productivity, c/ha | High | Very high |
| Berry weight g, average-maximum | 300.0 | 97.9 |
| Fruit shape | 11.0 | 11.0 |
| Vitamin C, mg% | broad-blunt-conical | broad-blunt-conical |
| Degust. score, point | 107.5 | 105.5 |
| Frost resistance | Bogema | Vladyka Zosima |
| Productivity, c/ha | Very high | High |
| Berry weight g, average-maximum | 300 | 70.0 |
| Fruit shape | 16.0 | 3.5 |
| Vitamin C, mg% | blunt-conical | blunt-conical |
| Degust. score, point | 99.8 | 124.5 |
|                   | 4.5 | 4.9 |
High stability and productivity over the years were noted in the Sadovo-Spasskaya variety. Early ripening, high winter hardiness, and high taste are characteristic of the Bersenevskaya variety. The Vladyka Zosima variety is distinguished by an early ripening period, high productivity in the year of planting, and a long fruiting period.

As a result of studies from 1999 to 2020, it was revealed that among the fertile seedlings, a huge variety of forms were obtained with different periods of fruiting, productivity, and weight of fruits, varied in shape and taste, whisker-forming and beardless, the constant selection criterion of which remains high winter hardiness.

4. Conclusion
The result of interspecific hybridization of strawberries was the creation of varieties with a complex of economically valuable traits: Sadovo-Spasskaya, Bersenevskaya, Vladyka Zosima.

High stability and productivity of the variety Sadovo-Spasskaya were noted. Early ripening, high winter hardiness, and high taste are characteristic of the Bersenevskaya variety. The Vladyka Zosima variety is distinguished by an early ripening period, high productivity in the year of planting, and a long fruiting period.

Thanks to scientific research from 1999 to 2020, the creation of diverse seedlings with different types and periods of fruiting, yield, and weight of fruits, varied in shape and taste, mustache-forming and beardless with high winter hardiness began.

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