

# Assessment of the adaptive potential of the plum-tree to the conditions of the winter period in the northern forest-steppe of the Southern Urals

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**Abstract.** The results of assessment are presented the stability of 13 sorts of plum-tree *P. salicina* subsp. *ussuriensis* Koval. et Kost. to the climatic conditions in the winter period from 2015/16 to 2020/21 in the northern forest-steppe of the Southern Urals. Like the control sort Ural'skaya zolotistaya by high adaptability to the conditions of the winter period are characterized sorts Altajskaya yubilejnaya, Zavet, Pionerka, Sapfir, Seyanec Krasnogo shara, Sodruzhestvo, Sinil'ga, Ural'skie zori, Chernosliv pozdnij. Stable fruiting over the years, regardless of weather conditions, during the flowering period with a yield of 62.0 to 91.6 hundredweight/ha are mark out with an increasing total sort Altajskaya yubilejnaya, Pionerka, Chernosliv pozdnij. The control sort Ural'skaya zolotistaya exceeds the yield of the sort Altajskaya yubilejnaya (91.6 hundredweight/ha), at the level of control the yield of the sorts Sodruzhestvo (71.5 hundredweight/ha), Sapfir (70.0 hundredweight/ha).

## 1 Introduction

One of the important conditions by growing and obtaining stable yields from stone fruit crops in a certain area is their adaptability, and in particular winter hardiness [1]. The basis of the zoned assortment in the northern zone of fruit growing in Russia – in the Far East, Siberia and the Urals are sorts of Ussuri plum-tree *P. salicina* subsp. *ussuriensis* Koval. et Kost., which allows to be grown them along the northern border of the plum-tree area.

The main limiting factor of successful plum-tree growth is resistance to low negative temperatures in winter [2].

Winter damages to plum-trees in the conditions of the Urals and the Middle Altai Mountains are caused by a complex of factors and most often occurs when early frosts occur, low negative temperatures in the middle winter period, sharp temperature fluctuations in the autumn-winter period and due to winter desiccation [3,4].

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The purpose of the work is to analyze the climatic conditions of the northern forest-steppe of the Southern Urals during the research period, to assess the adaptive potential of the plum-tree to the conditions of the winter period and their impact on productivity.

## 2 Objects and methods of research

The research was carried out in the department of selection and sorts study of fruit and berry crops of the Sverdlovsk selection station of gardening - structural subdivision of the FGBNU Ural Federal Agrarian Research Center of the Ural Branch of the Russian Academy of Sciences during 2016-2020. The research was carried out according to the State task of the Ministry of Education and Science of the Russian Federation in the direction of the Program 150 of the of Fundamental scientific research of the State Academies of Sciences.

The research was carried out in the northern forest-steppe zone of the Southern Urals on the Chelyabinsk State Fruit and berry sort-testing lot located in the Krasnoarmeysky district of the Chelyabinsk region.

Objects of study – 13 sorts of Ussuri plum-tree *P. salicina* subsp. *ussuriensis* Koval. et Kost. (table 1).

**Table 1.** Research objects and their origin

Sort	Origin ♀ x ♂
Sorts, which are created in the conditions of the Southern Urals (South Ural Scientific Research Institute of Horticulture and Potato Growing - branch of the Ural Federal Agrarian Research Center Ural Branch of the Russian Academy of Sciences)	
Ural'skaya zolotistaya *- (st)	Kyzyl pioner x Zheltaya Hopty
Zhemchuzhina Urala	Alycha P-31 x Uvel'skaya
Sorts, which are introduced from the Altai (Department of the M.A. Lisavenko Research Institute of the Federal Altai Scientific Center of Agrobiotechnologies)	
Altajskaya yubilejnaya*	Seedling from free pollination of the sort Chernosliv man'chzhurskij.
Kseniya	Seedling from free pollination of the sort Krasnyj Shar
Seyanec Krasnogo Shara	Seedling from free pollination of the sort Krasnyj Shar
Sapfir*	Katunskaya × (Ashtarakskaya 2 × Piramidal'naya)
Sinil'ga	Seedling from free pollination of the sort Amurskaya rannyaya
Chernosliv pozdnij	
Sorts, which are introduced from Middle Urals (Sverdlovsk selection station of gardening – structural division of Ural Federal Agrarian Research Center Ural Branch of the Russian Academy of Sciences)	

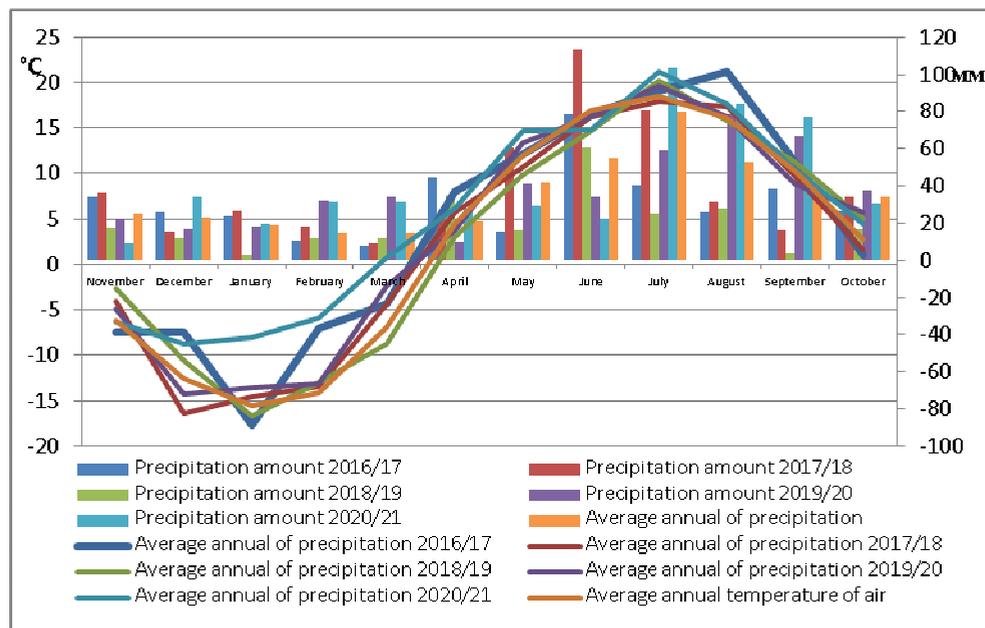
Zavet	Seedling from free pollination of the sort Man'chzhurskaya krasavica
Pionerka*	Seedling from free pollination of <i>Pr. salicina</i> subsp. <i>ussuriensis</i>
Rakityanskaya	Seedling from free pollination of <i>Pr. salicina</i> subsp. <i>ussuriensis</i>
Sodruzhestvo*	Immunnaya x 14-26 ( <i>Pr. salicina</i> subsp. <i>ussuriensis</i> )
Ural'skie zori*	Seedling from free pollination of <i>Pr. salicina</i> subsp. <i>ussuriensis</i>

Note: \* - sorts, which are zoned in the Ural region.

The studied sorts were planted in the autumn of 2009 according to the methodology of the state sort-testing [5]. The planting scheme is 5 × 3 m. The repetition is 3-divisibly with 10 plants in each. The rootstock, which is zoned in the Ural region – *Prunus bessyi*. Agrotechnics is generally accepted for plum-trees, a plot on the dry-farming land. The assessment of the degree of freezing, the general state and yield was carried out in accordance with generally accepted methods [6].

### 3 Results and discussion

The climatic conditions during the study period (2016-2020) are shown in Figure 1. The average annual air temperature was higher in comparison with long-term data (+2.1°C): in 2016/17 by 1.6°C, in 2017/18 - by 0.1°C, in 2018/19 – by 0.2°C, 2019 / 20 - by 0.8°C, 2020/21 - by 3.0°C.



**Fig. 1.** Climatic conditions in the years of research 2016-20201 (according to the data of the Chelyabinsk State University Center for Hydrometeorology and Environmental Monitoring - the village weather station Brodokalmak, Krasnoarmeysky district, Chelyabinsk region).

The average monthly air temperature in January 2016 was lower than the average annual values (-15.4 °C) by 2.3 °C, in 2018 by 1.3 °C. The absolute minimum of air

temperature was marked in January 2016 -35.5 °C (-38.0 °C on the snow surface), in December 2017 -38.3 °C (-42.2 °C on the snow surface) and in February 2019 -37.6 °C (-41.3 °C on the snow surface).

In the years of research were noted dry periods during the growing season. Thus in 2016, during mass maturing of the crop and in autumn when preparing plants for wintering was observed a deviation from the norm (424 mm per year) by 52.0 mm, in 2018 by 183.3 mm. Insufficient supply of moisture in July and August was noted in 2016 - less than the norm by 52.9 mm and in 2018 - less than the norm by 183.3 mm, which affected the decrease in the average weight and taste of fruits.

The control sort of the plum-tree Ural'skaya zolotistaya in all the years of research showed high winter hardiness of the tree and only in the winter period of 2016/17 with a decrease in the air temperature in December to -38.3 °C, and on the snow surface to 42.2 °C had a slight damage to the wood on average 0.3 points (table 2).

High winter hardiness at the control level in all the years of research with reversible damage of wood no more than 0.9 points was noted by sorts - Altajskaya yubilejnaya, Zavet, Pionerka, Sapfir, Seyanec krasnogo shara, Sodruzhestvo, Sinil'ga, Ural'skie zori, Chernosliv pozdnij. Reversible damage to wood after the winter period of 2019/20 had sort Zhemchuzhina Urala – 1.1 points. The sort Kseniya has an average winter hardiness in the conditions of the northern forest-steppe of the Southern Urals, with almost annual damage to wood up to 2.5-2.8 points.

The general state of the plants by the control sort and the studied sorts can be described as excellent.

An essential influence on the state of the sort plum-tree Kseniya from satisfactory to good was exerted by the degree of freezing of the wood, the conditions for providing moisture during the growing season and the degree of fruiting.

**Table 2.** Assessment of the degree of freezing and the general state of the plum-tree 2016-2020

Sorts	Degree of freezing, marks					General state, marks				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
Ural'skaya zolotistaya – st	0	0.3	0	0	0	5.0	5.0	5.0	4.7	4.6
Altajskaya yubilejnaya	0.1	0.8	0.1	0.1	0.6	4.7	4.8	5.0	5.0	4.8
Zhemchuzhina Urala	0.1	2.0	0.9	0.9	1.1	5.0	5.0	5.0	5.0	4.9
Zavet	0	0	0	0	0.8	5.0	5.0	4.9	4.9	4.8
Kseniya	0	2.8	2.8	2.5	0.6	4.5	4.3	3.9	3.9	4.0
Pionerka	0.2	0.2	0.1	0.1	0.8	5.0	4.9	4.8	4.8	4.8
Rakityanskaya	0.2	0.4	0	0.3	0.5	4.8	4.9	4.8	4.9	4.6
Sapfir	0	0	0.2	0.2	0.9	5.0	5.0	4.9	5.0	4.9
Seyanec krasnogo shara	0.1	1.0	0.5	0.1	0.5	5.0	5.0	4.6	4.9	4.8
Sinil'ga	0	0	0	0.1	0.3	5.0	5.0	4.9	4.8	4.9
Sodruzhestvo	1.3	1.0	0.1	0.1	0.6	4.9	5.0	4.9	4.6	4.8
Ural'skie zori	0.2	1.0	0.1	0.1	0.3	5.0	5.0	4.7	5.0	4.8

Chernosliv pozdnij	0.3	0.2	0	0.5	0.9	4.9	5.0	5.0	4.9	4.9
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Yield is one of the main signs, that determine the value of the sort [7]. The yield of sorts plum-trees varied depending on the climatic conditions during the flowering and growing season. Depending on the year of research, the yield of the control sort Ural'skaya zolotistaya varied from 2.1 (2019) to 139.1 hundredweight/ha (2018). The average yield according to the results of many years researches was 73.0 hundredweight/ha (Table 3).

The average many years yield is significantly higher than, that by the control sort Altajskaya yubilejnaya 91.6 hundredweight/ha (+18).

At the control level, the yield over the years of researches was noted by the sorts Sapfir - 70.0 (-3.0) and Sodruzhestvo - 71.5 (-2.5), as well as the yield is some lower by sorts Pionerka, Chernosliv pozdnij and Ural'skie zori from 59.2 to 65.1 hundredweight/ha. The others sorts are significantly inferior in yield to the control sort.

Stable fruiting over the years regardless from weather conditions during the flowering period with high and medium yields with an increasing total are distinguished sorts Altajskaya yubilejnaya, Pionerka, Chernosliv pozdnij.

**Table 3.** Yield of Plum-tree, 2016-2020 (hundredweight/ha)

Sort	2016.	2017	2018	2019	2020	Average	Deviation from st
Ural'skaya zolotistaya – st	63.0	32.9	139.1	2.1	127.9	73.0	-
Altajskaya yubilejnaya	49.3	28.7	61.0	84.1	2349	91.6	+18.0
Zhemchuzhina Urala	15.5	19.7	18.3	20.5	96.1	34.0	-39.0
Zavet	0	30.2	58.7	42.1	61.9	38.6	-35.0
Kseniya	102.0	0	28.0	31.2	3.3	32.9	-40.1
Pionerka	33.1	36.7	57.6	69.1	129.1	65.1	-7.9
Rakityanskaya	52.2	90.0	86.9	7.1	40.1	55.2	-17.8
Sapfir	54.7	31.1	106.9	57.0	100.1	70.0	-3.0
Sodruzhestvo	9.5	160.9	58.7	45.3	83.3	71.5	-2.5
Seyanec krasnogo shara	20.0	23.6	59.1	50.9	52.1	41.1	-31.9
Sinil'ga	52.1	48.3	56.2	38.6	65.1	52.1	-20.9
Ural'skie zori	61.0	114.5	44.9	2.9	72.8	59.2	-13.8
Chernosliv pozdnij	52.1	40.2	59.3	93.6	65.1	62.0	-11.0
The smallest significant difference <sub>05</sub>							8.8

According to the methodology the sorts were divided into medium-yielding (60-120 hundredweight/ha) by yield – Ural'skaya zolotistaya (control), Altajskaya yubilejnaya, Sapfir, Sodruzhestvo, Chernosliv pozdnij and low-yielding ( $\leq 60$  hundredweight/ha) –

Zhemchuzhina Urala, Zavet, Kseniya, Rakityanskaya, Sinil'ga, Seyanec krasnogo shara, Ural'skie zori.

## 4 Conclusions

Thus, the climatic conditions during the years of research reflected the features of the continental climate of the Chelyabinsk region, which allowed it to assess the adaptability of sorts plum-tree to the conditions of the winter period.

High winter hardiness on the level of the control sort Ural'skaya zolotistaya, was noted by sorts - Altajskaya yubilejnaya, Zavet, Pionerka, Sapfir, Seyanec krasnogo shara, Sodruzhestvo, Sinil'ga, Ural'skie zori, Chernosliv pozdnij.

It was established that the sort control Ural'skaya zolotistaya is characterized by a yield of 73.0 hundredweight/ha. The control sort is higher in yield than the sort sort Altajskaya yubilejnaya (91.6 hundredweight/ha), at the level of productivity by the sort Sodruzhestvo (71.5 hundredweight/ha) and Sapphire (70.0 hundredweight/ha).

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