

Creation and study of Russian plum varieties in the Middle Volga

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Abstract. Eight elites of Russian plum were created and transferred to the state test as a result of many years of breeding work on interstitial hybridization in the Samara region. According to the results of many years of observations and field surveys, the most frost-resistant varieties of Russian plum were identified; the nature of damage to plum plants in severe winters was studied. Experimental data proved the promise of growing Russian plum varieties in the Middle Volga region. The varieties Kompotnaya (23.6 kg per tree), Mara (19.4 kg), Smart (13.8 kg) and Poselkovskaya (10.4 kg) have high productivity. Ripening dates, weight and taste of fruits in Russian plum depend on the variety, air temperature and the amount of precipitation. The varieties possess large fruits (weighing 35-50 g) Kuban Comet, Found, elite Giantess, Canning, Dressy, 1/17. The best tastes were the varieties Kuban Comet (4.5 points), July Rose (4.4 points), Found (4.5 points), Pramen (4.5 points), the elite Long-awaited and Canned (4.4 points).

1 Introduction

Plum is the most important stone fruit cultivated in the Middle Volga region, and in second place in the distribution area after cherry. Plum is very popular among the population for quality fruits suitable for fresh consumption and in processed products.

The main factors limiting the successful growth of plums are low minimum temperatures in the winter, sharp temperature fluctuations in the late winter and early spring periods [1–4]. Dry and hot weather during flowering leads to premature drying of the stigmas of the pistils, as a result of which no ovaries form [5]. In cool, rainy weather, years of bees are disturbed, as a result of which pollination of plum flowers also does not occur. After severe frosts in adult plum plants, cracking of the bark of the stem and skeletal branches is observed, and flower buds completely freeze out. In severe winters, the death of some trees of poorly winter-resistant varieties, as well as severe freezing of skeletal branches, is noted [6–8]. Sunburns in March lead to severe damage to the stem and forks of skeletal branches, after which the plants dry out. A large moisture deficit in the spring-autumn periods leaves a negative imprint on the growth, development and fruiting of plums [9].

In the Samara region, Russian plum is a new fruit crop. There are no varieties of Russian plum registered in the Middle Volga region [10]. Since 1985, the introduction and selection of Russian plum have been conducted. As a result of hybridization carried out in 1989 and sowing seeds from free pollination of the Kuban Comet variety, the first in-

house elite forms were obtained [11]. Currently, an initial study of 8 elites of Russian plum is undergoing - Giantess (seedling of the Kuban Comet), Long-awaited (Kuban Comet X Mara), Kompotnaya (seedling of the Kuban Comet), Canning (Kuban Comet X Cleopatra), Lunar (seedling of the Kuban Comet), Dressy (seedling Found) and Poselkovskaya (seedling of the Kuban Comet).

In the Middle Volga region, plum varieties are subject to special requirements, primarily for frost resistance of a tree and flowering buds, which is especially relevant.

We solved the following tasks: conduct phenological observations of the growth, development and fruiting of the plum varieties of Russian plum available in the collection; evaluate the yield of varieties and elite forms; conduct a qualitative assessment of the studied varieties and elite forms.

2 Materials and methods

Work on the selection and primary study of Russian plum varieties was carried out in 2011 – 2019 in the Samara State Agrarian University. Initially, the objects of research were 19 varieties and elites of Russian plum of domestic selection. Uterine and grafted trees on wild cherry plum represent variety specimens in the primary study. The following indicators are estimated: productivity, the timing of flowering and ripening of fruits, fruit quality. Varieties in the collection were studied according to the program of various studies of fruit, berry and nut-bearing crops. The study, selection and transfer of hybrid seedlings to the state

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trials were carried out, guided by the method of selection of fruit, berry and nut-bearing crops. The productivity of Russian plum varieties was taken into account on 7-15-year-old trees in a visual way. The maturity of the fruit was determined by the onset of consumer ripeness of the fruit. The average weight of the fetus was calculated by weighing at least 30 pieces of fruit in the sample for each variety. Yields were processed as a one-factor experiment with double repetition and date conversion. The collected data were processed in an Excel spreadsheet processor.

3 Results and discussion

The sizes of trees of various varieties of Russian plum are mostly small up to 3.5 m, trunk diameter up to 30 cm. The bark on the stem and the main skeletal branches at a young age is green or grey, smooth, in the older bark on the stem it cracks. The layering in the arrangement of skeletal branches at the Russian plum is weakly expressed. Crohn in most varieties (July Rose, Kuban Comet, Found, Dolgojdannaya and other varieties) is rounded, in the variety Column-shaped pyramidal. Crohn in most varieties is slightly thickened; in others, it is rare (Mara variety).

Fruiting in most varieties occurs very early for 2-3 years from the planting of a seedling in the garden and is mainly concentrated on bouquet branches – very short fruit formations up to 1 cm long. Varieties also bear fruit at the lower ends of last year's growths. Russian plum flowers are small, 1-2 in the bud, white. It blooms in the conditions of the region early in early May, following an apricot or together with late-flowering apricot varieties. Therefore, spontaneous pollination between apricot and cherry plum is possible.

The shoots at the Russian plum are actively growing after flowering. Many varieties have high shoot-forming ability, resulting in a thickening of the crown. Excess shoots during the growing season must be removed. Most varieties have two or even three growth waves, and many of them do not have time to complete growth by autumn, for example, the Column-shaped variety. As a result, the trees go into the winter unprepared for wintering and freeze. The task of the gardener is to normalize the number of shoots, to support the growth of branches and to timely change bare branches.

Three primary winters took place during the primary variety study for varieties and hybrid forms of Russian plum - 2002-2003, 2005-2006, 2009-2010.

Varieties and hybrid forms of plum in the collection, these winters suffered from varying success. Could not withstand the harsh climate of the Middle Volga region and in the first harsh winter, the trees of the Russian plum varieties Globus, Dynnaya, and Abundant froze. The Cleopatra tree in the winter of 2002-2003 had severe freezing of the stem and skeletal branches by 3.5 points and then was restored due to the growth of shoots from sleeping buds. However, in the harsh winter of 2005-2006, this tree still froze. Plants of other varieties of Russian plum in these winters froze to an average degree by 2-3 points.

The weather conditions of the winter of 2005-2006 were extremely unfavourable for overwintering of stone stands. January frosts at minus 38-39 ° C (in the vicinity of Samara), observed for a long time, led to the death of about 20% of the available plum plantings.

In April, we conducted a detailed assessment of the degree of freezing of trees. The nature of the freezing of individual parts and organs of the plant was taken into account: flowering and growth buds, wood, bark, cambium in annual and perennial shoots, stem and forks of skeletal branches according to the appropriate technique.

A different degree of freezing was noted in the Russian plum varieties. In adult plants of stone fruits, cracking of the bark of the stem and skeletal branches was observed. The death of some trees of low winter resistant varieties was noted. Some trees of the cherry plum variety Kuban Comet, loaded with a harvest in 2005, were frozen.

In the Kolonvidnaya variety, the entire annual growth has frozen out, and two- and three-year-old wood have also suffered (freezing 2.5-3 points). On trees of other varieties, freezing of skeletal branches by 2.5-3.5 points was noted. In most varieties, 95-100% of flower buds died. In the spring, only 1/12 plum variety (thorns x plum) was blooming for 1-1.5 points.

Further examination of the state of fruit plantations in late May and early June revealed significant differences in the degree of winter damage by variety, by microzones of their growth. Dependencies of differences on the level of agricultural technology used, crop load in the previous year, site configuration, and the presence of protective strips are revealed. The picture, even within the same area, on the same varieties varied greatly depending on the above factors. Plant recovery after winter damage took place in unusually cold and humid weather in the spring of 2006 due to the growth of shoots from sleeping buds.

Severe winter 2009-2010 caused even more significant damage to the Russian plum plantations in the Samara region (Table 1).

In mid-December, frosts of minus 38-39 ° C were observed for three days. Dry freezing and fall of trees in the previous year also contributed to the severe freezing of plum trees.

According to the results of wintering, the most winter-hardy in the conditions of the region were the Kuban Comet, Found, July Rose, Pramen, Mara, 1/4 elite and Outfit. Varieties Granite, Kolonoobraznaya, Late Comet, Moscow Comet, elite forms 26-492 and 26-470 completely frozen out. Varieties Gek, Zlato Skifov, the elite of the Samara selection Konservnaya and Kompotnaya had severe freezing. After last winter, only one elite of the Russian plum Poselkovskaya (seedling of the Kuban Comet from free pollination) had bloom by 1.5 points.

As a result of the death of trees of poorly resistant plum varieties after severe winters, 16 varieties of Russian plum of domestic and foreign selection remained in the primary study.

Table 1. The degree of freezing of varieties of Russian plum in the winter of 2009-2010.

Grade name	Tree age	Growing method	Place of tree variety breeding	The degree of freezing, score
Gek	7	Grafted on a plum home	Krymsk	4.0
Granite	7	Same	Krymsk	5.0
Zlato Skifov	7	Same	Moscow	3.5
July Rose	7	Same	Krymsk	3.0
Columnar	7	Same	Krymsk	5.0
Comet Late	7	Same	Krymsk	5.0
Kompotnaya (Elite 1/2)	7	Mother tree	Samara	4.0
Konservnaya (Elite 1/7)	7	Same	Samara	3.5
Kuban Comet	7	Grafted on a plum home	Krymsk	3.0
Lunar (Elite 2/3)	7	Mother tree	Samara	3.5
Mara	7	Grafted on a plum home	Belarus	2.0
Moscow Comet	7	Same	Moscow	5.0
Naydena	7	Same	Krymsk	3.0
Naryadnaya (Elite 2/4)	7	Mother tree	Samara	3.0
Poselkovskaya	7	Same	Samara	2.0
Pramen	7	Grafted on a plum home	Belarus	2.0
Elite 26 - 492	7	Same	Moscow	5.0
Elite 26 - 470	7	Same	Moscow	5.0
Elite 1/4	7	Same	Samara	3.0

The weather conditions of 2012 and 2013 were favourable for the restoration of plum trees, which froze in the winter of 2009-2010. All plum trees that had slight freezing of wood were well restored. However, the weather conditions during flowering for most plum varieties in 2012 were extremely difficult. During the flowering period of the main group of plum varieties, there was hot, dry weather with dry winds. In May, there was an increased temperature regime and a deficit of precipitation. The maximum air temperatures were 27-33 °C. The average air temperature for the month turned out to be 2.5-3.9 °C higher than the perennial ones. The amount of precipitation averaged over the territory was 19-33 mm or 58-71% of the norm. In the second decade, abnormally hot weather was observed everywhere. Under such conditions, the stigmas of the

stigmas dried out quickly and normal fertilization did not occur. Therefore, the yield of most plum varieties in 2012 was slightly weaker than in 2013 (Table 2).

Table 2. The productivity of Russian plum varieties (2012, 2013, 2016, 2017-2019)

Sample name	Productivity from a tree, kg						Grade average
	2012	2013	2016	2017	2018	2019	
Giantess	2.0	0.5	3.0	8.0	4.0	20.0	7.5
Dolgojdannaya			6.0	4.0	5.0	25.0	10.0
July Comet	1.0	2.0	4.0	2.0	5.0	5.0	3.8
Kompotnaya	8.0	10.0	29.0	1.0	30.0	40.0	23.6
Konservnaya			2.0	1.0	3.0	5.0	2.8
Kuban Comet	5.0	2.0	7.0	3.0	8.0	10.0	7.0
Lunar	5.0	1.0	4.0	2.5	3.0	4.0	3.9
Mara	8.0	12.0	22.0	13.0	22.0	20.0	19.4
Moscow comet	3.0	3.0	7.0	4.0	6.0	8.0	6.2
Naydena	7.0	4.0	10.0	4.0	10.0	14.0	9.8
Naryadnaya	2.0	4.0	32.6	0.5	24.0	6.0	13.8
Poselkovskaya	3.0	5.0	8.0	5.0	17.0	14.0	10.4
Pramen	2.0	2.0	5.0	3.0	3.0	8.0	4.6
Elite 1/4	1.0	1.0	5.0	2.0	10.0	10.0	5.8
Elite 2/17	0.5	1.0	4.0	3.0	7.0	14.0	5.9
Elite 1/17			5.0	4.0	3.0	6.0	4.5
Year average	3.7	3.7	9.6	3.8	10.0	12.9	7.3

The plants of the Russian plum varieties Mara, Naydena, Kuban Comet and the new elite forms Kompotnaya, Nyadarnaya, Poselkovskaya, Dolgojdannaya and Giantess, differed in good productivity.

The weather conditions in 2012 contributed not only to the earlier start of the growing season but also to the earlier ripening of the fruits of Russian plum. In 2012, the fruits of Russian plum early varieties ripened ten days earlier. Fruits of late varieties ripened 5-7 days earlier than in 2013.

The overwintering conditions of 2014 and 2015 were unfavourable, therefore, the crop on almost all plum varieties was absent in these years.

In the last four years of research (2016-2019), weather conditions during the wintering and growing season of the plum tree developed differently.

Winter weather conditions 2015-2016 and 2017-2018 developed favourably for wintering plum trees. Freezing of flower buds was not observed during these winters. The conditions of the growing season in these years were ideal. The year 2016 was especially favourable for the growth and development of Russian plum trees. The winter of 2016 was marked as the warmest. The average temperature was only minus 5.3 °C. The temperature in all three months of winter was observed above normal. In 2016, the elite Giantess, Kompotnaya, Lunar and Nyadnaya (flowering degree 5 points) differed in the best flowering. The duration of flowering averaged 6-10 days. Summer turned out to be quite dry and hot. In all months, the average temperature was above normal. All elite forms this year showed high productivity. Higher productivity in the observed year was

noted among the elites Kompotnaya (29.0 kg per tree) and Smart (32.6 kg).

Autumn, on the contrary, was quite rainy. October was characterized by cold, cloudy weather throughout the month with an average monthly temperature of 4.1 ° C. In such weather, the processes of formation of flowering buds at the plum and tissue maturation proceeded very poorly. December turned out to be the coldest, and on the eve of the new year 2017, there was a thaw due to a wave of warm air rushing from the Atlantic. The conditions of the autumn-winter period hurt the differentiation and preservation of flower buds. However, some elites were less responsive to thaws and had good flowering.

During the flowering of the trees, there was also cool, rainy weather. In 2017, the beginning of the flowering of Russian plum was observed on May 4-6. Elites A 1/17, A 2/17, Lunar, though bloomed by 4 points, however, fruit set was not observed. Elite trees A 1/4 and Giantess bloomed by 5 points. Weak flowering was observed among elites Dolgojdannaya (2.5 points), Kompotnaya and Naryadnaya (1.0 points). It should be noted the high load of elite crop Kompotnaya and Nyadnyaya in the 2016 season, which subsequently affected the degree of flowering and productivity. As a result, the harvest in 2017 on Russian plum was weak.

Wintering conditions 2017-2018 and 2018-2019 were by the passage of even temperatures without significant fluctuations in frost and thaw. The observed weak and short thaws of the second half of the winter of 2018 led to minor damage to the flower buds of Russian plum. The elite Kompotnaya (30.0 kg per tree) and Naryadnaya (24.0 kg) were again loaded with a high yield. Elite A 1/4 had an average yield (10 kg per tree).

The productivity of other elites was significantly lower than average. 2019 was a particularly fruitful year for plums. Almost all varieties of Russian plum in the reporting year had the highest productivity.

The fruits of Russian plum ripen at different times (Table 3).

By maturity, plum varieties were divided into three groups: early, middle and late. The early varieties whose fruits ripen in mid-late July include July Comet, Kuban Comet, Naydena, Pramen, Moscow Comet, Samara selection elites A 1/4. In the middle term (the first and second decades of August), the fruits of the elites Kompotnaya, Giantess, Lunar, 1/17 and 2/17 ripen.

The fruits of the variety Mara, elites Dolgojdannaya, Konservnaya and Naryadnaya ripen in late terms – the third decade of August-early September. In 2016, the period of removable ripeness of the fruits began and ended a week earlier than in the cool and rainy 2017.

Table 3. Qualitative characteristics of Russian plum fruits

Sample name	The average mass of the fetus (g)	The taste of fruit (score)	Fruit ripening
Giantess	41.2	4.0	27-30.07
Dolgojdannaya	24.0	4.4	21-30.08
July Rose	22.8	4.4	10-14.07
Kompotnaya	20.6	4.1	4-18.08
Konservnaya	32.8	4.4	20.08-1.09
Kuban Comet	28.4	4.5	13-20.07
Lunar	18.8	4.3	27.07-1.08
Mara	23.0	4.0	23.08-3.09
Moscow comet	25.7	4.1	16-21.07
Naydena	26.1	4.5	15-23.07
Naryadnaya	39.9	4.0	19-28.08
Poselkovskaya	19.8	4.3	19-21.07
Pramen	16.4	4.5	17-20.07
Elite 1/4	19.5	4.0	20-29.07
Elite 1/17	44.5	4.0	3-10.08
Elite 2/17	19.6	4.2	27.07-6.08

The mass of fruits depends both on the genetic characteristics of the variety and on the weather conditions of a particular growing season. In the crop-loaded year (season 2016), the fruits of Russian plum are smaller. In the wet (2017), the fruits of the same varieties become larger. In years with a high content of the sum of active temperatures and normal humidity (vegetation season 2018), the fruits are also large.

A different mass of fruits characterizes the studied elites. Of the varieties under study, the Kuban Comet possess larger fruits (35-50 g), and the elite Giantess, Konservnaya, Naryadnaya, 1/17 are found.

The flavouring qualities of fruits are more dependent on the genetics of the variety and vary from year to year depending on weather conditions. The best fruit tastes were the Kuban Comet (4.5 points), July Rose (4.4 points), Naydena (4.5 points), Pramen (4.5 points), and the elite Dolgojdannaya and Konservnaya (4.4 points).

4 Conclusion

As a result of long-term observations and field surveys, the most frost-resistant varieties of Russian plum were identified, the nature of damage to plum plants in severe winters was studied. The prospects of growing Russian plum in the Middle Volga region is proved. The most fruitful are the varieties of Russian plum Dolgodzhannaya, Kompotnaya, Naryadnaya and Poselkovskaya. The studied indicators: productivity, fruit ripening dates, as well as the quality of Russian plum fruits depend both on the genetic characteristics of the variety and the weather conditions of wintering and vegetation.

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