Evaluation of the yield of wrinkled rosehip (*Rosa rugosa* Thunb.) in conditions of the south of Primorsky krai

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Abstract. The article studies the yield of wrinkled rosehip (*Rosa rugosa* Thunb.). This species is the most promising for industrial breeding in the Far East. The studies were carried out on three plots on different types of soils. Measurements of such indicators as: density, height, age, number and weight of fruits, followed by analysis of the results are obtained. The dependence of the number of rosehip fruits on age has been revealed. Habitat conditions affect the number of stems. The results have shown that the number of stems (density) in curtains is much less than in continuous thickets, therefore, the yield here is smaller. According to the data obtained, the height of rosehip thickets belongs to the 1st productivity class with an average height of 1.6 m and 1.28 m, respectively. According to the data obtained, the most fruit-bearing age is 5 years. From the studies obtained, it was revealed that approximately 7.57 fruits per m^2 grow in sandy mane conditions, and twice as many – 16.93 fruits per m^2 – on meadow soils. The yield of dry weight of rosehip in relation to raw weight ranges from 37.66 % to 38.30 %.

1 Introduction

Rosehip is of great importance in human life. It is a natural vitamin carrier. It is used as a raw material for the manufacture of a number of products: medicines, wine, perfume, essential oil, vitamins, vinegar. Many species of wild rosehip are used in ornamental gardening, in the construction of hedges, as well as to secure mountain slopes and ravines from soil washing away [1].

It is well known that vitamins are of great importance in the vital activity of the body and for therapeutic purposes. Vitamins are necessary not only for humans, they are also essential for increasing the productivity of livestock farming.

Among the wild vitamin-bearing plants, rosehip contains a large number of vitamins. Rosehip contains 10 to 20 times more vitamin C or ascorbic acid than blackcurrant fruits, or 500 times more than lemon fruits. The branches contain vitamin P. Polysaccharides,

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carotenoids, vitamin C are found in the leaves. Fruits contain vitamins C, P, K, rutin, carotenoids, flavonoids, essential oil, sugars. The pulp of the fruit also contains potassium, calcium, iron, manganese, phosphorus, and magnesium [2-19].

A very valuable product extracted from the seeds and petals of rosehips is rose oil. The fruits are used to make jam, compotes and mashed potatoes. Scientific research and practice have established that the best plant raw material for obtaining high-value natural vitamin concentrates are rosehip fruits [1].

Rosehip is quite well studied for the regions of Central Russia. In the Far East, information has been found only about the Sikhote - Alin State Reserve, which is located in the north of the Barabashsky forestry. The growing conditions of rosehips in the reserve are harsher. For the south of Primorsky Krai, studies on wrinkled rosehip were not carried out. In this regard, this study is devoted to the study of wrinkled rosehip in the south of Primorsky Krai, i.e. in the conditions of the Barabashsky forestry.

The purpose of the research was to determine the yield of wrinkled rosehip in natural growing conditions, depending on a number of factors, for further planning of measures to increase yields. Based on the set goal, the following tasks were solved:

- to study the density of rosehip shoots per unit area;
- to measure the height of shoots;
- to determine the age of the shoots that form the bush;
- to study the yield depending on the age of the shoots;
- to establish the number of healthy fruits;
- to determine the weight of the fruit pulp, seeds and sepals;
- to determine the yield of dry fruits from the weight of raw fruits.

2 Materials and methods

The research was carried out in June-September 2022, during the period of mass flowering and ripening of fruits on the territory of the Barabashsky forestry, located in the south of the Primorsky Territory. Its coordinates are longitude – 131°48.171' N, latitude – 43°188.587' W.

For the study, three sites were selected, where rosehips grow in different conditions. The first sample grows in a curtain wall and is located on the sandy mane of the seashore. These ridges have silty layers formed as a result of the activity of water and the deposition of alluvial sand of different thickness. The second sample is also a curtain wall and is represented by meadow soils. Due to the wide variety of herbaceous plants, it can be said that the soil here is rich and favorable for the growth of rosehip. The third sample is located on a sandy mane along the seashore in a continuous, dense thicket. Here, rosehips grow on slopes and elevated places of the manes.

Such indicators were determined as density, height, age, number and weight of fruits, with the following analysis of the obtained results. The dependence of the number of rosehip fruits on age was also revealed.

To determine the density of rosehip on m^2 two sample sites were laid (sample 1 and 2). Two accounting sites, which are situated in different conditions, were laid on each sample. 13 accounting sites with the size 1m×1m were laid on the sample 3. It is located on a sandy mane along the seashore.

The height of the thicket was determined on two accounting sites. Its value was established on the basis of 10-12 measurements of the heights of different bushes and three classes of productivity were established according to it: class 1, average height – from 1.21 m and above; class II – from 0.81 to 1.20 m; class III – 0.80 m and below, with the prevailing age of the above-ground part of the thickets being 3 years and above.

The counting stems in the curtain wall were selected by random sampling in the amount of 10 pieces for the first sample and 12 pieces for the second, and therefore they should characterize all the stems of this curtain wall. The average height of the curtain wall was determined by the height of the felled trunks by calculating the arithmetic mean.

The age of the above-ground part of the thicket is considered to be the one that has the largest part of the trunks forming this thicket, i.e. the prevailing age, and is determined by cutting down the trunks and counting the growth rings on the cut at the base of 10-12 trunks and is calculated as a weighted average.

The average age of the thicket on the sample (Asp) is defined by calculating the arithmetic mean.

To take into account the yield of rosehips depending on the age, all trunks were cut down on the already laid 13 accounting sites (sample 3), the age was determined and the number of fruits on shoots of a certain age was counted.

To determine the yield of healthy fruits all the fruits were collected on the 1st and 2nd samples. The number of fruits was counted and simultaneously sorted from dry and diseased fruits. The yield of healthy fruits can be calculated by the percentage of healthy fruits out of the number of all fruits harvested or the total weight of the fruit.

To determine the weight of the fruit pulp, seeds and sepals, weighing was carried out immediately after harvesting. After that, the fruits were tied in a bag so that there was no loss of moisture while the fruits were being cleaned of seeds and sepals. At the end of it, the fruits were weighed again, cleaned of seeds and sepals. The last weighing was carried out after the end of drying.

In order to calculate the yield of dry fruits, it is first necessary to dry these fruits with the least loss of vitamin C.

The yield of dry fruits was calculated after weighing the pulp, seeds and sepals separately. And after compiling the proportion of dry pulp weight to the total weight of raw pulp, we obtained percentages showing the share of dry fruit yield [20].

3 Results and discussion

The results of determining the density of rosehip shoots depending on the conditions of its habitat are presented in Table 1.

Table 1. Number of shoots per m^2 depending on the growing conditions.

№ of sample	Growing conditions	Number of shoots on m^2
1	Sparse thickets on the seashore	21.5
2	Territory of the former airfield (meadow)	17.5
3	Solid thickets on the seashore	22.8

In the third sample at 13 accounting sites, annual shoots that appeared in the year of the study were taken into account (Table 2).

Table 2. Number of annual stems on sample 3.

№ of accounting site	1	2	3	4	5	6	7	8	9	10	11	12	13	∑	Average
Number of annual stems	9	3	9	6	8	5	7	5	4	8	4	3	9	80	6.15

The following formula was used to determine the average number of stems per m^2.

$$\tilde{X} = \frac{80}{13} = 6.15 stem / m^2 \quad (1)$$

It is noted that for every 22 trunks per m^2 there are 6-7 trunks of annuals. The percentage of young stems in the total number of stems was 27%.

It was revealed that the conditions of the habitat affect the number of stems. From the studies carried out, it can be seen that the number of trunks (density) in curtain walls is much less than in solid thickets. The obtained data confirmed the research of Payberdin M. V. [20] that in small curtain walls, the density of shoots, as a rule, is less. This indicates that it is necessary to create plantations in solid thickets.

The average value of height by calculating the arithmetic mean, for single curtain wall is presented in Table 3.

Table 3. Average height, m.

# of curtain wall	Average height, m
1 curtain wall	1.6
2 curtain wall	1.28

According to the data obtained at the height of the rosehip thicket, both samples belong to the 1st productivity class with an average height of 1.6 m and 1.28 m, respectively.

From the data obtained, it can be seen that the curtain growing on the territory of meadow soils is lower than the second one growing on a sandy mane along the seashore. This can be caused by different soil compositions. After all, in the conditions of the meadow, there are much more forbs, as a result of which there is competition in growth, and the grass prevents the rosehip from developing well.

It was set, that the age on the plot is $\tilde{x} \pm m_x = 4.25 \pm 0.23$ years , it means between 4.48 and 4.02 (4-4.5) years.

Possible age on the sample:

$$\tilde{x} \pm 3\sigma = 4.25 \pm 3 \cdot 0.89 = 4.25 \pm 2.67, \quad (2)$$

i.e. from 6.92 till 1.58 (2-7) years.

$$\tilde{X} = P_X = \frac{100 \cdot 0.23}{4.25} = 5.41\% - \text{high accuracy} \quad (3)$$

Next, let's check the degree of reliability of the computed data or the reliability of the conclusion:

$$t = \frac{4.25}{0.23} = 18.48 \quad (4)$$

Since the quotient is greater than three, the age value is reliable.

The data obtained show that the height of the shoots depends on age. For example, on the territory of meadow soils, the height was lower compared to sandy soils. The reason for this is the youngest age.

It was also revealed that on the first sample, growing on a sandy mane, the average age was 6.3 years. This site, as it turned out earlier, is sparse. The growing conditions are better than in a continuous thicket on the third sample – 4.09 years.

Yield indicators of wrinkled rosehip are given in Table 4.

Table 4. The number of fruits on stems of different age.

Age, yrs	# of accounting site	1	2	3	4	5	6	7	8	9	10	11	12	13	Average number of fruits, st.
	Number of stems, st.	Number of fruits, st.													
1	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	12	-	8	-	-	2	-	1	-	-	1	-	-	-	1.0
3	35	6	9	1	9	5	-	8	2	-	-	8	2	5	1.57
4	27	3	5	-	3	9	3	8	-	2	1	7	9	1	1.88
5	40	10	5	14	14	1	7	4	7	4	5	6	-	3	2.0
6	34	7	-	9	6	-	4	7	8	4	10	1	6	-	1.82
7	30	2	3	5	1	-	6	-	3	7	5	3	6	7	1.6
8	22	1	-	7	2	-	5	4	2	6	4	4	2	4	1.86
9	3	-	-	-	-	-	1	-	-	-	-	-	-	-	0.33
10	9	-	-	-	1	-	1	-	-	3	2	-	2	2	1.22
11	1	-	-	1	-	-	-	-	-	-	-	-	-	-	1.0
12	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2.0
∑	296	31	30	37	36	17	27	32	22	26	28	29	27	22	

The dependence of rosehip yield on age is most clearly seen in the graphic representation in Figure 1.

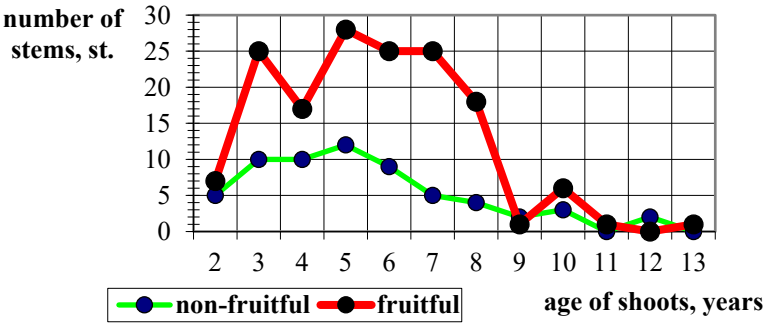

Fig. 1. Ratio of fruiting and non-fruiting stems depending on age.

The average value of the number of fruits per a stem of a certain age is shown in the graph (Figure 2).

The correlation coefficient showed that the relationship between age and fruiting is direct, reliable ($tr > 3$), significant ($r = 0.65$), variability in age is large, and in fruiting is significant. It has been established that fruiting has a certain dependence on the age of the trunks: it begins at the age of 2 years and gradually increases in the number of fruits per stem up to 5 years.

Rosehip, as all fruiting plants, is affected by diseases caused by harmful plant organisms (fungi and bacteria) and damage is also caused by insects, which leads to a decrease in yield. Therefore, in order to find out how much rosehips are affected in these conditions, the yield of healthy fruits was determined.

The obtained data are presented in Table 5. The influence of growth conditions is noticeable. In conditions of sandy mane along the sea shore yield of healthy fruits

comprised 85.71-88.24 %, and in conditions of meadow it is noticeably more, within 94.12 -97.37 %.

The weight of one fruit due to the researches comprised 4.20-5.0 g.

The fruit pulp comprised 60.26-61.11 % or in weight ratio varied within 18.68-49.74 g/m^2. The significant loss of weight when drying should be noted. The yield of dry weight in relation to wet weight of rosehip was from 37.66 % till 38.30 %.

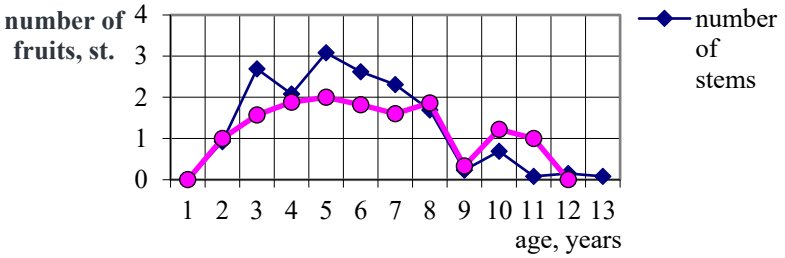

Fig. 2. Ratio of stems due to age and yield of rosehip.

Table 5. The dependence of the yield of healthy fruits on growth conditions.

# of site	Growth conditions	Square on sample sites, m^2	Number of fruits on sample sites,				The yield of healthy, %
			common	including		healthy on m^2	
				healthy	affected		
1	sea shore	20.608	178	156	22	7.57	87.64
2	meadow	9.45	170	160	10	16.93	94.12
3	sea shore	1	34	30	4	34	88.24
4	sea shore	1	28	24	4	28	85.71
5	meadow	1	40	38	2	40	95.0
6	meadow	1	38	37	1	38	97.37

4 Conclusion

Thus, in order to project plantations for rosehip cultivation it is necessary to select the best conditions for its growth and development.

Habitat conditions affect the number of stems. From the studies carried out, it can be seen that the number of stems (density) in curtains is much less than in continuous thickets, therefore, the yield will be smaller. This indicates that it is necessary to create plantations in a continuous thicket.

The height of bushes has an influence on convenience of picking rosehip fruits, on selection conducting bush care, in particular in cutting out old shoots. The height of the rosehip thickets is 1.6-1.28 m. The most decisive factor in fruiting is the age of shoots.

For the proper organization of industrial farming, it is necessary to establish the age of the trunks for rosehips, in which there is maximum fruiting. According to the research data, the most fruit-bearing age is 5 years.

For further design of a rosehip plantation, it is necessary to know what kind of possible harvest will be obtained. To do this, the yield of healthy fruits was determined. In sandy mane conditions along the seashore, the yield of healthy fruits is 85.71-88.24 %, and in meadow conditions it is noticeably higher in the range of 94.12-97.37 %.

In conclusion, we can say that in different conditions (meadow or seashore) rosehip bears fruit in different ways. Approximately 7.57 fruits per m^2 grow in sandy mane conditions, and twice as many – 16.93 fruits per m^2 – in meadow soils.

The dry weight yield of rosehips in relation to wet weight ranges from 37.66 to 38.30 %.

The research was carried out within the state assignment of Ministry of Science and Higher Education of the Russian Federation (theme No. 124012200183-8).

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