Evaluation of apple varieties with summer ripening in intensive-type orchards

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Abstract. The study results of the main economic and biological indicators of summer ripening apple varieties on low-growing rootstocks in intensive plantings were generalized. It was found that the use of low-growing intercalars has the same weakening effect on the apple tree growth as when using it as a rootstock. In terms of the total yield, 10-year-old trees of the Orlinka and Yablochny Spas varieties did not show significant differences in the options for using low-growing forms in as an intercalary or root stock. Modeling the damaging factors of the winter period revealed good resistance to early winter frosts, to a decrease in the freezing temperature in the middle of winter to -40 °C and to frosts after thaws at the end of winter. On the medium-sized rootstock 3-3-72, Rannee Aloe variety showed high early ripening and productivity significantly higher than Papirovka. The highest yields of the studied varieties on the rootstock 3-3-72 were given at the age of 10 to 20 years and are characterized as mildly periodically fruiting. According to the complex of economic and biological indicators, the varieties of summer ripening period for intensive plantings, farm and homestead gardens were identified.

1. Introduction

In accordance with the Federal Program for the Development of Agriculture in Russia for 2017-2025, a scientific and technical strategy for the horticultural industry development has been determined; it is providing priority directions for increasing the production of fruit products through further intensification and rational use of land. Intensification of horticulture aims at an innovative approach to fruit production, providing for the transition of the industry to laying gardens with dense planting patterns using low-growing rootstocks, new fast-growing high-yielding varieties and effective technologies for their cultivation.

It has been proven by domestic and foreign researchers and practitioners that a sharp increase in fruit production can be obtained by creating intensive plantings of apple trees using low-growing rootstocks and adaptive disease-resistant varieties [1-6].

The rootstock influence on the strength of tree growth and early ripening has been reported by many authors [5-9].

Apple trees on low-growing clonal rootstocks are distinguished by a more superficial arrangement of skeletal and encrusting roots, yielding seedling rootstocks according to the specific length of skeletal roots [5]. Therefore, a higher demand for the water regime is noted in an apple tree grafted on
low-growing rootstocks due to the weak development and fixation of roots in the soil, they require the installation of supports, which complicates and increases the cost [10].

One of the ways to create intensive apple trees' plantings is to grow trees using the technology of using low-growing rootstocks as an intercalary on a tall-growing seed stock, which provides deeper penetration and good fixation of roots in the soil and a weakly growing insert provides growth weakening and fruiting acceleration of the graft. Trees with dwarf interstocks have good root anchoring in the soil and do not require supports.

The efficiency of using the technology of growing trees with a low-growing intercalar is confirmed by the data of various researchers [6, 11-15]

The purpose of this work was to assess the main production and biological characteristics of variety-rootstock combinations of summer apple varieties in an intensive-type orchard on low-growing rootstocks when used as rootstocks and as inserts.

Of particular interest are apple varieties of early summer ripening to meet the needs of consumers in the summer.

2. Materials and methods
The research was carried out in the intensive type VNIISPK plantings.

1. Experiment “Study of the main production and biological characteristics of summer apple trees' varieties on various types of clonal low-growing rootstocks.

   Planting scheme 5x2m (1,000 trees per hectare), repetition - three-fold, 10 trees per accounting plot. Planting year - autumn 2011.

   The research objects were apple varieties Orlinka and Yablochny Spas. Rootstocks - 62-396 (rootstock and intercalary), 3-17-38 (intercalary).

2. Experiment “Study of summer apple trees' varieties on medium-sized rootstock 54-118.

   Planting scheme - 5 x 2.5 m (800 trees per hectare). Repetition - three-fold, 10 trees per accounting plot. Planting year - autumn 2015.

   The objects of research were apple varieties Avgusta, Orlinka, Maslovskoe, Osipovskoe, Solnyshko, Yablochny Spas.

3. Experiment "Study of summer apple trees' varieties on a medium-sized interstock 3-3-72".

   Planting scheme: 6 x 3 m. Repetition - three-fold, 10 trees per accounting plot. Planting year - 1991.

   The objects of research were apple varieties Bordovoe, Orlovim, Rannee aloe, Zhelannoe, Melba, Papirovka.

   The study was carried out according to the “Program and methodology for the variety study of fruit, berry and nut crops” [16]. Appropriate developments were used in the pomological description of the varieties [3, 4]. The fruting frequency index (J) was calculated according to the method [17].

   According to this indicator, the varieties were divided into groups:

   1 - regularly fruting (J - less than 0.39);

   2 - mildly fruting (J = 0.40–0.75);

   3 - sharply periodically fruting (J - more than 0.75).

Artificial freezing of apple varieties to determine resistance to low temperatures of the winter period was determined by the laboratory method [18] according to the components of the frost resistance complex: resistance to low temperatures of the late autumn period (1st component) to early frosts in late November-early December by modeling -25 °C maximum level of resistance in the middle of winter (2nd component) at a temperature of -40 °C after hardening -5 °C, -10 °C and frost resistance at the end of winter -25 °C after a thaw (3rd component).

The experiments were carried out in May and July in 6 repetitions. Leaf samples were taken from the middle part of the bush with annual shoot increment.

Analysis of variance at a significance level of 0.05 was performed using the Microsoft Excel 2010 software package [19]. To assess the traits' significance level, the Student's test (T) was used with the trait significance of $P \leq 0.05$. 
3. Results and discussion

3.1. Winter hardiness

The main criterion for the possibility of growing apple varieties with high fruits' quality in the middle horticulture zone of Russia is resistance to unfavorable winter conditions and in the summer period - the ability of the variety to correspond to the development phases of a short growing season. The greatest danger to fruit trees is posed by winters with frequent thaws followed by a rapid drop in temperature, as well as sharp fluctuations in temperature during the day at the end of winter when trees come out of deep dormancy and the degree of tissue hardening is decreased.

During the study period since 1990, 4 most frosty winters were noted with the sum of average daily negative temperatures of more than 1000°C (1995/1996, 2002/2003, 2005/2006, 2009/2010 and 2020/2021) with a minimum air temperature of -30, -36°C, when the maximum frost damage was noted.

Modeling of damaging factors in the late autumn period showed the resistance of tissues to a temperature decrease during this period to -25 ºС with good hardening in the previous period for all options of using low-growing rootstocks. In the middle of winter, the varieties studied on various rootstock types showed sufficient resistance to a decrease in the freezing temperature to -40 °С. The maximum was reversible damage to wood up to 2.0 points and to bark up to 1.0 points in the case of using insert 62-396 for Yablochny Spas variety, which was significantly higher than freezing in other options (table 1). Both apple varieties have shown resistance to frost down to -25 °C after a thaw at the end of winter.

Table 1. The freezing degree of apple varieties on different types of rootstock (II component of frost resistance, -40 °C), score

| Rootstock type | Varieties       | Total damage score |          |          |
|----------------|-----------------|--------------------|----------|----------|
|                | Orlinka         | Yablochny Spas     | bark     | wood     | bark     | wood     |
| Insert 3-17-38 | 0.2             | 1.2                | 0.5      | 1.1      | 0.3      | 1.2      |
| Insert 62-396  | 0.4             | 1.2                | 1.0      | 2.0      | 0.7      | 1.6      |
| Rootstock 62-396 | 0.4             | 1.1                | 0.7      | 1.0      | 0.3      | 1.2      |
| Average        | 0.5             | 1.3                | 0.7      | 1.2      | 0.5      | 1.3      |
| LSD 05         | 0.4             | 0.4                |          |          |          |          |

Young trees of varieties Avgusta, Maslovskoe, Orlinka, Osipovskoe, Solnyshko, Yablochny Spas planted in the fall of 2015 on a semi-dwarf rootstock 54-118 safely endured the adverse conditions of the winter months of 2020/2021. Favorable conditions for a gradual decrease in air temperature in autumn contributed to good hardening of apple trees. The average temperature of the winter months was close to the long-term average. There was a thaw (+2 ... +4 °C) at the end of January, after which there were prolonged frosts in February down to -30 °С; even in March (second decade), the air temperature dropped to -24 °С. After such a stable cold winter, a slight damage to the ends of the annual increment and tissues at the peduncles' base of the studied varieties was noted, no more than 1 - 1.5 points.

On a semi-dwarf interstock 3-3-72, summer ripening varieties (planted in 1991) Bordovoye, Zhelannoye, Orlovim, Rannee aloe, Yubilyar safely survived long-term persistent frosts with slight wood freezing of branches and bases of fruit formations, even the coldest winter of 2005/2006 without thaws under favorable conditions for hardening of the previous fall. In the spring of this year, the varieties gave high yields.

On average, over the years of study in the field, the varieties showed resistance to unfavorable winter conditions with reversible tissue damage at the level of the Central Russian variety of folk selection Papirovka (Table 2).
In field conditions, resistance to unfavorable winter conditions with reversible damage to tree tissue of not more than 2.0 points was revealed in varieties Orlovim, Rannee aloe, Yubilyar at the level of the Central Russian variety Papirovka.

Table 2. The total freezing degree of apple varieties' trees on a semi-dwarf interstock 3-3-72 on average for the study period in the field conditions (1991 planting year).

| Summer ripening varieties | bark | wood | branches | peduncles | general |
|---------------------------|------|------|----------|-----------|---------|
| Papirovka                 | 2.2  | 1.3  | 1.7      | 1.3       | 2.0     |
| Orlovim                   | 2.7  | 1.3  | 2.1      | 2.0       | 2.0     |
| Zhelannoye                | 2.7  | 1.6  | 2.1      | 2.0       | 2.5     |
| Melba                     | 2.6  | 1.2  | 2.3      | 2.0       | 2.6     |
| Bordovoe                  | 2.4  | 0.8  | 1.5      | 1.5       | 2.4     |
| Rannee aloe               | 2.4  | 1.6  | 1.7      | 1.6       | 2.0     |
| Yubilyar                  | 2.2  | 1.5  | 1.7      | 1.4       | 2.0     |
| LSD _0.05                 | 0.6  | 0.7  | 0.5      | 0.5       | 0.6     |

3.2. The growth strength
The apple trees' growth strength depends on the biological characteristics of apple varieties and rootstocks. The characteristics' study of the growth and fruiting of apple varieties on low-growing interstocks showed the advantages and weakening effect of dwarf and semi-dwarf interstocks.

A long-term behavior study of apple varieties on various rootstock types showed a weakening effect of clonal low-growing rootstock forms both when using them both as rootstocks and as an intercalary, but varietal differences in the development strength were noted already at the age of five. In all growth indicators (height, crown width, trunk diameter), Orlinka variety trees were inferior to the tall-growing variety Yabolchny Spas.

With age, these differences in varieties and rootstocks remained. By the age of 10, the greatest restraining effect on the crown habitus was exerted by 3-17-38 interstock: the stem diameter of Orlinka trees was 6.9 cm with a tree height of 2.9 m, Yabolchny Spas - 9.2 cm and 3.4 m, respectively, significantly differing from the habitus indicators of trees on the rootstock and insert 62-396 (Table 3)

Table 3. Dimensions of apple trees on various types of dwarf rootstocks (Age of trees - 10 years)

| Rootstock type | Varieties | average |
|----------------|-----------|---------|
|                | Orlinka   | Yabolchny Spas |
|                | tree height, m | trunk diameter, cm | tree height, m | trunk diameter, cm | tree height, m | trunk diameter, cm |
| Insert 3-17-38 | 2.9       | 6.9     | 2.2       | 1.3     | 9.2       | 3.2   | 8.1 |
| Insert 62-396  | 3.8       | 9.4     | 4.0       | 11.5    | 3.9       | 10.4  |
| Rootstock 62-396 | 3.5   | 9.4     | 3.8       | 10.6    | 3.6       | 10.0  |
| average        | 3.4       | 8.6     | 3.7       | 10.3    | 3.6       | 9.5   |
| LSD _0.05 A    | 0.16      | 0.51    | 0.19      | 0.63    | 0.27      | Ff < Ft |

The rootstock form 62-396 had a weakening effect on the height of the tree when used as a root stock. But the tree height is regulated by pruning, so more objective data can be given by indicators of the trunk size. Differences in the trunk diameter when using 62-396 as an insert and rootstock were on average insignificant in varieties Orlinka and Yabolchny Spas; that is, the inhibitory effect of a low-growing intercalary is confirmed at the level of its use as a rootstock, which is consistent with the data of other researchers [11, 13, 20, 21].
The parameters study of the varieties' crown on rootstocks of different growth strength showed a stronger effect of the dwarf stock 62-396 in comparison with the semi-dwarf stock 57-118. The trunk diameter of Orlinka and Yablochny Spas varieties' trees of the same age on a dwarf rootstock 62-396 was significantly less than the trunk diameter of these varieties' trees on a semi-dwarf rootstock (Table 4).

**Table 4.** Apple varieties' trunk diameter on rootstocks of different growth strength (tree age - 5 years)

| Variety, A | Rootstock, B   | Trunk diameter, cm |
|------------|----------------|--------------------|
| Orlinka    | dwarf 62-396   | 3.1                |
|            | semi-dwarf 54-118 | 5.1               |
| average    |                |                    |
| Yablochny Spas | dwarf 62-396   | 3.0                |
|            | semi-dwarf 54-118 | 6.1               |
| average    |                |                    |
| LSD 05 A   |                | 0.3                |
| B          |                | 0.3                |
| AB         |                | 0.4                |

The weakening role of interstocks can be traced throughout the entire period of varieties' study. By the age of 25, Zhelannoye variety on a semi-dwarf interstock 3-3-72 was at the level of Papirovka control in terms of crown height and width; the other varieties were at Melba level also in the tree trunk circumference except for Bordovoe variety, which had the strongest trunk (Table 5). By the age of 30, the height and width of the crown of the studied varieties were maintained at the same level, but the trunk circumference increased.

**Table 5.** Growth strength of apple varieties' trees on a semi-dwarf interstock 3-3-72

| Variety  | Height, m | Crown width, m | trunk circumference, cm | Cross-sectional trunk area, cm² |
|----------|-----------|----------------|--------------------------|-------------------------------|
| Papirovka| 3.1       | 3.9            | 63.2                     | 320                           |
| Melba    | 4.1       | 4.5            | 71.2                     | 401                           |
| Bordovoe | 3.8       | 4.5            | 80.8                     | 522                           |
| Zhelannoye| 3.3      | 3.6            | 73.2                     | 426                           |
| Orlovim  | 4.0       | 4.3            | 71.2                     | 401                           |
| Rannee aloe | 3.8      | 4.6            | 65.8                     | 345                           |
| average  | 3.6       | 4.2            | 70.8                     | 402.5                         |
| LSD 05   | 0.3       | 0.4            | 6.4                      | 34.8                          |

Thus, the characteristics study of the growth and fruiting of apple varieties showed a significant weakening of tree growth when using low-growing (dwarf and semi-dwarf) rootstocks. The use of low-growing intercalars has the same weakening effect on growth as when using it as a root stock.

### 3.3. Early ripeness, yield

The studied variety-rootstock combinations showed high early ripening: the first flowering of Orlinka variety was noted in the second year of tree growth, and at the age of 3, trees began to bear fruit in all options of using low-growing rootstocks.

Five-year-old trees of varieties Orlinka and Yablochny Spas on interstocks 3-17-38 and 396 yielded 5.4–7.0 kg/tree each, not significantly differing from the yield of root stock 396 option. The maximum yield was obtained in 2018, differing significantly by varieties: Orlinka variety - 20.3
kg/tree, Yablochny Spas -12.4. For Orlinka variety, the yield of more than 20 kg/tree (20-23 t/ha) was obtained in 2018 on options using 62-396 as both root stock and as an intercalary. In Yablochny Spas variety, the insert 3-17-38 option gave the best results.

In 2019, apple varieties on various types of clonal rootstocks with good flowering gave small yields due to unfavorable conditions during the flowering period (sharp cooling, dry soil and air). On the 62-396 interstock, the yield of both varieties was significantly higher compared to the 3-17-38 insert and 62-396 rootstock.

On average over 10 years of growth in the orchard, high yields of Orlinka and Yablochny Spas varieties were revealed when used as both a rootstock and insert 62-396 without significant differences in the usage options. The interstock 3-17-38 showed higher yields in Yablochny Spas variety in some years (2018 and 2020), but on average for 2016–2020, no significant differences in the yield of scion-rootstock combinations were revealed (Table 6). Yablochny Spas variety showed a tendency to annual fruiting (the fruiting frequency index on average for the experimental options amounted to 0.33). Orlinka variety bore fruit mildly periodically (the fruiting frequency index ranged from 0.33 to 0.55 for rootstock options).

Orlinka variety has same-dimensional fruits of high marketability with an average weight of 140 g on all rootstock types, Yablochny Spas variety - fruits with an average weight of 170 g, not same-dimensional (with a maximum weight of up to 270 g) with an extended ripening period.

Table 6. Productivity of apple varieties on various types of low-growing rootstocks.

| Variety, A | Insert | Rootstock, B | Average yield for 2016-2020 kg/tree | Index period | Fruit weight | Harvest load per unit of trunk diameter, kg/cm² |
|------------|--------|--------------|-------------------------------------|--------------|-------------|-----------------------------------------------|
| Orlinka    | ins. 3-17-38 | 7.6          | 0.47                                | 140          | 1.10        |
|            | ins. 62-396 | 8.7          | 0.33                                | 140          | 0.92        |
|            | r. 62-396   | 9.3          | 0.55                                | 140          | 1.00        |
|            | average     | 8.5          | 0.39                                | 140          | 1.00        |
| Yablochny Spas | ins. 3-17-38 | 9.3          | 0.30                                | 170          | 1.01        |
|            | ins. 62-396 | 8.5          | 0.32                                | 170          | 0.74        |
|            | r. 62-396   | 8.1          | 0.32                                | 170          | 0.76        |
|            | average     | 8.6          | 0.33                                | 170          | 0.83        |
| LSD 05     | A          | 2.2           |                                      |              |             |
|            | B          | 2.7           |                                      |              |             |
|            | AB         | 3.9           |                                      |              |             |

The study of summer apple varieties on a medium-growing rootstock 54-118 (site planted in 2015) revealed high early ripening of the varieties Avgusta, Maslovskoe, Solnyshko and Yablochny Spas. In Maslovskoye variety, the first flowering and fruiting was noted in the third year after planting; at the age of 5, the yield amounted to 8.6 kg per tree (6.5 t/ha), while individual trees brought up to 15-18 kg. Avgusta, Solnyshko, Yablochny Spas varieties gave a good total harvest (8-10 kg/tree) for the first 5 years of growth. Osipovskoe variety showed low early ripening (Table 7).

Table 7. Early ripening of apple varieties when grown on a medium-sized rootstock 54-118.

| Variety    | Yield at the age of the tree, kg/tree | The yield amount for the first 5 years of growth in the orchard, kg/tree |
|------------|---------------------------------------|------------------------------------------------------------------------|
| Avgusta    | Weak bloom                            | 8.4                                                                    |
| Maslovskoe | Single yield                          | 8.6                                                                    |

6
Comparison of apple varieties’ early ripening on rootstocks of different growth strength shows that varieties on a dwarf rootstock begin to bear fruit earlier and the increase in yield in the first 5 years of varieties on a semi-dwarf rootstock is slower than on a dwarf rootstock (Table 8). With the age of the tree, the variety-specific features are more pronounced and, in some years, the differences in rootstocks are leveled.

### Table 8. Apple varieties' yield on different rootstock types.

| Variety, A          | Rootstock, B           | Yield at the age of the tree kg/tree, B | The yield sum for the first 5 growth years in the orchard, kg/tree |
|---------------------|------------------------|----------------------------------------|------------------------------------------------------------------|
|                     |                        | 3 years | 4 years | 5 years |                                                        |
| Orlinka             | 62-396- dwarf          | 2.4     | 2.7     | 6.5     | 11.6                                               |
|                     | 54-118 - semi-dwarf    | 0       | 3.0     | 4.3     | 7.3                                                |
|                     | average                |          |         |         |                                                     |
| Yablochny Spas      | 62-396 - dwarf         | 2.8     | 4.0     | 6.6     | 13.4                                               |
|                     | 54-118 - semi-dwarf    | 0       | 4.3     | 6.4     | 10.7                                               |
|                     | average                |          |         |         |                                                     |
| LSD 05, A           |                        |          |         |         | 1.3                                                |
| B                   |                        |          |         |         | 1.6                                                |
| AB                  |                        |          |         |         | 2.2                                                |

Rannee Aloe variety was the fastest-growing on the semi-dwarf insert 3-3-72; its first flowering was noted at the age of 3-4 years, and at the age of 5, high-quality fruits were obtained with the average of 14 kg per tree. At a young age, this variety was distinguished by annual yields that were uniform over the years (periodicity index \( J = 0.05 \), later switched to mildly periodic fruiting (periodicity index \( J = 0.55-0.60 \)). Annual fruiting of young trees was also noted in varieties Bordovoye and Melba.

During the fruiting period, varieties Orlovim, Rannee aloe, Melba surpassed Papirovka in yield, and Bordovoe was significantly inferior to the control. The highest yields of the studied varieties on the rootstock 3-3-72 were given at the age of 10 to 20 years and were characterized as mildly periodically fruiting (Tables 9 and 10). In some years, the average yield of the studied varieties reached 60 kg per tree and more (Figure 1).

### Table 9. Yield of apple varieties on a semi-dwarf rootstock 3-3-72 in different periods (planted in 1991)

| Variety | Productivity kg/tree by periods | Periodicity index by periods, J |
|---------|---------------------------------|---------------------------------|
|         | 1996-2000 | 2001-2010 | 2011-2020 | Average by periods | 1996-2000 | 2001-2011 | 2012-2020 | Average for 1996-2020 |
| Orlinka |                        |                                   |                                |                |            |            |            |                                |
Table 10. Productivity and specific yield load of apple varieties on semi-dwarf interstock 3-3-72 for 2000-2020

| Variety      | The yield amount for all fruiting years, kg/tree) | Specific crop load on the cross-sectional area of the trunk, kg/cm² |
|--------------|--------------------------------------------------|---------------------------------------------------------------|
| Zhelannoye   | 516.3                                            | 1.3                                                          |
| Papirovka    | 486.3                                            | 1.6                                                          |
| Bordovoe     | 378.0                                            | 1.0                                                          |
| Rannee aloe  | 532.2                                            | 1.6                                                          |
| Melba        | 558.4                                            | 1.2                                                          |
| Orlovim      | 540.2                                            | 1.4                                                          |

In terms of taste and marketability of Zhelannoye, Orlovim, Rannee aloe varieties, they significantly surpassed Papirovka, but ripen 5-7 days later. On low-growing rootstocks, the studied apple varieties showed high fruits' marketability: the number of fruits of the highest and first commercial grade amounted to: 95% for Orlovim variety, 93% for Zhelannoye, 70% for Rannee Aloe, with a predominance of fruits with a caliber of more than 50 mm. The fruits of these varieties have a great dessert taste.
3.4. Assessment of fruit quality and recommendations for their use

VNIISPK makes a great contribution to the implementation of the set tasks by introducing scientific achievements in breeding new disease-immune, triploid, high-quality apple varieties and improving technology elements in intensive plantings [22, 23]. Long-term study of new scab immune, heteroploid varieties of different ripening periods, including early summer ones in terms of basic production and biological indicators, allows to recommend the best of them for modern intensive plantings, farms and homestead orchards (Table 11). According to the complex of economic and biological indicators, varieties Maslovskoye, Orlinka, Orlovim, Rannee aloe, Solnyshko, Osipovskoye are suitable for intensive plantings. For farm and homestead orchards (in addition to them) - Zhelannoye, Zhilinskoye, Bordovoye, Yubilyar, Yablochny Spas.

Here is a brief description of summer ripening apple varieties, which are promising for production plantings and for use in breeding.

Table 11. General characteristics of promising apple varieties.

| Variety       | Origin                                      | Ripening period | Resistance to fruit and leaf scab | Average fruit weight, g | Fruit shape       | Fruit taste score | The nature of the fruit taste |
|---------------|---------------------------------------------|-----------------|-----------------------------------|--------------------------|-------------------|-------------------|--------------------------|
| Avgusta (3 n*)| VNIISPK. (Orlik × tetraploid Papirovka)     | late summer     | resistant                         | 160                      | Rounded conical   | 4.5               | Sweet and sour          |
| Bordovoe      | VNIISPK, seedling from free pollination of the McIntosh variety | late summer | average                           | 160                      | Rounded conical   | 4.6               | Sweet and sour          |
| Zhelannoye    | VNIISPK, seedling from free pollination of the McIntosh variety | late summer | medium resistant                  | 170                      | Flat-rounded      | 4.4               | sweet                   |
| Maslovskoe (3 n) | VNIISPK. (Redfree × tetraploid Paprovka) | summer          | High (RVi6 gene)                 | 180                      | Flat-rounded      | 4.3               | Sweet and sour          |
| Melba         | Variety of Canadian selection               | late summer     | medium resistant                  | 140                      | Rounded conical   | 4.5               | Sweet and sour          |
| Orlinka       | VNIISPK. (Stark’s Earliest prekos × Pervyi Salut) | early summer | resistant                         | 140                      | Rounded conical   | 4.3               | Sweet and sour          |
| Orlovim       | VNIISPK                                     | summer          | highly resistant                  | 160                      | Flat-rounded      | 4.4               | Sweet and sour          |
Osipovskoe (3 n) VNIISPK. (Mantet × tetraploid Papirovka) early summer resistant 140 Flat-rounded 4.4 Sweet and sour

Rannee aloe VNIISPK Melba × Papirovka early summer resistant 140 Flat-rounded 4.3 Sweet and sour

Solnyshko VNIISPK. (Seedling 814 - free pollination) late summer High (RVi6 gene) 150 Oblong-rounded 4.3 Sweet and sour

Yubilyar (3 n) VNIISPK. (Seedling 814 - free pollination) late summer High (RVi6 gene) 140 Rounded conical 4.3 Sweet and sour

Yablochny Spas (3 n) Redfree × tetraploid Papirovka summer High (RVi6 gene) 170 Rounded conical 4.3 Sweet and sour

* - ploidy of varieties

4. Conclusions
1. The use of low-growing apple intercalars has the same weakening effect on growth as when using it as a root stock of an apple tree. Differences in the trunk diameter (an objective indicator of tree growth) when used as an insert and rootstock 62-396 were on average insignificant in varieties Orlinka and Yablochny Spas.
2. In terms of the total yield, 10-year-old trees of Orlinka and Yablochny Spas varieties also did not show significant differences in the options for using low-growing forms as an intercalary or root stock.
3. Modeling the damaging factors of the winter period revealed good resistance to early winter frosts, to a decrease in the freezing temperature in the middle of winter to -40 °C and to frosts after thaws at the end of winter. The maximum was reversible damage to wood up to 2.0 points and to bark up to 1.0 points in the combination Yablochny Spas/insert 62-396.
4. On a medium-sized rootstock 3-3-72, Rannee Aloe variety showed high early ripening and yield significantly higher than Papirovka. The highest yields of the studied varieties on the rootstock 3-3-72 were given at the age of 10 to 20 years and are characterized as mildly periodically fruiting.
5. According to the complex of economic and biological indicators, varieties Maslovskoye, Rlinka, Orlovim, Rannee aloe, Solnyshko, Osipovskoye are suitable for intensive plantings. For farm and homestead orchards (in addition to them) - Zhelannoe, Bordovoe, Yubilyar, Yablochny Spas.

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