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ORIGINAL ARTICLE

Winter damage of frost semi-resistant half-cultured apple-trees varieties in sounthern predbaikal'ye

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The study was focused on the varieties of macrocarpous semi-culture apple-trees, which are promising for growing in Southern Predbaikal'ye. Most of varieties studied were shown to be characterized by low winter-resistance in the case of low trunk grafting. Tree skeleton grafting demonstrated an increase of winter-resistance of macrocarpous semi-culture apple-trees.

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Pribaikal'ye occupies a fairly large area; therefore, it would not be adequate to discuss the possibility of pomiculture all over the territory. The climate on the whole is sharply continental and fruit-bearing trees growing, particularly in northern regions, is quite complicated. The Southern Predbaikal'ye region including Irkutsk district is best suited for commercial and amateur pomiculture. This is primarily due to geographic location of the area and high level of agriculture development. Fruit plantations examination conducted by our researchers on horticultural and farmers' lands in the Southern Predbaikal'ye region showed a considerable increase in the number of apple-trees (Rachenko *et al*., 2010). Increasingly growing demand for planting material in amateur horticulture is accounted for by successful cultivation of this cultivar in the region. Creation of commercial gardens in the Southern Predbaikal'ye region is currently hindered by the lack of relevant studies in this realm. To replenish the assortment, it is crucial for our region to evaluate varieties' adaptability to local conditions and their ability to ensure stable high quality fruit-bearing.

Apple-tree assortment in the Irkutsk region is largely based on the varieties selected by Buryat Fruit and Berry Test Station and Krasnoyarsk Research Station for Horticulture (Krutikov, 2007). The major advantage of these varieties is their high winter resistance. But small fruits and low quality

taste reduce their consumer value. That is why it is critical to select for growing in the Southern Predbaikal'ye region apple-tree varieties with fairly large fruits (40-100 g) and good taste. The studies in this direction formed the primary goal of the present work.

MATERIALS AND METHODS

The objects of the study were apple-trees of 11 varieties from different selection stations and of folk selection: 'Altaiskoe krapchatoe', 'Altaiskoe rumjanoe', 'Altaiskoe ubileinoe', 'Alyye parusa', 'Krasnaya gorka', 'Nezhenka', 'Podarok sadovodam', 'Yunga' (SRI named after M.A. Lisavenko); 'Svetloye' (Krasnoyarsk Research Station for Horticulture); 'Serebryanoye kopyttse' (Sverdlovsk Horticulture Experiment Station); 'Prevoskhodnoye' (folk selection). All the studies were performed in 2005-2010 in Siberian Institute of Plant Physiology and Biochemistry SB RAS, private farms of Irkutsk district, Irkutsk region.

The planting material for collection lot was grown in identical climatic and agrotechnical conditions. As seedling stocks there were used 2-year old seedlings of apple-tree of Siberian crabapple (for implanting into the tree body), 5-7 year old apple-trees for implanting into skeletogenous organ at 1.2 meters, in 3-5 skeleton branches. Apple-trees were evaluated by winter-resistance in field conditions (Program and investigation methods…, 1999).

Collection and primary investigation of apple-trees varieties was conducted on the test lots of the total area of 2.5 ha. Each variety was presented by 7-10 trees. Plantation scheme: interval between rows - 6 m, interval between trees - 3 m.

RESULTS AND DISCUSSION

Climatic conditions of Siberia as a whole and Southern Predbaikal'ye in particular, significantly differ from those of the regions with well developed industrial and private horticulture. There may be identified three primary factors limiting apple-trees groping in Siberian climate: short vegetation period and lack of the positive temperatures sum; short hardening period and rapid transfer to low negative temperatures with the minimum snowpack; long-term impact of extremely low temperatures at the end of winter and beginning of spring (thaw-frost; large range between night negative and day positive temperatures); repeated frosts during vegetation and blooming.

Analysis of temperature data over six years of monitoring allowed to identify the most unfavorable seasonal weather changes.

2006-2007 were the most favorable years: long autumn (stable negative temperatures were observed only at the beginning of November) with smooth temperature reduction by late November (from -3° to -25°C) helped the apple-trees to fully complete hardening; comparatively soft winter (minimal average temperatures of December, January and February: -17,4°, -17,8° and -16,6°C) and early spring (by the 20-th of April air temperature grew up to 26.4°C); 2007-2008 were also favorable: long-term autumn hardening (the temperature did not go below -15°C before mid November), only January was extremely cold (average minimal temperature was -26.4°C, the same parameter for December and January was 17.6°C and 20.9°C respectively); the spring started early, positive temperatures were observed already at the beginning of March.

2008-2009 proved unfavorable for winter survival: unstable autumn (temperature fluctuations in November from 6° to -25°C),

relatively cold winter (average minimal temperatures of December, January and February equaled 21.7°C, -21.4°C and -24.2°C respectively) and cold spring (temperature exceeded 0°C only by the end of the third week of March); 2009-2010 were also unfavorable: practically no hardening period (negative temperatures were reached only in late October, in the first ten days of November temperatures was as low as -25.2°C), anomalously cold winter (average monthly temperatures of December, January and February equaled -24.6°, -24.9° and -25.8°C respectively) with long-term periods of extremely low temperature (below -30°C), late spring (minimal temperature before the third week of March often dropped below -15°C) with large temperature fluctuations (in the fourth week of April they ranged from 16,6° to -6,6°C, in the first and second ten days of May it varied from 21.4 to -2.6°C).

Evaluation of winter resistance of macrocarpous semi-cultured apple-trees implanted into low tree body demonstrated that by the end of the monitoring period all the varieties studied had an intense and very intense bark and one-year old wood frost pockets однолетней древесины (Fig. 1). The trees of 'Altaiskoe krapchatoe', 'Altaiskoe rumjanoe' and 'Serebryanoye kopyttse' were completely winter-killed, the other studied varieties of macrocarpous semi-cultured trees had large bark damage areas and intense damage of wood (Fig. 2), the damages were noticeable at the basis of skeleton branches, particularly at the sharp angle of the first order branch bifurcation from the central conductor and on the trunk at the snow level (Figs. 3-4). Only 'Podarok sadovodam', 'Prevoskhodnoye' and 'Svetloye' varieties representing macrocarpous semi-cultured trees had satisfactory and good state.

An important constituent of fruit tree winter resistance is its ability to recover after winter damages (Creation of new varieties.., 2002). This is particularly critical for the varieties, which are most intensely affected by unfavorable winter factors. Unfortunately, in our conditions not all the varieties possess this property. After severe winter of 2009/2010 only 'Podarok sadovodam', 'Prevoskhodnoye' and 'Svetloye' varieties managed to recover (Fig. 6).

The monitoring demonstrated that most frequent and intense damages are suffered by the tree skeleton, in particular the tree body and basis of lower skeleton branches. So it is efficient to use a winter-resistant variety or species as a tree-former or skeletogenous organ (wild apple-tree species, crab apples, winter-resistant semi-cultured species) (Susov, 1993). We used the most winter-resistant apple-tree species – Siberian Berry (*Malus baccata (L.) Borkh*.) as a skeletogenous organ. Implantation of macrocarpous semi-cultured trees into skeletogenous organ significantly increased their winter resistance (Fig. 6).

Over six years of monitoring no considerable freezing of bark and wood was observed in most of macrocarpous semi-cultured trees implanted into skeletogenous organ. Only after the winter of 2009-2010, when minimal air temperature was below -30°C for a long time, 'Altai Jubilee' and 'Silver Hoof' varieties developed significant bark damages with wood necrosis, which negatively affected the general tree status.

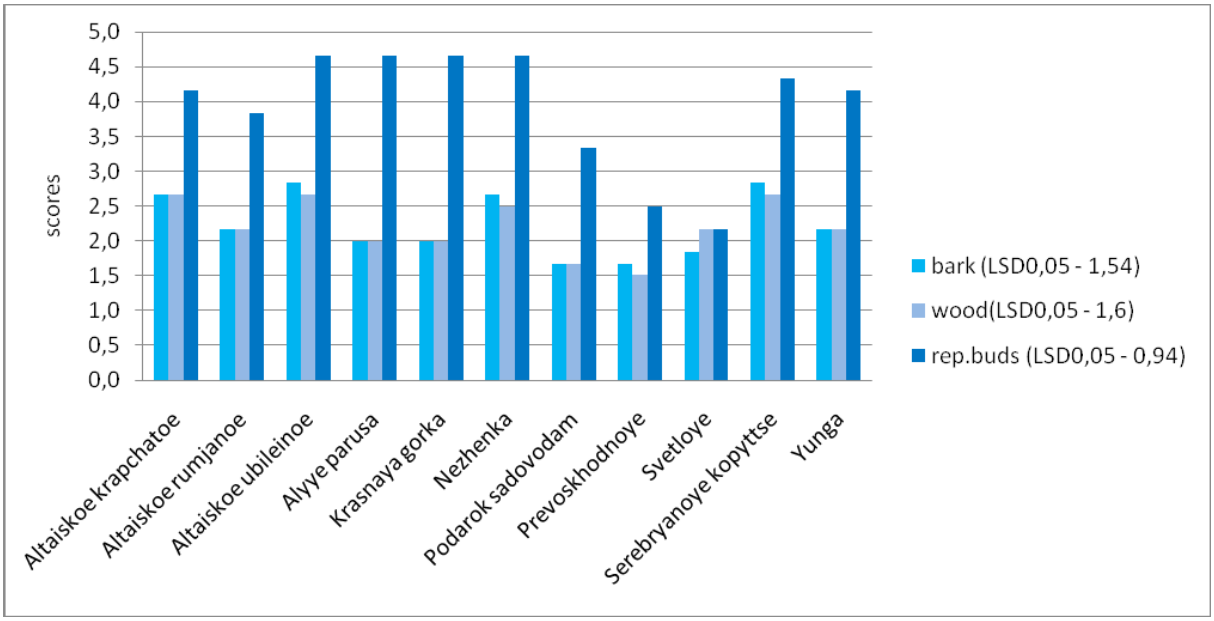

Figure 1. Average indices of damage degree for bark, one-year-old wood and reproductive buds of macrocarpous semi-cultivated apple-trees, implanted on low tree body, over the monitoring years.

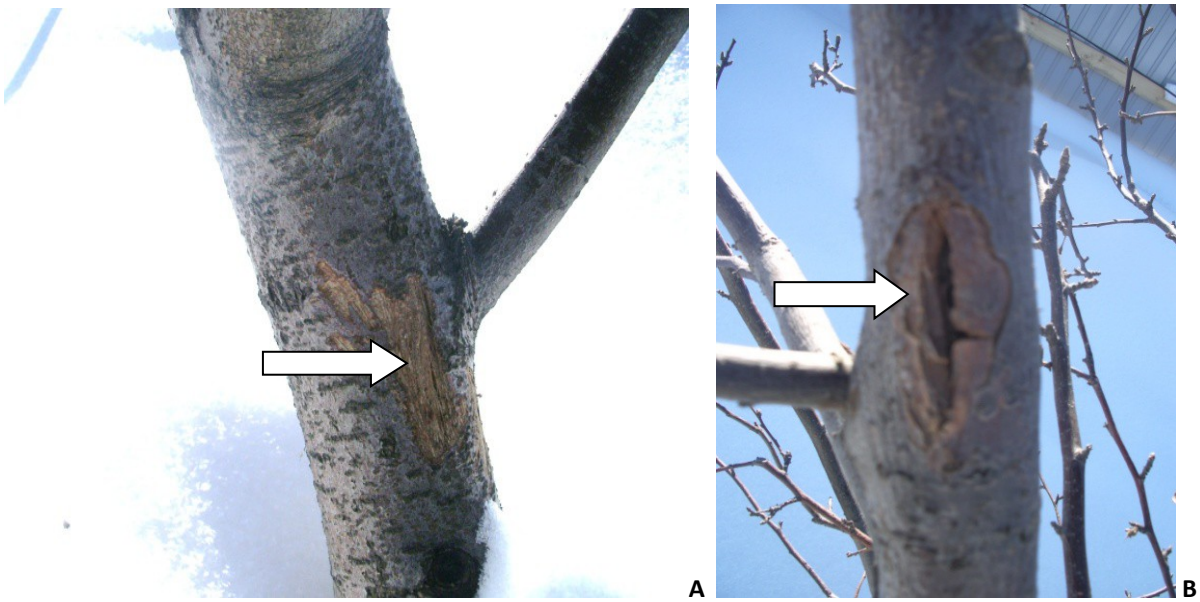

Figure 2. Sunscald of the bark of 'Svetloye' variety (A) at the snow level and frost cleft (B) on the 'Altaiskoe rumjanoe' tree trunk.

Figure 3. Damages at the basis of skeleton branches at the sharp angle of the first order branch bifurcation from the central conductor 'Alyye parusa' variety.

Figure 4. Consequences of winter damage on the trunk of apple-tree, 'Altaiskoe krapchatoe' and 'Yunga' varieties.

Figure 5. Regeneration after winter damage on the trunk of apple-tree, 'Prevoskhodnoye' variety.

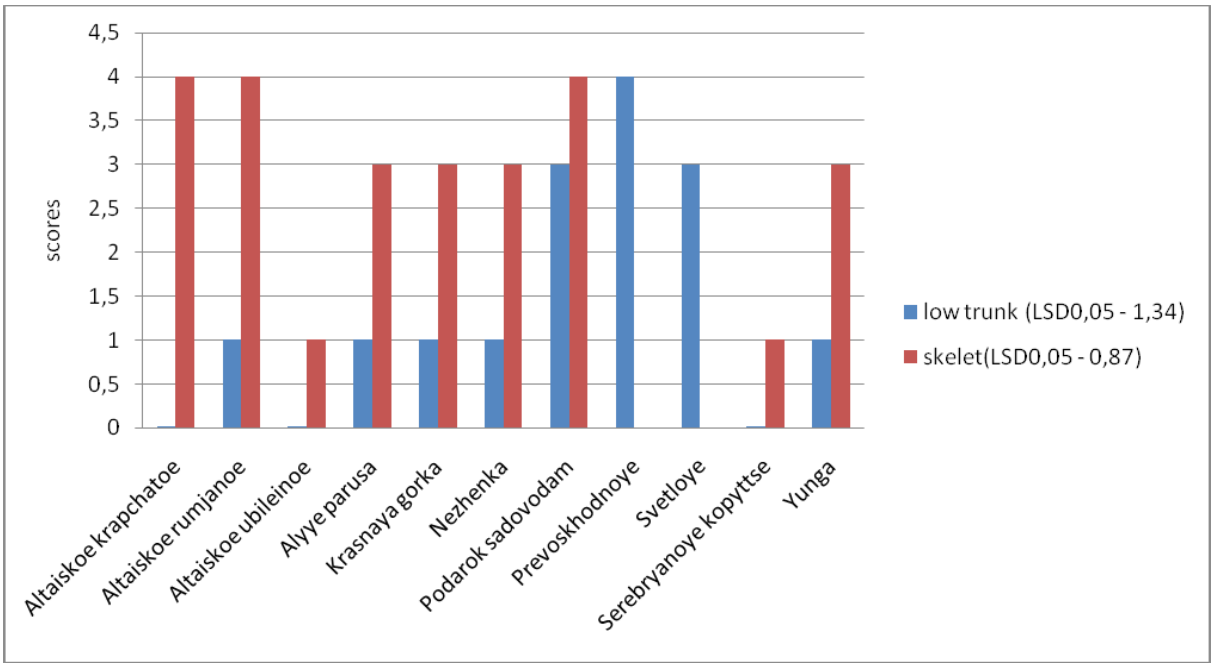

Figure 6. Comparison of tree general status at the end of monitoring period; breakdown for semi-cultured apple-trees with implantation into low trunk and skeletogenous organ.

Thus, the research conducted allows to conclude the following:

1. The studied varieties of macrocarpous half-cultured apple-trees: 'Altaiskoe krapchatoe', 'Altaiskoe rumjanoe', 'Altaiskoe ubileinoe', 'Alyye parusa', 'Krasnaya gorka', 'Serebryanoye kopyttse', 'Yunga' with low tree body implantation proved to be the varieties of low winter resistance in Southern Predbaikal'ye. The apple-trees varieties 'Podarok sadovodam', 'Prevoskhodnoye' and 'Svetloye' were classed as varieties of medium winter resistance.

2. Implantation into winter-resistant skeletogenous organ reduces the amount of winter damages in the apple-trees varieties under study: 'Altai Spotted', 'Altai Ruddy', 'Altai Jubilee', 'Crimson Sails', 'Red Hill', 'Silver Hoof', 'Yunga'.

We recommend to grow macrocarpous semi-

cultured apple-trees in Southern Predbaikal'ye with implantation either into winter-resistant skeletogenous organ or in the zone with favorable microclimate. Siberian berry apple-tree is recommended to be used as a skeletogenous organ.

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