

Response of Some Malus Mill. Species Representatives to Extreme Low Temperatures in Baikal Siberia

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The paper presents the results of study of maximal frost resistance of apple-tree varieties of Novosibirsk, Krasnoyarsk, Buryat, Canadian selection by the method of artificial freezing. The research found virtually all apple-tree varieties to withstand the temperature as low as -45°C without serious damage to bark, cambium and wood; with only Melba variety exhibiting significant bark damage. Apple-tree varieties of Buryat ACRI selection, regardless of cultivation location, demonstrated high tissue resistance to critical low negative temperatures. The investigated forms of *Malus baccata* L. Borkh, are characterized by high frost resistance in the middle of winter regardless of their location. Critical temperatures of -50° and -55°C proved lethal for Lada, Krasnaya Grozd' varieties, as well as for Melba variety of Canadian selection.

Key words: apple-tree, varieties, *Malus baccata* L. Borkh. forms, winter resistance, frost resistance, damage

Apple-tree is one of the top horticultural crops of Russia, with its plantations taking over 70 % of the overall area of horticultural crops (Bakhanova, 2003, Rachenko, 2011).

Winter resistance is the most important biological property of apple-tree; it is responsible for the areal of species distribution, productivity, longevity and economic value. This feature is of particular significance for apple-trees in severe extreme continental climate of Baikal region (Batuyeva, 2005). Climatic conditions of this area significantly differ from the conditions of the regions with well-developed commercial and amateur horticulture. Periodically recurring severe winters, annual long-term periods with intense frost, short vegetation period, drastic air temperature fluctuations at the end of winter and other unfavorable factors set constraints on cultivation of diverse apple-tree varieties (Batuyeva, 2014). Implementation of potential frost resistance in horticultural crops is related to their preparedness for wintering and response to unfavorable environmental factors reducing resistance level in cold seasons. High winter resistance of the phenotype forms gradually, enhancing after termination of growth, transfer to peace state, hardening with low positive temperatures, with final frost resistance significantly increasing at the final stage (Krasova *et al.*, 2011). Under environmental conditions, which are unfavorable for horticulture, of particular value are the varieties, which are able to combine productive potential and resistance to abiotic factors (Zhuchenko, 2001).

Periodically recurring severe winters in the region contribute to topicality of investigation of the potential resistance of different apple-tree varieties to winter period

climatic stressors. That is why, along with field evaluation of frost resistance, the potential of frost resistance of apple-tree genotypes was identified by the laboratory method of freezing via simulating damaging factors.

Application of the method of freezing by simulating damaging factors of cold season under controlled conditions enables faster evaluation of winter resistance of apple-tree varieties and hybrids (Rachenko, 2011, Rachenko, 2014).

The present study aims to determine maximal level of frost resistance of *Malus baccata* L. Borkh apple-tree varieties and forms (II winter resistance component).

MATERIALS AND METHODS

The objects of the study were 14 varieties of apple-tree varieties of Novosibirsk, Krasnoyarsk, Buryat, North-American and folk selection grown on the test site of Buryat AG RI and in Irkutsk district, as well as four forms of *Malus baccata* growing in Irkutsk, Cheremkhovo, Zalari districts and five forms of small-fruit apple-tree grown in Buryatia. One-year old branches of the selected apple-tree genotypes were used as the material. Prior to the tests the material was kept at -10°C. The study of winter resistance of apple-tree varieties and forms was performed in compliance with the "Program and methods of variety studies of horticultural, small-fruit and nut-crop cultivars" (Program and methods of variety studies... 1999). The damage extent of cut branches was determined by brown staining of tissues on longitudinal and transverse slices according to five-grade scale: 0 - no damage; 5 - tissue perished. Artificial freezing was conducted in low-temperature chamber Binder MKT-240 of Phytotron test station at temperature range from -35 to

-55°C. Freezing time equaled 24 hours. The tests were performed in three-fold biological repetition.

RESULTS AND DISCUSSION

All the investigated forms of *Malus baccata* L. Borkh, regardless of their growth location, were characterized by high frost resistance of tissues in the middle of winter. Low damage degree (1-1.5 points) was observed in brown and dwarf forms of *Malus baccata* after 24 hours of exposition at -55°C.

Comparison of frost resistance of variety apple-trees found that virtually all apple-tree varieties withstood the temperature not below -45°C (Fig.1, 2, 3), with only Melba variety demonstrating considerable wood freezing (Fig.2).

Dobrynya variety demonstrated frost resistance, close to that of *Malus baccata* L. Borkh (wood damage extent -

1.2 scores at - 55°C).

All the apple-tree varieties of Buryat AG RI, regardless of their growth location, were characterized by high resistance to low negative temperatures. The varieties Komsomoletz Buryatii, Slava Buryatii, Podarok Bamu, Krasa Buryatii at -55°C had reversible wood damage from 3 to 3.5 points (Fig. 2).

Alenushka and Krasnoyarsk Seyanets varieties were found to have a similar winter resistance level.

Despite demonstrating high winter resistance in field conditions, Lada and Krasnaya Grozd' varieties had high extent of wood, bark and cambium damage in artificial freezing tests (Fig.1, 2, 3).

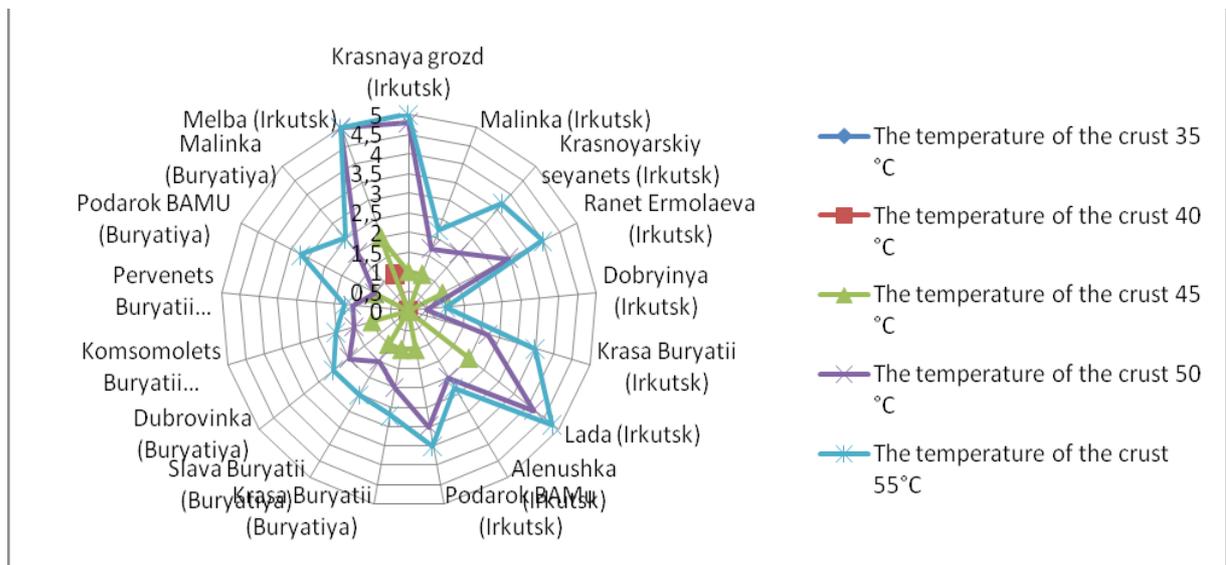


Figure 1. Bark subfreezing extent in apple-tree varieties

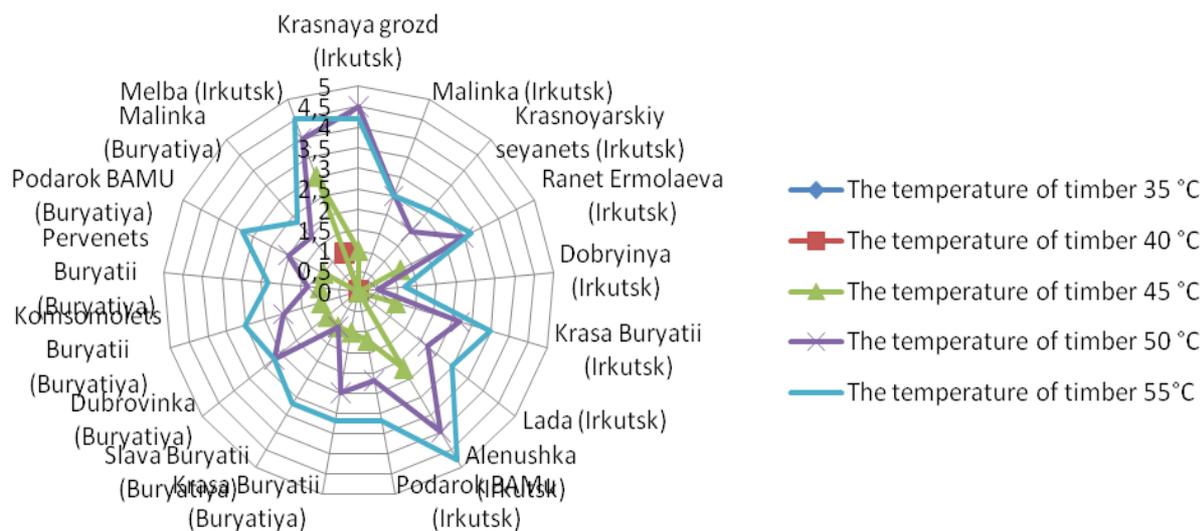


Figure 2. Wood subfreezing extent in apple-tree varieties

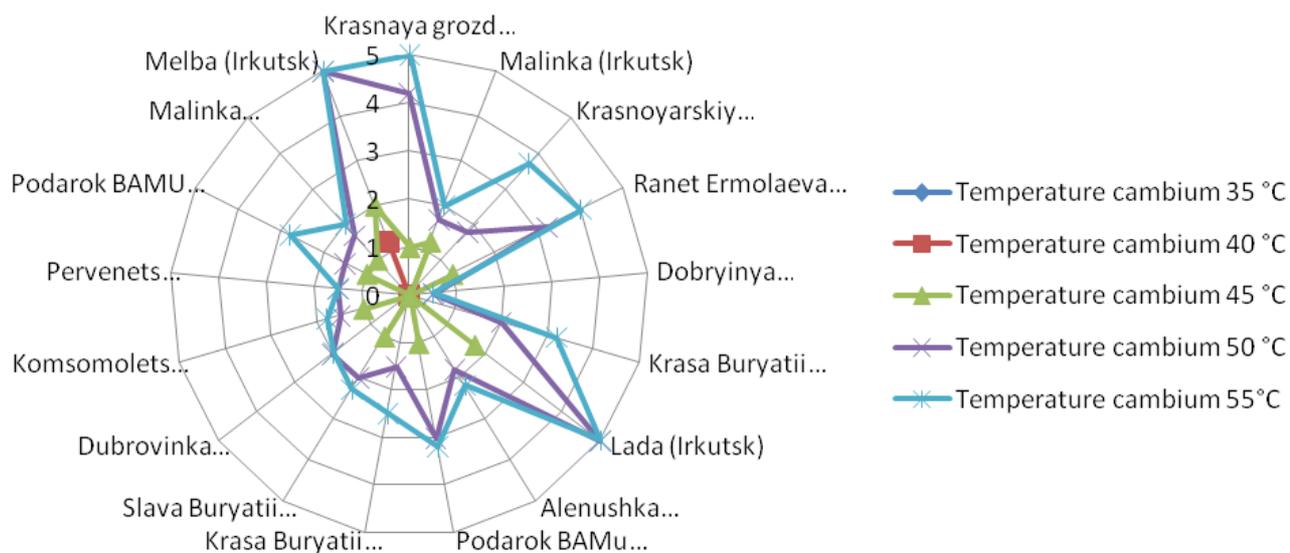


Figure 3. Cambium subfreezing extent in apple-tree varieties

Different winter resistance in these species in field and controlled environment is accounted for by the fact that in the last decade minimal air temperature in the area of cultivation of these apple-tree varieties did not reach values below -45°C . Critical low temperatures -50° and -55°C for the varieties Lada, Krasnaya Grozd' proved lethal, as well as for Melba variety of North-American

selection.

CONCLUSIONS

All the *Malus baccata* varieties covered by the research, regardless of their cultivation location, are characterized by high frost resistance of tissues in the middle of winter.

All the apple-tree varieties managed to withstand the temperatures as low as -45°C without serious injuries.

All the apple-tree varieties of Buryat AG RI, regardless of their growth location, were characterized by high resistance to low negative temperatures.

Lada and Krasnaya Grozd' varieties had high extent of wood, bark and cambium damage in artificial freezing tests. Temperatures of -50° and -55°C proved lethal for these varieties, as well as for Melba variety of North-American selection.

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