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**STUDYING WINTER HARDINESS OF APPLE TREES  
IN THE FEDERAL HORTICULTURAL CENTER FOR BREEDING,  
AGROTECHNOLOGY AND NURSERY**

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**Abstract:** *This paper reviews scientific literature related to the study of winter hardiness in apple trees at the Federal Horticultural Center for Breeding, Agrotechnology and Nursery. The contribution of scientists from the research center to the study of winter hardiness of apple trees is analyzed.*

**Keyword:** *apple, breeding program, winter hardiness.*

**Introduction.** Apple is one of the most widely grown fruit crops. Apple tree plantations face various abiotic stress factors due to prolonged exploitation, including low temperatures during winter [1]. Since a significant portion of apple plantations in Russia is in high-risk horticultural zones [1], breeding programs prioritize characteristics based on the specific climate of the cultivation areas [2]. The apple breeding programs place the main focus on winter hardiness, in addition to enhancing fruit quality and disease resistance. The successful cultivation of new apple varieties relies heavily on their high winter hardiness levels. Winter hardiness, a crucial biological trait of apples, determines the selection of the most adaptable genotypes [3, 4, 5]. The purpose of the present review article is to study and analyze the scientific literature devoted to current trends and the latest achievements in the study of winter

hardiness of apple trees in the Federal Horticultural Center for Breeding, Agrotechnology and Nursery.

**Material and methods.** To conduct the analytical review, open resources were used, containing information on the study of winter hardiness at the Federal Horticultural Center for Breeding, Agrotechnology and Nursery.

**Results.** The study on the selected trait of winter hardiness at research center dates back to 1957. Methodological advancements were compiled in the publication titled “Methods of Determining Frost Resistance of Plants/*Metody opredeleniya morozostojkosti rastenij*” edited by Tumanov in 1967. These developments were further elaborated by Tyurina and Gogoleva in 1978 and subsequently refined with new testing methods. Updated programs were summarized in 1995 by Tyurina, Gogoleva, Trunova in “Program and Methodology of Fruit, Berry, and Nut Crops Selection/*Programma i metodika selekcii plodovyh, yagodnyh i orehoplodnyh kul'tur*” and in 1999 by Tyurina et al. in “Program and Methodology of Varietal Studies of Fruit, Berry, and Nut Crops/*Programma i metodika sortoizucheniya plodovyh, yagodnyh i orehoplodnyh kul'tur*”. The study of resistance through stressor modeling was complemented with field observation methods. The latest publication outlining these developments, titled “Determining Resistance of Fruit and Berry Crops to Cold Season Stressors in Field and Controlled Conditions/*Opredelenie ustojchivosti plodovyh i yagodnyh kul'tur k stressoram holodnogo vremeni goda v polevyh i kontroliruemyyh usloviyah*”, was issued in 2002. The proposed winter hardiness assessment methods are utilized in various institutions, including All Russian Research Institute of Fruit Crop Breeding, Federal State Scientific Institution “Michurin Federal Scientific Center”, and others [6].

A team headed by Kichina began to create winter-hardy apple tree varieties at Federal Horticultural Center for Breeding, Agrotechnology and Nursery. The primary method for developing highly winter-hardy varieties involved artificially freezing hybrid seedlings. Research into the winter hardiness of apple tree varieties, forms, and interspecific hybrids was also part of a number of dissertation studies. For instance, Alekseev has extensively examined over 450 cultivars of different origins regarding freezing susceptibility of wood, bark, and branches. Morozova has assessed the winter hardiness of columnar apple tree forms from the Federal Horticultural Center for Breeding, Agrotechnology and Nursery selection. Motovilova has identified several winter-hardy interspecific apple tree hybrids. Fisenko has isolated elite forms with high winter hardiness levels and observed the transgressive winter hardiness levels in various cross-breeding combinations. Tugareva has pinpointed columnar apple tree forms with highly winter-hardy reproductive organs, and Danilova has identified specific dates and critical temperatures that could significantly harm apple tree plantations in the Non-Black Earth zone of Russia.

**Conclusion.** Currently, research is ongoing to examine the winter hardiness of introduced apple varieties to select initial highly winter-hardy forms for breeding and hybrid samples for identifying potential varieties with better winter hardiness compared to the existing ones. The application of methodological guidelines released by Federal Horticultural Center for Breeding, Agrotechnology and Nursery in various

scientific institutions confirms the effectiveness of enhancing apple breeding through comprehensive winter hardiness assessments. By combining field studies and controlled environment modeling, researchers can expedite variety testing, predict plant conditions after winters with varying weather patterns, and take timely measures to preserve plantation productivity. The extensive research on apple variety, form, and hybrid winter hardiness at Federal Horticultural Center for Breeding, Agrotechnology and Nursery holds both theoretical and practical importance for advancing the breeding process.

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### PROBIOTICS IN FEEDING LAYING HENS

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