УДК 634.11: 634.13: 631.8
DOI: 10.32782/2415-8240-2025-107-1-155-163

YIELD AND FRUIT QUALITY OF APPLE AND PEAR TREES UNDER SOIL FERTILIZATION AND FOLIAR FEEDING

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Наведено аналітичний огляд вітчизняних і закордонних досліджень, щодо урожайності насаджень та якості плодів яблуні і груші залежно від ґрунтового удобрення й позакореневого підживлення в різних ґрунтово-кліматичних умовах. Мінеральне живлення є критично важливим компонентом метаболізму рослин, безпосередньо впливаючи на їхній ріст, розвиток, продуктивність насаджень та якість врожаю. Оптимізація забезпечення яблуні та груші основними макро- та мікроелементами значно підвищує врожайність даних насаджень. Тому, актуальним є питання щодо збільшення виробництва плодів яблуні та груші, за рахунок цілеспрямованого керування ростом і плодоношенням садових рослин з метою отримання високих й сталих врожаїв за рахунок раціонального ґрунтового удобрення та позакореневого підживлення.

Ключові слова: *яблуня, груша, урожайність насаджень, якість плодів, ґрунтове удобрення, позакореневе підживлення, елементи живлення, продуктивність дерев, норми добрив, сорт, підщепа.*

State of the problem. On the fresh produce market, the most popular apple varieties are those whose fruits are characterized by excellent taste, good shape, and a bright red overcolor over the entire surface, or a simple green or yellow ground color [1]. Along with apples, pear fruits also have high nutritional value and are characterized by high yields in the orchards. They are classified as a dessert product. Pear fruits contain beneficial substances that are harmoniously combined. These fruits possess superb taste qualities, which is why the importance of this fruit crop is quite significant [2]. The productivity of a cultivar can be significantly modified by the choice of rootstock, fertilizer application, and other factors [3–7]. Therefore, increasing the production of apple and pear fruits remains a relevant objective, and fertilization continues to be the most accessible method of targeted management of the growth and fruiting of orchard plants in order to achieve high yields.

Research methodology. The methodological framework of the research was based on contemporary scientific works by both domestic and foreign scholars. The

research methods included a systems approach, comparative analysis, and generalization.

Results of the research. The issue of fertilizer application has been studied and practically tested mainly in orchards of the primary horticultural crop-the apple tree. The nutrition and fertilization of apple and pear trees are often considered simultaneously, even though there are some differences between them in this regard [8, 9]. When considering pear cultivation, it can be noted that, compared to the apple tree, it requires certain specific considerations in its cultivation technology, which is related to its climatic requirements. Its trees are less resistant to frost than apple trees, and the flowers are more frequently damaged by frost due to earlier blooming. The pear is more demanding of soil conditions and mineral nutrition [2, 10]. Its normal development requires increased potassium nutrition, upon which the quality of generative buds, fruit size, color, and taste depend. Potassium plays an essential role in the mineral nutrition of fruit crops, as it affects the water regime, enzyme activation, and stress resistance [3, 11, 12].

In the research conducted by K. Zygmuntowska and E. Jadczuk-Tobjasz [13] on the application of various rates of potassium fertilizers in young pear orchards, it was established that the potassium rates did not affect tree size but contributed to an increase in fruit mass and higher yield. An annual application of 200 kg of K2O/ha was the most effective. Research by I. I. Sereda [14], conducted in long-term experiments within an apple orchard, established that the ten-year application of mineral (N180P180K180) and organic (20 t/ha) fertilizers on slightly acidic sod-podzolic sandy soil ensures an increase in tree trunk diameter, overall yield, and the output of high-quality produce.

The positive effect of applying mineral and organic fertilizers on the growth, fruiting, and yield quality of apple orchard has been confirmed by studies conducted under various soil and climatic conditions [3, 8, 13, 15, 16]. In the United Kingdom, research conducted in apple orchards on semi-dwarfing rootstocks established that increasing nitrogen (N) rates from 63 to 189 kg/ha contributed to an increase in yield. However, a decrease in yield was also observed in some years [16].

Research on various nitrogen fertilization options, conducted in Brazil in apple orchards on dwarfing rootstocks, established that nitrogen application isn't necessary on soils with a high organic matter content to ensure excellent fruit quality. This is likely because the nitrogen required for tree growth and fruit production is sufficient from the mineralization of organic matter [17].

A similar influence was also established by D. Wrona [18] in research conducted at the Warsaw University of Life Sciences (SGGW). In an experiment studying different rates and methods of autumn application of nitrogen fertilizer in an apple orchard with various rootstock types, it was established that nitrogen fertilizers did not have a significant impact on yield and fruit quality, whereas the rootstock type significantly affected these indicators. According to the author, nitrogen should preferably be applied in the spring when the demand for it is highest, and its release from organic matter through the mineralization process is negligible.

Modern fruit growing requires a rapid increase in tree yield alongside the corresponding quality indicators. Under these conditions, foliar fertilization with

macro- and microelements is an effective measure for the operative regulation of fruit crops' mineral nutrition. Foliar application positively influences the intensity of flowering, the formation of generative buds, and contributes to an increase in fruit set and overall yield. During foliar feeding, substances enter the part of the plant where metabolic processes are typically most intense, and where a nutrient deficiency is most often observed. It should be noted that foliar fertilization is most effective when combined with main soil fertilization [5, 7–9, 19, 20, 21].

Research by D. O. Kyselov and I. V. Hrynyk [22] established that a significant increase in apple fruit size was achieved through foliar treatment of the 'Florina' variety trees with the Tera-Sorb Complex preparation. The increase in yield ranged from 0.57 to 10.88 kg/tree compared to the control (treatment with water). The application of the preparation also contributed to an improvement in the biochemical composition of the apple fruits.

Microelements, compared to macroelements, are utilized by fruit crops in smaller quantities. However, their application during specific phases of tree growth and development is significant, as it subsequently affects the productivity of the orchards [23, 24]. Ensuring that trees receive microelements is a very important task, even when these elements are present in sufficient quantities in the soil. This is because the transport of these elements from the soil to the leaves and fruiting wood is complicated during periods of critical demand. Specifically, the demand for boron (B) increases sharply during the flowering period, as it participates in pollen germination and fruit formation at that time [25, 26]. During this period, the demand for it is very significant. Even with a sufficient content of it in the soil, a deficiency can manifest in the aerial parts of the plant, although boron may accumulate in the plant roots [27]. Along with boron, calcium (Ca) is of great importance for the formation of a future high-quality yield. It improves the firmness of the fruit flesh and extends its storage life [28, 29].

The application of microelements in 'Vyzhnytsia' pear orchards contributed to an increase of 6–8 % in the output of Extra and First commercial grades of fruit. Furthermore, the fruit's storage period was extended by 6–21 days, and the biochemical indicators of the pears improved due to a reduction in microbiological diseases and physiological disorders [30].

Research conducted at the Institute of Horticulture [31] established that, against the background of optimal NPK content in the soil, the most significant increase in apple yield, compared to the control, was obtained in the variant involving three applications of spraying with a 0.3% solution of boron and a mixture of microelements. The application of microelements also improved the indicators of the trees' functional state. The positive impact of micronutrient fertilization on the yield and fruit quality of pome fruit crops is also confirmed by studies conducted in various soil and climatic conditions across many countries [32, 34].

There is an opinion that the weather conditions during the growing season are one of the most important factors influencing the accumulation of nutrients in fruits, their ripening time, quality, and storability. Optimal ambient temperature (air, soil) and a full supply of moisture contribute to the formation and accumulation of sugars. Soil moisture during fruit formation significantly affects their size, mass, and structure. The conditions of the growing season can lead to the occurrence of physiological fruit

disorders during storage. In years with excessive moisture during the growing season, an insufficient sum of effective temperatures, as well as due to the retardation of tree growth processes, insufficient outflow of assimilates to the fruits, and reduced accumulation of dry matter and sugars, apples and pears have poorer taste quality [35–38]. The effect of nutrient elements, particularly nitrogen, phosphorus, potassium, as well as micronutrients, on fruit growth and quality is related to the complex biochemical processes that take place in their tissues. When the main mineral elements are insufficient in the soil, fruits cease to grow and their size decreases. An excessive amount of fertilizers, especially nitrogen, leads to a reduction in flesh firmness and deterioration of storability [3, 8, 37, 38].

Conclusions. From the presented data, it can be concluded that the applied fertilizers, both when introduced into the soil and applied foliarly, positively affect the growth processes and the overall productivity of apple and pear orchards. The study of different timings, methods, and rates of fertilization remains insufficiently investigated, particularly in various soil and climatic conditions. Therefore, the study of the influence of soil fertilization and foliar nutrition on apple and pear trees in a specific soil and climatic zone remains a relevant issue.

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Annotation

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Yield and quality of apple and pear fruits under soil fertilization and foliar feeding.

The article provides an analytical review of domestic and foreign research on the yield of fruit stands and the quality of apple and pear fruits depending on soil fertilization and foliar feeding in various soil and climatic conditions. Mineral nutrition is a critically important component of plant metabolism, directly influencing their growth, development, stand productivity, and harvest quality. Optimizing the supply of key macro- and microelements to apple and pear trees significantly increases the yield of these stands. Therefore, the issue of increasing apple and pear fruit production by means of purposeful management of garden plant growth and fruiting is relevant for obtaining high and stable yields through rational soil fertilization and foliar feeding.

On the fresh produce market, the most popular apple varieties are those whose fruits are characterized by excellent taste, good shape, and a bright red blush over the entire surface or only a basic green or yellow coloration. Pear fruits, along with apples, also have great nutritional value and are characterized by high stand productivity. This can be achieved by selecting the appropriate variety composition, rootstock, and fertilization system.

The issue of fertilizer application has been primarily studied and practically tested in orchards of the main horticultural crop: the apple tree. The nutrition and fertilization of apple and pear trees are often considered simultaneously, although there are some differences between them in this regard. Considering the pear crop, it can be noted that, compared to apple trees, it requires certain specific features in the cultivation technology due to its demands regarding climatic conditions.

Modern fruit growing requires a rapid increase in tree yield with corresponding quality indicators. This can be achieved by promptly regulating the mineral nutrition of apple and pear trees through foliar feeding with macro- and microelements. Foliar feeding positively affects the intensity of flowering, the laying of generative buds, and contributes to increased fruit set and yield. It should be noted that foliar feeding is most effective when combined with basic soil fertilization.

Key words: *apple tree, pear tree, stand productivity, fruit quality, soil fertilization, foliar feeding, nutrients, tree productivity, fertilizer rates, cultivar, rootstock.*