PRODUCTIVITY OF THE ORCHARD AGROECOSYSTEM

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STATE OF THE PROBLEM. A prerequisite for the creation and use of highly productive agroecosystems capable of producing high-quality products is a sufficient level of soil quality [1–3]. Without human support, the agroecosystem loses its high productivity and returns to its natural state. Under conditions of perennial plantations, a long-term biocenosis is created, which may be characterized by self-regulation, but its sufficient economic productivity is not ensured. Thus, in horticulture, it is impossible to do without active management of the agroecosystem, which requires significant expenditures of additional energy aimed at ensuring maximum tree productivity [4–6].

RESULTS OF THE RESEARCH. Fruit trees form the autotrophic basis of the agroecosystem. Using solar radiation, water, and inorganic nutrients, they create products for human consumption. Its natural value is determined by the balanced flow of energy and substances, which determines the balance of the ecosystem. Humans also...
use materials to supply trees with nutrients and water and to destroy competitors in the struggle for these vital resources – weeds, pests, diseases, and other phytopathogenic macro- and microorganisms [7–10].

Orchard agroecosystems, together with forests, form perennial plantations. In terms of their functioning, they have many similarities and significant differences. What these systems have in common is that in one and the other, the producers are perennial woody plants that live in one place for a long time, while in a field ecosystem, crops replace each other in crop rotation annually or frequently. After the plantations are uprooted, other trees are planted in their place, which will also be grown in the same place for a long time. Thus, the biogeocenotic features of fruit crops are significantly different from field phytocoenoses. At the same time, orchard agrobiocenoses, which are a perennial tree monoculture and therefore a relatively unstable ecosystem, differ significantly from fields and forests in that they require more intensive anthropogenic impact to maintain growth and productivity at a high level. Fruit monoculture has some similarities with permanent field crops in that, like them, it is subject to the same factors or causes of yield reduction, namely physical, chemical and biological. In the case of permanent culture, replant disease also has a significant negative impact [4, 11–14]. This negative phenomenon is caused by the accumulation of toxic substances and disease-causing microflora microflora in the soil, which is confirmed by our research [37, 67].

Changes in soil properties in orchards manifest themselves somewhat differently than in fields, often more strongly, due to the high intensity and concentration of crop, as well as the peculiarities of the impact of fruit plantations on meso- and microclimatic conditions of the area and the hydrothermal regime of the soil under them [15–17]. In the forest, the species composition is quite diverse, while in orchards, trees grow of the same species. The reproduction and spread of pests and diseases in the orchard is more widespread than in the forest, where different species are grown that can partially protect themselves. In the forest, soil and air humidity do not fluctuate to the same extent as in the garden [18].

What forests and gardens have in common is that garden crops originated in forests in the distant past, so they need sufficient moisture, especially at a young age, and thorough protection from strong winds. In the forest, maintenance felling is carried out, while in the orchard, a whole system of agrotechnical measures is used to create good conditions for growth and fruiting. Therefore, the orchard, as a cultural agroecosystem, requires a large amount of artificial energy, without the use of which it is impossible to grow crops in modern conditions [18, 19].

With the use of high-performance rootstock combinations in horticulture and an increase in the number of trees per hectare, the orchard agroecosystem has become more like a forest. However, with the increase in production and its removal from the orchard, the use of single-species plantings, and the reduction in the number of varieties, the modern orchard has become more intensive in terms of environmental, anthropogenic, and biotic factors. Therefore, the role of mineral nutrition of plants, water supply, and the creation of phytosanitary conditions that would minimize the harmful effects of intensification has increased. There is a need to use high-yielding
varieties and rootstocks in orchards that make good use of natural soil fertility, respond adequately to fertilization, and resist air and soil pollution [20–22].

A decrease in soil organic matter negatively affects the agroecosystem and disrupts its stability. Therefore, the orchard's agrobiocenosis system is very sensitive and requires careful measures aimed at restoring and preserving soil fertility. Using only mineral fertilizers can help to achieve the desired yields for some time, but without using organic fertilizers, the effective fertility decreases over a certain period of time and signs of irreversible degradation processes in the soil appear [1, 4]. In this case, the higher the previous harvest, the greater the soil degradation and the faster the plantation needs to be reconstructed due to a decrease in its yield. Avoidance of these negative phenomena is facilitated by the development of targeted measures to reproduce soil fertility in orchards as a result of their assessment through operational monitoring of changes in fertility indicators. Predicting these processes is an urgent issue today. Since soil is the main component of the biosphere, the reproduction and maintenance of its fertility at an optimal level are a prerequisite not only for soil development, but also for environmental safety and sustainability of the natural environment in general [23–25].

The basis for intensifying horticulture and obtaining high yields of quality fruits should be the development of a rational fertilizer system, which should be based on optimizing all soil fertility indicators and introducing those nutrients that the plant lacks. It needs to be developed for each specific type of orchard agroecosystem. It is important to keep in mind that the basis of all agroecosystems is the area with its inherent soil cover. This is the most important component that determines the development of the vegetation that will be grown on it. Studies have identified a number of important features of the impact of orchard agroecosystems on the environment, including the soil [26–30].

Not much fundamental research has been conducted in fruit plantations. This is due to the fact that it is possible to detect visible changes in soil formation processes under fruit trees only after their long-term cultivation in the same place [1, 30, 32]. Most studies have been conducted on issues related to the selection of soils for fruit plantations, as well as their response to different soil conditions due to different soil fertility. These studies were carried out in different soil and climatic conditions and are covered in various scientific papers [4, 19, 33, 34]. Numerous studies have also been conducted to regulate soil conditions for growing and nourishing fruit trees through garden experiments with fertilization, maintenance, and tillage in orchards in Ukraine and abroad [1, 4, 27, 31, 35, 40, 41].

Nevertheless, a significant drawback of these studies in horticulture is the insufficient study of changes in the main parameters of soil fertility and the impact on their productivity of plantations depending on variety-stock combinations and plantation designs in general. In most experiments, it was limited to determining the content of basic macronutrients, humus, changes in acidity, soil moisture, and soil density. Most studies were conducted in short-term experiments, although such studies should be conducted in the dynamics in long-term experiments.
Conclusions. Thus, the productivity of orchard agrobiocenoses is determined not only by mineral nutrition, but also by their ecological state, an important regulator of which is the soil environment, which is significantly influenced by agricultural practices, in particular fertilization. Therefore, before recommending the application of certain measures that have an anthropogenic impact in orchards, in particular on the productivity of plantations, it is necessary to find out what changes in the soil environment contributed to an increase or decrease in yield. This issue is relevant in horticulture, especially when establishing new intensive plantings in the places of uprooted orchards where replant disease is evident, and the need to improve soil fertility under them for further high productivity.

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Annotation

Yakovenko R. V., Kopytko P. G., Yakovenko O. O., Chepurnyi V. G.
Productivity of the orchard agroecosystem

The article presents an analytical review of Ukrainian and foreign sources of literature on the peculiarities of the productivity of the orchard agroecosystem and the impact of agrotechnical measures, in particular fertilization. As a result of the analysis, it was found that the productivity of orchard agrobiocenoses is determined not only by mineral nutrition, but also by their ecological state, an important regulator of which is the soil environment, which is significantly influenced by fertilization. However, before recommending the application of certain measures that have an anthropogenic impact in orchards, in particular on the productivity of plantations, it is necessary to find out what changes in the soil environment contributed to an increase or decrease in yield. Therefore, this issue is relevant in horticulture, especially when establishing new intensive plantations in the places of uprooted orchards, where soil fatigue is manifested, and there is a need to improve soil fertility under them for further high productivity.

Nevertheless, a significant drawback of these studies in horticulture is the insufficient study of changes in the main parameters of soil fertility and the impact on their productivity of plantations depending on variety-stock combinations and plantation designs in general. In most experiments, it was limited to determining the content of basic macronutrients, humus, changes in acidity, soil moisture, and soil density. Most studies were conducted in short-term experiments, although such studies should be conducted in the dynamics in long-term experiments.

Key words: productivity, fruit plantations, woody monoculture, yield, agroecosystem, fertilizers, agrobiocenosis, replant disease.