УДК 634.1: 631.5: 631.8
DOI: 10.32782/2415-8240-2023-102-1-17-25

PRODUCTIVITY OF THE ORCHARD AGROECOSYSTEM

R. V. YAKOVENKO, *Doctor of Agricultural Sciences*
P. G. KOPYTKO, *Doctor of Agricultural Sciences*
Uman National University of Horticulture
O. O. YAKOVENKO, *Candidate of Economic Sciences*
Sirius-Agro LLC
V. G. CHEPURNYI, *Candidate of Agricultural Sciences*
Research Station of Pomology named after L. Symyrenko IH NAAS of Ukraine

Представлено аналітичний огляд українських і зарубіжних джерел літератури, щодо особливостей продуктивності садової агроекоситеми та впливу на неї агротехнічних заходів, зокрема удобрення. У результаті проведеного аналізу встановлено, що продуктивність садових агробіоценозів обумовлюється не тільки мінеральним живленням, але і екологічним станом у них, важливим регулятором якого є ґрунтове середовище, на яке значно впливає удобрення. Проте, перш ніж рекомендувати застосування тих чи інших заходів, які виявляють антропогенний вплив у садах, зокрема на продуктивність насаджень, потрібно з'ясувати, які ж зміни ґрунтового середовища сприяли підвищенню або зниженню врожайності. Тому, дане питання є актуальним у садівництві, особливо при закладанні нових інтенсивних насаджень на місцях розкорчованих садів, де проявляється ґрунтовтома, і є необхідність покращення родючості ґрунту під ними для подальшої високої продуктивності.

Ключові слова: *продуктивність, плодові насадження, деревна монокультура, урожайність, агроекосистема, удобрення, агробіоценоз, ґрунтовтома.*

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.

Література:

1. Козак В. М. Агроекологічні основи збереження родючості ґрунтів в промислових насадженнях яблуні та їх якісна оцінка в садівництві України. Афтореферат дис. д. с.-г. наук. Харків, 1999. 32 с.
2. Господаренко Г. М. *Основи інтегрованого застосування добрив*. К.: Начлава, 2002. 344 с.
3. Wojcik P. Zrównoważone nawożenie roślin ogrodniczych. Instytut Ogrodnictwa, Skierniewice. 2014. P. 4-19.
4. Копитко П. Г. *Удобрення плодових і ягідних культур*. К.: Вища школа, 2001. 206 с.
5. Заморський В. В. Агробіологічне обгрунтування конструкцій насаджень яблуні в Лісостепу України: автореф. дис. ... д-ра с.-г. наук: 06.01.07– плодівництво. Умань, 2012. 32 с.
6. Омельченко І. К. *Культура яблуні в Україні*. К.: Урожай, 2006. 264 с.
7. Кондратенко П. В. *Адаптація яблуні в Україні*. К. 2001. 190 с.
8. Lysaniuk V. H., Volskyi V. A., Savchenko I. F., Rykhlivskyi P. A., Kotsiubanskyi R. V. Research of agrotechnical methods of increasing soil fertility in the system of organic agriculture. *Colloquium-journal*. 2022. №5 (92). P. 58-61.
9. Балаєв А. Д., Богданович Р. П., Алексеєнко І. М. Трансформація і гуміфікація рослинних решток за різного обробітку, удобрення і гумусованості грунту (на прикладі модельного досліду). *Наук. вісн. НАУ*. 2005. Вип. 81. С. 15–21.
10. Kopytko P., Karpenko V., Yakovenko R., Mostoviak I. Soil fertility and productivity of apple orchard under a long-term use of different fertilizer systems. *Agronomy Researh*. 2017. № 15(2). P. 444-455.
11. Бутило А. П. Динаміка вмісту гумусу в ґрунті садового агрофітоценозу за різних систем утримання. *Вісник Уманської ДАА*. 2001. №1–2. С. 10–12.
12. Mazzola M., Mullinix K. Comparative field efficacy of management strategies containing Brassica napus seed meal or green manure for the control of apple replant disease. *Plant Disease*. 2005. Vol. 89. P. 1207–1213. DOI: 10.1094/PD-89-1207
13. Szczygiel A., Zepp A. L. An occurrence and importance of apple replant disease in Polish orchard. *Acta Hort*. 1998. Vol. 477. P. 99–101.
14. Красноштан А. О. Мінеральні добрива в сучасному садовому біоценозі – реальність і проблеми. *Зб. наук. пр. УСГА*. 1997. С. 23-25.

15. Яковенко Р. В. Ґрунтовтома та заходи її послаблення в насадженнях яблуні. *Вісник Уманського НУС*. 2021. №2. С. 69–72. DOI: 10.31395/2310-0478-2021-2-69-72

16. Kopytko P. G., Yakovenko R. V., Yakovenko O. V., Chepurnyi V. G., Fomenko O. O. Feasibility to Neutralize Replant Disease under the Recultivation of an Apple Orchard. *Indian Journal of Agricultural Research*. 2022. Vol. 56. P. 621-625. DOI: 10.18805/IJARe.AF-695

17. Яковенко Р. В. Битва за землю. *Садівництво по-українськи*. 2022. №2-3 (50-51). С. 28–30.

18. Гром М. М. *Лісова таксація*. Львів: НЛТУ, 2007. 416 с.

19. Красноштан А. О. Продуктивність яблуні залежно від підщепи та удобрення ґрунту в умовах Лісостепу України: Автореф. дис… д-ра с.-г. наук. – К., 1997. 46 с.

20. Kai T.; Kubo M. Chemical and biological properties of apple orchard soils under natural, organic, hybrid, and conventional farming methods. *J. Agric. Chem. Environ*. 2020. V. 9. P. 134–146. DOI: 10.4236/jacen.2020.93012.

21. Бабинцева Н. О., Лисанюк В. Г. Ріст і продуктивність дерев груші (*PIRUS COMMUNIS L.*) в різних типах насаджень на слаборослій підщепі. *Садівництво*. Вип. 68. 2014. С. 166 171.

22. Kowalczyk W., Wrona D., Przybylko S. Effect of nitrogen fertilization of apple orchard on soil mineral nitrogen content, yielding of the apple trees and nutritional status of leaves and fruits. *Agriculture*. 2022. V. 12. DOI:10.3390/agriculture12122169

23. Wooldridge J. Effects of early season and autumn nitrogen applications on young “Keisie” canning peach trees on a sandy, infertile soil. *Plant and Soil*. 2006. 23 (3). DOI: 10.1080/02571862.2006.10634751.

24. Wojcik P. *Nawozy i nawożenie drzew owocowych*. Warszawa, 2009. 252 p.

25. Yakovenko R. V., Kopytko P. G., Petrishina I. P., Butsyk R. M., Borysenko V. V. Productivity of Pear Plantings Depending on the Content of Main Macroelemants (n, p, k) in the Soil after Optimized Fertilization. *Indian Journal of Agricultural Research*. 2019. Vol. 54. P. 77–82. DOI: 10.18805/IJARe.A-454.

26. Kozak N. V. Problems of Soil Productivity in Horticulture. *Eurasian Soil Science*. 1994. №26. P. 84–95.

27. Копитко П. Г., Геркіял О. М., Господаренко Г. М. Збереження ґрунту і відтворення його родючості в Правобережному Лісостепу. *Агрохімія і ґрунтознавство.* 2002. С. 82–92.

28. Мельник О. В. Удобрення. *Інтенсивний сад: закладання і догляд Новини садівництва.* 2018. №3. С. 2-12.

29. Яковенко Р. В., Копитко П. Г. Збереження родючості ґрунту за довготривалого удобрення яблуневого саду. *Агрохімія і ґрунтознавство (спецвипуск)*. 2010. С. 219–221.

30. Xing-xing P., Zheng G., Yu-jiao Z., Jun L. Quantitative simulation of the effect of long-term organic manure and chemical fertilizer application on water productivity and soil organic carbon contents of apple orchards in Weibei Highland. *Journal of Plant Nutrition and Fertilizers*. 2018. № 24(1). P. 33–43. DOI: 10.11674/zwyf.17045.

31. Середа І. І., Мовчан Н. Ф. Вплив довгострокового застосування добрив на агрохімічні властивості темно-сірого опідзоленого ґрунту і продуктивність яблуні. *Садівництво*. 1998. Вип. 46. С. 95–98.

32. Майдебура В. І., Майдебура О. В., Заморський В. В. Якість та тривалість зберігання плодів яблуні в залежності від рівня мінерального живлення. *Зб. наук. пр. УДАУ.* 2005. Ч. 1. № 61. С. 536–548.

33. Середа І. І. Вплив передпосадкового та поточного окультурення на водно-фізичні властивості дерново-підзолистого піщаного ґрунту, мінеральне живлення та продуктивність яблуні. *Садівництво*. 1999. Вип. 49. С. 116–124.

34. *Придатність ґрунтів під сади і ягідники* / за ред. П. Д. Поповича. Київ: Урожай, 1981. 160 с.

35. Рубін С. С. *Удобрення плодових і ягідних культур*. Київ, 1962. 547 с.

36. Chyba J., Kroulik M., Krištof K., Misiewicz P., Chaney K. Influence of soil compaction by farm machinery and livestock on water infiltration rate on grassland. *Agronomy Research*. 2014. Vol. 12. P. 59–64.

37. Six J., Paustian K., Elliott E. T., Combrink C. Soil structure and organic matter I. Distribution of aggregate-size classes and aggregate-associated carbon. *Soil Sci. Soc. of America Journal*. 2000. Vol. 64. P. 681-689. DOI: 10.2136/sssaj2000.642681x

38. Zuoping Zh., Sha Y., Fen L., Puhui J., Xiaoying W., Yanan T. Effects of chemical fertilizer combined with organic manure on Fuji apple quality, yield and soil fertility in apple orchard on the Loess Plateau of China. *Int J Agric end Biol Eng Open Access*. 2014. Vol. 7. № 2. P. 45–51.

39. Бутило А. П. Продуктивність яблуні при повторній культурі за парової і дерново-перегнійної систем утримання ґрунту в міжряддях саду. *Зб. наук. пр. УДАА*. 2001. № 53. С. 152–155.

40. Красноштан А. О., Манзій В. В. Ефективність мінеральних добрив при повторному використанні ґрунту під яблунею. *Зб. наук. пр. УСГА (на честь 150 річчя)*. 1999. С. 253–255.

41. Gao Y. M., Tong Y. A., Lu Y. L., Ma H. Y. Effect of long-term application of nitrogen, phosphorus and potassium on apple yield and soil nutrient accumulation and distribution in orchard soil of Loess Plateau. *Journal of Fruit Science*. 2012. Vol. 29. P. 322–327.

References:

1. Kozak, V. M. (1999). Agroecological bases of soil fertility preservation in industrial apple plantations and their qualitative assessment in horticulture of Ukraine. Doctoral dissertation in agricultural sciences. Kharkiv, 32 p. (in Ukrainian).

2. Gospodarenko, G. M. (2002). *Fundamentals of integrated fertilizer application*. K.: Nachlava, 344 p. (in Ukrainian).

3. Wojcik, P. (2014). *Zrównoważone nawożenie roślin ogrodniczych*. Instytut Ogrodnictwa, Skierniewice, pp. 4-19. (in Polish).

4. Kopytko, P. G. (2001). *Fertilization of fruit and berry crops*. K.: Vysha Shkola, 206 p. (in Ukrainian).

5. Zamorsky, V. V. (2012). Agrobiological substantiation of apple tree plantations in the Forest-Steppe of Ukraine. PhD thesis. Uman, 32 p. (in Ukrainian).

6. Omelchenko, I. K. (2006). *Apple tree culture in Ukraine*. K.: Urozhay, 264 p. (in Ukrainian).

7. Kondratenko, P. V. (2001). *Adaptation of apple trees in Ukraine*. K., 190 p. (in Ukrainian).
8. Lysaniuk, V. H., Volskyi, V. A., Savchenko, I. F., Rykhlivskyi, P. A., Kotsiubanskyi, R. V. (2022). Research of agrotechnical methods of increasing soil fertility in the system of organic agriculture. *Colloquium-journal,* no. 5 (92), 2022, pp. 58-61. (in Ukrainian).
9. Balaev, A. D., Bogdanovich, R. P., Alekseenko, I. M. (2005). Transformation and humification of plant residues under different cultivation, fertilization and soil humusification (on the example of a model experiment). *Scientific Bulletin of the National Academy of Sciences of Ukraine,* Issue 81, pp. 15-21. (in Ukrainian).
10. Kopytko, P., Karpenko, V., Yakovenko, R., Mostoviak, I. (2017). Soil fertility and productivity of apple orchard under a long-term use of different fertilizer systems. *Agronomy Researh,* no. 15(2), pp. 444-455. (in Ukrainian).
11. Butylo, A. P. (2001). Dynamics of humus content in the soil of garden agrophytocenosis under different systems of maintenance. *Bulletin of Uman State Agricultural Academy*, no. 1-2, pp. 10-12. (in Ukrainian).
12. Mazzola, M., Mullinix, K. (2005). Comparative field efficacy of management strategies containing Brassica napus seed meal or green manure for the control of apple replant disease. *Plant Disease*, vol. 89, pp. 1207–1213. DOI: 10.1094/PD-89-1207.
13. Szczygiel, A., Zepp, A. L. (1998). An occurrence and importance of apple replant disease in Polish orchard. *Acta Hort*., vol. 477, pp. 99–101. (in Polish).
14. Krasnoshtan, A. O. (1997). Mineral fertilizers in the modern garden biocenosis - reality and problems. *Collection of scientific papers of the USGA*, pp. 23-25. (in Ukrainian).
15. Yakovenko, R. V. (2021). Soil stiffness and measures of its weakening in apple trees. *Bulletin of Uman NUS,* no. 2, pp. 69-72. DOI: 10.31395/2310-0478-2021-2-69-72 (in Ukrainian).
16. Kopytko, P. G., Yakovenko, R. V., Yakovenko, O. V., Chepurnyi, V. G., Fomenko, O. O. (2022). Feasibility to Neutralize Replant Disease under the Recultivation of an Apple Orchard. *Indian Journal of Agricultural Research*, vol. 56, pp. 621-625. DOI: 10.18805/IJARe.AF-695 (in Ukrainian).
17. Yakovenko, R. V. (2022). The Battle for the Land. *Gardening in Ukrainian*, no. 2-3 (50-51), pp. 28-30. (in Ukrainian).
18. Grom, M. M. (2007). *Forest taxation*. Lviv: NLTU, 416 p. (in Ukrainian).
19. Krasnoshtan, A. O. (1997). Productivity of apple trees depending on rootstock and soil fertilization in the forest-steppe of Ukraine: Author's dissertation... Doctor of Agricultural Sciences, 46 p. (in Ukrainian).
20. Kai, T., Kubo, M. (2020). Chemical and biological properties of apple orchard soils under natural, organic, hybrid, and conventional farming methods. *J. Agric. Chem. Environ*., vol. 9, pp. 134–146. DOI: 10.4236/jacen.2020.93012. (in Japanese).
21. Babintseva, N. O., Lisanyuk, V. G. (2014). Growth and productivity of pear trees (*PIRUS COMMUNIS L*.) in different types of plantations on a weak rootstock. *Horticulture,* issue 68, pp. 166-171. (in Ukrainian).
22. Kowalczyk, W., Wrona, D., Przybylko, S. (2022). Effect of nitrogen fertilization of apple orchard on soil mineral nitrogen content, yielding of the apple

trees and nutritional status of leaves and fruits. *Agriculture,* vol. 12. DOI:10.3390/agriculture12122169. (in Polish).

23. Wooldridge, J. (2006). Effects of early season and autumn nitrogen applications on young "Keisie" canning peach trees on a sandy, infertile soil. *Plant and Soil*, no. 23 (3). DOI: 10.1080/02571862.2006.10634751. (in South African).

24. Wojcik, P. (2009). *Nawozy i nawożenie drzew owocowych*. Warszawa, 252 p. (in Polish).

25. Yakovenko, R. V., Kopytko, P. G., Petrishina, I. P., Butsyk, R. M., Borysenko, V. V. (2019). Productivity of Pear Plantings Depending on the Content of Main Macroelemants (n, p, k) in the Soil after Optimized Fertilization. *Indian Journal of Agricultural Research*, vol. 54, pp. 77–82. DOI: 10.18805/IJARe.A-454 (in Ukrainian).

26. Kozak, N. V. (1994). Problems of Soil Productivity in Horticulture. *Eurasian Soil Science, no*. 26 (10), pp. 84–95. (in Ukrainian).

27. Kopytko, P. G., Herkyial, O. M., Gospodarenko, G. M. (2002). Soil conservation and reproduction of its fertility in the Right-Bank Forest-Steppe. *Agrochemistry and soil science*, pp. 82–92. (in Ukrainian).

28. Melnyk, O. V. (2018). Fertilization. *Intensive garden: laying and care News of gardening*, no. 3, pp. 2-12. (in Ukrainian).

29. Yakovenko, R. V., Kopytko, P. G. (2010). Preservation of soil fertility under long-term fertilization of an apple orchard. *Agrochemistry and soil science,* special issue, pp. 219-221. (in Ukrainian).

30. Xing-xing, P., Zheng, G., Yu-jiao, Z., Jun, L. (2018). Quantitative simulation of the effect of long-term organic manure and chemical fertilizer application on water productivity and soil organic carbon contents of apple orchards in Weibei Highland. *Journal of Plant Nutrition and Fertilizers*, no. 24(1), pp. 33–43. DOI: 10.11674/zwyf.17045. (in Chinese).

31. Sereda, I. I., Movchan, N. F. (1998). Influence of long-term fertilizer application on the agrochemical properties of dark gray podzolic soil and apple tree productivity. *Horticulture,* issue 46, pp. 95-98. (in Ukrainian).

32. Maidebura, V. I., Maidebura, O. V., Zamorsky, V. V. (2005). Quality and duration of storage of apple fruits depending on the level of mineral nutrition. *Collection of scientific papers of UDAU,* no. 61, pp. 536–548. (in Ukrainian).

33. Sereda, I. I. (1999). Influence of preplanting and current cultivation on water-physical properties of sod-podzolic sandy soil, mineral nutrition and productivity of apple trees. *Horticulture*, issue 49, pp. 116–124. (in Ukrainian).

34. Popovich, P. D. (Eds.) (1981) *Suitability of soils for gardens and berry gardens.* Kyiv: Urozhay, 160 p. (in Ukrainian).

35. Rubin, S. S. (1962). *Fertilization of fruit and berry crops*. Kyiv, 547 p. (in Ukrainian).

36. Chyba, J., Kroulik, M., Kristof, K., Misiewicz, P., Chaney, K. (2014). Influence of soil compaction by farm machinery and livestock on water infiltration rate on grassland. *Agronomy Research*, vol. 12, pp. 59-64. (in Slovakian).

37. Six, J., Paustian, K., Elliott, E.T., Combrink, C. (2000). Soil structure and organic matter I. Distribution of aggregate-size classes and aggregate-associated carbon. *Soil Sci. Soc. of America Journal*, vol. 64, pp. 681-689. DOI: 10.2136/sssaj2000.642681x.

38. Zuoping, Zh., Sha, Y., Fen, L., Puhui, J., Xiaoying, W., Yanan, T. (2014). Effects of chemical fertilizer combined with organic manure on Fuji apple quality,

yield and soil fertility in apple orchard on the Loess Plateau of China. *Int J Agric end Biol Eng Open Access*, vol. 7, no. 2, pp. 45–51. (in Chinese).

39. Butylo, A. P. (2001). Productivity of apple trees during repeated culture under steam and sod- humus soil maintenance systems in the garden aisles. *Collection of scientific works of UDAA*, no. 53, pp. 152-155. (in Ukrainian).

40. Krasnoshtan, A. O., Manziy, V. V. (1999). Efficiency of mineral fertilizers in the reuse of soil under the apple tree. *Collection of scientific papers of the USGA (in honor of the 150th anniversary)*, pp. 253-255. (in Ukrainian).

41. Gao, Y. M., Tong, Y. A., Lu, Y. L., Ma, H. Y. (2012). Effect of long-term application of nitrogen, phosphorus and potassium on apple yield and soil nutrient accumulation and distribution in orchard soil of Loess Plateau. *Journal of Fruit Science*, vol. 29, pp. 322–327. (in Chinese).

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.*