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THE FORMATION OF BIOLOGICAL SYSTEMS AND CONTROL OF MICROFAUNA IN AGROPHYTOCENOSES (STATE OF THE QUESTION)

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Have been disclosed the impact of microfauna to the formation of biological systems in the rhizosphere of plants. It is shown that accounting all elements of the soil biome is an integral component of functional rhizosphere's system of agrophytocenosis and basis in the management of these components.

Statement of a problem. Vegetating plant is a main medium for the existence of a large number of different groups of organisms in the aboveground vegetative mass and soil, including the rhizosphere of the root system. The composition of the rhizosphere organisms includes the mycorrhizal fungi, free-existing rhizospheric microorganisms, saprotrophic organisms, herbivorous insects, pathogenic fungi and nematodes. These organisms influence and determine of plants' growth and development. But currently understanding of the aggregate of interactive impact of all elements of the system that includes of above-mentioned organisms didn't disclose fully, as accumulated knowledge to date are based mainly on studies of isolated (separate) groups (species) of organisms. It is necessary to explain how these organisms evolve and interact with each other during the growth and development of plants for understand the functions of biological systems [1-3, 23, 24]. The plant is regarded by the different consumers as a carbon source or as an organism that interacts with them through the formation of difficult relations, thereby defining of soil processes. It should be noted that the relationships between plants and soil's fauna are far broader and more difficult than just a producer and consumer.

The main material. Scientists consider that the role of microfauna (nematodes and protozoa) in the rhizosphere is to "roughly" using the flows of carbon and nitrogen or to manifestation of disease [4, 5]. Bacteria are more important often in system of transformation of substances than micromycetes, due to the arrival of a large quantity of readily available organic matter in rhizosphere [6, 7]. Thus, the interaction between bacteria and microfauna has an important and key role. Activity of microorganisms in the soil is determined to a greater extent by the flows of carbon, in contrast to the rhizosphere, where the plants supply the readily available carbon for microorganisms regularly. So, in the root system the conditions for microflora are formed, including of fast-growing bacteria, thereby is increased of their biomass and activity. At the same time the nematodes and protozoa that feed by bacteria cause the control of development to the bacterial groups [8]. The production of carbon-containing compounds in the form of root's exudates is up to 40% of the dry matter of plants [9].Even if the C-production into the plant's exudates is 10–20% of fixed carbon, other symbiotic microorganisms, such as mycorrhizal or nitrogen-fixing, would be able to absorb about 10–20% of carbon [10]. The preservation and support of microbial interactions in the rhizosphere is a priority for plants. This allows to compensate for significant losses of carbon that could be used for photosynthesis and the formation of above-ground biomass. This raises the question why plants provide energy for microbial groups in the form of exudates that compete with the root system for nutrients? The answer lies partly in the structure of ties in the energy flows and relationship with bacteria in the rhizosphere. Nutrients are temporarily transferred in an immobilized state (bacterial biomass) in the rhizosphere with their subsequent release [11]. The interaction between microorganisms and microfauna determines the rate of exchange of nutrients and increases the availability of mineral nutrients for plants. It is believed that the mechanism known as "microbial loop in the ground" [12], are launched by plants production of root exudates, which contribute to the growth and activity of bacteria in the rhizosphere. The formation of microbial cenosis in rhizosphere is especially important for microfauna because the plant nutrients will be immobilized by microorganisms and they will be in the bacterial biomass during some time. If the metabolism of nematodes and bacteria are not growing and has not a regular character, then the nutrients will be available and thus will flow to the plants. Increased nitrogen fixation fully reflected in experimental systems [13]. Root carbon exudate promotes an increase in rhizosphere, compared with the general soil, the microfauna populations, for example increasing in 27 times increasing the number of nematodes [14] and in thirty five times increase of the simplest. However , the role of quantitative increase of microfauna in total nitrogen nutrition of the plants of the rhizosphere is negligible. Models nitrogen balance indicate that the livelihoods of the simplest associated with the use of nitrogen contained in the fluid, but not nitrogen mineralization of soil organic matter, and also has a low rate of nitrogen fixation . In rhizosphere the microfauna populations often reach maximum at the older parts of the root system. For example, the root system of barley (*Hordeum vulgare*) reaches a maximum nematode populations in 10 days [16], with a significant number of the active simplest in rhizosphere of plants used root exudates [17]. Distribution of the simplest can be different, and they may be some distance (and time) of the root system itself. The spread of bacterial groups along the roots may be due to the peculiarities of "predator - victim " due to the vital functions of the simplest, although some researchers this is considered unlikely. So the process of increasing the number of protozoa in rhizosphere zone usually occurs at the beginning of the growing season annuals during an active ontogeny and flowering. Microfauna (eg fitonematody) have a decisive influence on rhizosphere flows relating to carbon and nitrogen. Small amounts of the colonization of the root system by the nematode (*Heterodera trifolii*) (typical natural habitats) on white clover (*Trifolium creeping*) increase the flow of products of photosynthesis to the roots, exudation of carbon and increased microbial biomass in rhizosphere [17]. Increased exudation of substances containing carbon was confirmed in further studies of four species of root nematodes.

Increasing the number of root secretions clover was in reaction to the nematode infection , the root system of neighboring plants growing in the vicinity of species that have not been settled nematodes, such *Lolium perenne*, also increased its exudation . This was associated with an increase of the flow of the clover containing nitrogen substances that were used perennial rye-grass. There is also a direct effect of microscopic nematodes and protozoa in rhizosphere on the transformation of nutrients that otherwise might remain immobilized in the microbial biomass. However, quantitative release of the nitrogen which is homologous volumes root exudation, does not play a significant role in the metabolism of plants. The consequences of reducing of the rhizosphere's flows of the carbon as a result of life herbivorous nematodes directly contributes to the availability of nitrogen.

Indirect impact of the microfauna's livelihoods may be more important than the direct effect due to trophic flows of nutrients. The presence in the rhizosphere of certain types of the simplest helped increase plant biomass, which does not depend on the composition of nutrients in them.

Plants are not just passive recipients of nutrients because they received information from the environment determines their underground metabolism, structure and level of exudation, forming symbiotic ties (eg mycorrhizae) or bacterial nitrogen fixation, changes in the rate of exudation , the interaction of free-living bacteria or production of secondary metabolites of compounds inhibitors of pathogenic protozoa [23, 28]. Because the root system morphologically and genetically programmed and has ecological importance, it must be a way of the transfer of signaling that define complex environmental conditions and activate genes that cause the formation of symbiosis or the formation of the secondary root system at a certain time in a certain place. The exchange of signals between plants and microorganisms, a colonization of the root system with symbionts and infection pathogens, has great potential for large-scale studies [25, 26].

From the microbiological point of view of evolution strategy and the ability to control the transport of nutrients to the root system will enhance the role of microorganisms and thus affect gene regulation in plants by signals. Functionally specialized bacteria are dominant colonizers of plant roots, a significant number of rhizosphere bacteria have the potential, through which they are able to determine the production of plant hormones [18]. Up to 80 % of the bacteria isolated from the basal zone of plants capable of producing auxin, cytokinins, gave suggests that growth promoters can come to the plant solely by microorganisms [19]. Extensive ability as useful and harmful microorganisms rhizosphere of plants to produce hormones, gives reason to believe that rhizosphere in which living bacteria play an important role in the management by the interaction of the root system, growth and development of plants. An effective tool that controls the formation of rhizosphere bacterial biomass, which determines the level of interaction between the plant root system development of micro-organisms are nematodes and protozoa. Last relating highly selective to the choice bacterial sources foodstuff and significant changes in the composition of bacterial communities associated with vital functions of the simplest, as was confirmed by the example of freshwater systems [20] and in the rhizosphere of plants. This trophic -induced differentiation of microbial composition determines the fundamental properties of the ecosystems, since soil bacteria occupying the most important milestones in the exchange of nutrients and plant growth. For example, the process of nitrogen fixation , nitrification and denitrification dominate in the nitrogen cycle. Stimulation of the activity of nitrifying bacteria is usually observed in the presence of protozoa is likely predators [11]. Some conceptual model of the structure and functioning of the microfauna, hormonal influence on the growth and development of the root system shown in Fig.

The impact of the microfauna on the formation of the root systems of plants, together with other representatives of the dominant rhizosphere is an integral component of a functional system.

Settling of the root system by the rhizosphere symbiotic microorganisms affect the populations of protozoa, especially if the plant is under the influence of various environmental factors, including increased concentration of atmospheric CO_2 and others. This is because the mycorrhizal fungi may be immediately obtained from the roots of carbonaceous material, thus reducing the allocation of these substances in the rhizosphere. The difference between mycorrhizal and non mycorrhizal plants likely is conditional as the number of carbon-containing substances in the rhizosphere. Bonkowski experiments with ectomycorrhizal fungi and protozoa in soil showed a decrease in the number of bacteria in the presence of mycorrhizal fungi, and vice versa mushroom mycelium growth inhibition in the presence of some of the simplest, explaining that the carbon balance exudates (see Fig.).

Mycorrhizal fungi are known to stimulate the development and activity of insects, obviously , because of the high content of nutrients in the juice of the plant, but they are also able to reduce activity of herbivorous insects. Perhaps this is due to the high content in leaves of structural elements [21]. There is a dependence interaction due to phase ontogeny plants. Active livelihoods of the representatives of some species of microfauna of the soil passes more active place in the presence of certain types of microorganisms, as well as their nutrient regime, but there are facts that have been obtained in the

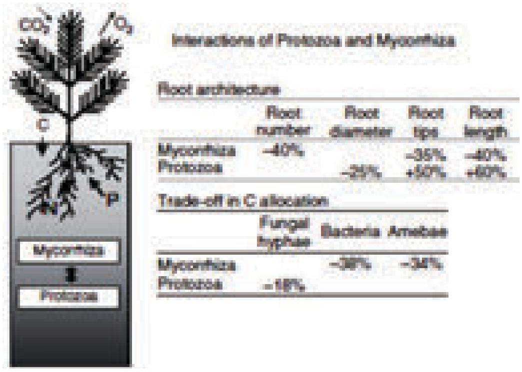

Fig. Schematic representation of a compromise in the C– division between rhizosphere and mycorrhizal symbionts microfauna [11]

study of potato (*Solanum tuberosum*), in which nematodes positively affect the vital indicators of bacteria *Comamona ssp.* These rhizosphere bacteria have a stimulating effect of growth, which opens the possibility of using this interaction of nematodes for the formation of bacterial metagenesis in the rhizosphere, ultimately determines the growth and development of plants that are using exudation determine the formation of the mikrobiome in the rhizosphere [22, 24, 27]. Interaction between rhizosphere organisms and protozoa is determined by the reaction of plants. Herbivorous microfauna inhabits and uses a vegetative aboveground and underground biomass plants, but in any case, causes in the root system of plants increased allocation of carbon compounds in the form of fluid and CO_2 emissions. Defoliation may increase the number of nematodes in the rhizosphere, it can also be linked to trophic increased production of exudates of plants in the rhizosphere. The balance of substance with carbon compounds in plants in the formation of various systems with microorganisms and interact with them varies depending on the phase of plant growth and the presence of herbivorous symbiotic mycorrhizal fungi and protozoa.

Conclusion

Thus, the interaction between plants and rhizosphere microfauna has a more complex organization than as previously thought in relation to nutrient regime, namely, functional differentiation of life determines the formation of a system of interaction with the plant and microfauna. At the heart of these interactions is the number of complex multi-level (from molecular to structural elements of plant tissues, such as pectin) biochemical interactions between plants and symbiotic micro flora , fauna against the background of the nutrient regime and physical properties of soil. These interactions also take place at various levels – within one specific plants and a plant biological community. It is known that the different nutrient content of the soil influence on the plants. Thus, growth and root development is determined by soil nutrient regime, which in the period to several hours by a system of plant rhizosphere receives certain signals. It remains an open question to what extent and what role, in terms of evolution, occupies a plant that is able to guide and regulate the flow of carbon to optimize their nutrient regime toward various members that form the system of the rhizosphere. Vital functions of soil fauna, flora, root system, herbivorous, predators formed in rhizosphere's system, which subsequently function as one coherent body. Rhizosphere's microfauna and its functional orientation with the successful study of the complex relationships in the future will provide an understanding of the mechanisms and enable form of governance and regulation rhizosphere's organisms using systematic approaches.

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АНОТАЦІЯ

Патика М.В., Доля М.М., Сахненко В.В., Колодяжний О.Ю. *Формування біологічних систем і контроль мікрофауни агрофітоценозів (стан питання) // Біоресурси і природокористування. – 2015. – **7**, № 5–6. – С. 5–10.*

Показано вплив мікрофауни на формування біологічних систем у ризосфері рослин. Доведено, що врахування усіх елементів ґрунтового біому є інтегральною складовою функціональної системи ризосфери агрофітоценозів і основою в управлінні цими компонентами.

АННОТАЦИЯ

Патыка Н. В., Доля Н. Н., Сахненко В. В., Колодяжный А. Ю. *Формирование биологических систем и контроль микрофауны агрофитоценозов (состояние вопроса) // Биоресурсы и природопользование. – 2015. –**7**, № 5–6. – С. 5–10.*

Рассмотрено влияние микрофауны на формирование биологических систем в ризосфере растений. Показано, что учет всех элементов почвенного биома является интегральной составляющей функциональной системы ризосферы агрофитоценозов и основой в управлении этими компонентами.