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Vera Popović[1], Ljubica Šarčević-Todosijević[2], Željka Đurišić[3], Vesna Gantner[4], Vladimir Filipović[5], Jelena Bošković[6], Aleksandar Stevanović[7], Nataša Ljubičić[8]

[1]Institute of Field and Vegetable Crops, Novi Sad, Serbia;
[2]High Medical - Sanitary School of Professional Studies, Belgrade, Serbia;
[3]Institute of Hydrometeorogy and Seismology, Podgorica, Montenegro;
[4]J.J. Strossmayer University of Osijek, Faculty of Agrobiotechnical Sciences, Croatia
[5]Institute of Medicinal Plant "Dr. Josif Pančić", Belgrade, Serbia;
[6]University of Metropolitan, Tadeuša Košćuška, Belgrade, Serbia;
[7]Academy of Applied Technical Studies, Belgrade, Serbia;
[8]University of Novi Sad, Biosens Institute, Novi Sad, Serbia;
*Corresponding author: ljsarcevic@gmail.com; drvvpopovic@gmail.com

THE SIGNIFICANCE OF AGROECOLOGY IN WATER AND SOIL PROTECTION

Abstract

The ecosystem is the central object of the study of ecology, while the central object of the study of agroecology is the agroecosystem. Agroecology applies ecological principles in the management of sustainable agroecosystems. Within the agroecosystem, it is very important to know the effect of ecological factors on the members of living communities, especially cultivated plants and soil microorganisms, because the productivity of the agroecosystem depends on them, the possibility of sustainable management of agroecosystems, as well as the protection of all environmental components, especially the water and soil.

Key words: agroecology, ecosystem, agroecosystem, ecological factors, soil protection.

INTRODUCTION

Ecology is a science that studies living organisms (biocenosis) and non-living environment (biotope), which living organisms inhabit and with which they stand in inseparable relationships, representing a unique ecosystem. The pursuit of higher profits

and the uncontrolled use of natural resources in order to reduce hunger in underdeveloped countries significantly disrupts environment. The negative consequences of conventional agriculture are: degradation of soil, uncontrolled application of artificial fertilizers, pesticides, antibiotics and growth stimulants, use of GMOs and climate change. Soil is a non-renewable natural resource. Sustainable soil management and other natural resources should be the most important part of every country's policy. The green economy in agriculture aims to develop organic agriculture, with the aim of preserving the soil and producing organic and safe food. In this sense, agroecology, which applies ecological principles in the management of sustainable agroecosystems, is particularly important (Stevanović and Janković, 2001; Molnar et al., 2003; Popović, 2015).

This study discusses the concepts and principles of agroecology, the influence of environmental factors and their importance for cultivated plants, as well as the importance of agroecology in soil protection.

Principles and importance of agroecology in sustainable management of natural resources and soil protection

Ecology is a science that studies living organisms (biocenosis) and non-living environment (biotope), which living organisms inhabit. Biotope and biocenosis represent a unique system - ecosystem. The ecosystem is the central object of the study of ecology, while the central object of the study of agroecology is the agroecosystem. Agroecosystems are land areas on which different types of cultural plants are grown, which are used in food or in industry. The biosphere refers to all life phenomena on the planet or on a part of the planet where life exists. The biosphere can also be defined as a gigantic ecosystem, within which all biological macrosystems are united in one. Throughout the biosphere, a unique and relatively simple principle is maintained: the flow of energy and the circulation of matter (Janković, 1975; Stevanović and Janković, 2001; Molnar et al., 2003).

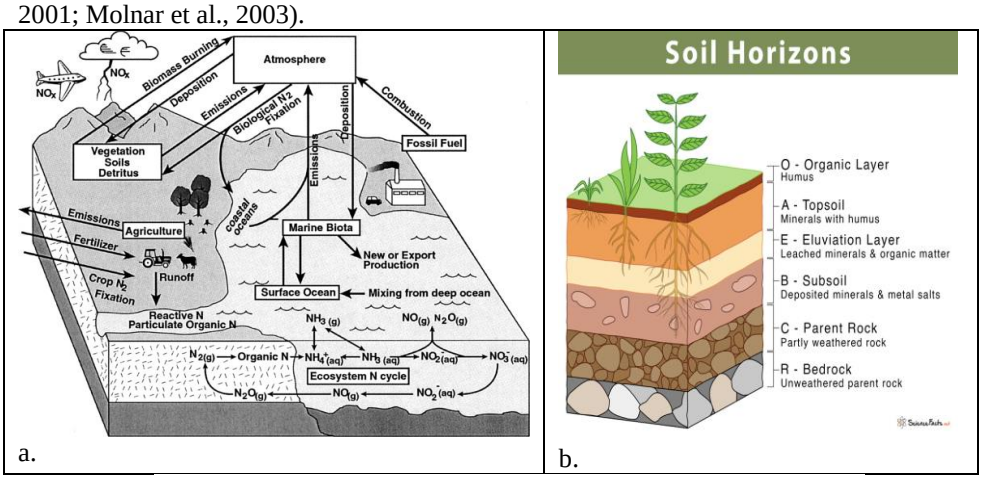

Figure 1. a) The nitrogen cycle in the ecosystems, b) soil horizons,

(source a: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/nitrogen-cycle, source b: https://www.sciencefacts.net/soil-horizons.html)

The flow of energy means the flow of solar energy, which is bound as potential chemical energy in organic compounds by green plants through the process of photosynthesis. Later in the course of the metabolic processes of organisms, primarily in the process of breathing, it is gradually released and transformed into heat energy, which is lost into space. New amounts of solar energy are included in the processes again, so the flow of energy through the biosphere takes place without interruption. The circulation of matter through the biosphere represents a principle realized by more complex principles, but still simple in essence. It is the circulation of matter through food chains. In the process of circulation of matter in the biosphere, the first place belongs to green plants, which produce primary organic matter through photosynthesis from inorganic matter in the presence of solar energy. Plant and animal remains are decomposed by soil microorganisms into mineral components. Green plants re-incorporate mineral substances into the circulation of matter in the biosphere, which continues in this way. Cycles of matter are particularly important in agroecosystems because the productivity of the agroecosystem is based on them. Since these processes in agroecosystems, as well as ecosystems in general, depend on living organisms, it is very important to ensure the preservation of biodiversity (Janković, 1975).

Within the agroecosystem, it is very important to know the effect of environmental factors on the members of the biocenosis because the productivity of the agroecosystem depends on them. Thanks to this knowledge, the possibility of sustainable management of agroecosystems increases. Ecological factors are life factors on which the life of species and communities depends and represent all actions and influences that come from the external environment. Each organism can survive in a limited range of conditions. Ecological valence or ecological amplitude is the amplitude of variation of an ecological factor, within the limits of which the life of any biological species is possible. The values of ecological valence are the minimum and maximum, as the end and limit values of the action of an ecological factor, within which the life of any species is possible. Depending on the width of ecological valence in relation to some factor, organisms are divided into eurivalent and stenovalent. Optimum is the most favorable area for life processes (Pavlović and Radović, 2014; Ikanović and Popović, 2020; Ikanović et al., 2020). From the aspect of knowing the effect of environmental factors on cultivated plants within the agroecosystem, it is very important to determine the optimal area of action of environmental factors, with the aim of achieving maximum productivity of the agroecosystem, with minimal pollution of the soil and other components of the environment.

Climate, abiotic and biotic ecological factors

Ecological factors are related to non-living and living nature, so they are divided into: abiotic and biotic factors. Abiotic factors are physical and chemical environmental conditions. The effects of all organisms on a living individual constitute biotic factors. A human being is also an integral part of nature. Human influence is referred to as an anthropogenic factor (Stevanović and Janković, 2001; Pavlović and Radović, 2014; Šarčević-Todosijević et al., 2019a,b). Climate represents the average state of weather

elements in one place, observed for a longer period of time, at least for ten years. The influence of climate on living organisms is very significant. Climate is a complex vegetation factor, and its basic elements are: light, heat, air and water. Climate change and extreme weather conditions, especially floods and droughts and their consequences, represent a challenge for various cultivated plants. Light is one of the most important factors affecting the variability of plant organs morphology. With an insufficient amount of light, the plant undergoes major morphological changes. The leaves of the light are thicker and harder, hairier, with large but less numerous nerves, a small area of the leaf and a shorter stem than the leaf of the shadow. The leaves of the shadow are thin, smooth, larger in size, and paler in color (Molnar et al., 2003; Oljača, 2008; Pavlović and Radović, 2014; Šarčević-Todosijević et al., 2019a; Ikanović et al., 2020; Šarčević-Todosijević et al., 2023). The length of day and night changes during the year, which affects the transition of plants from the vegetative to the generative phase of growth. In relation to the reaction of plants to the length of day and night, i.e. according to the photoperiod reaction, plants are divided into long-day plants, short-day plants and neutral plants.

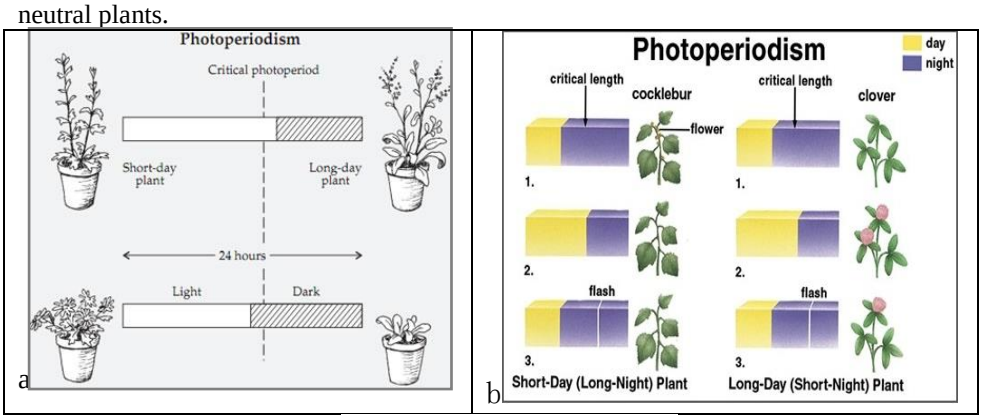

Figure 2. Photoperiodism a, b.
(source a: http://lifeofplant.blogspot.com/2011/03/photoperiodism.html,
source b: https://botanystudies.com/discovery-of-photoperiodism-in-plants/)

The light stage is the period of plant development towards the stage of flowering and fruit formation. Long-day plants (rye, wheat, barley, oats, flax, clover, cabbage, beets, onions, sugar beets, beans, peas, spinach) need a longer period of lighting during the day. If they do not receive a certain amount of light, they will not flower, but will develop vegetatively. Short-day plants (millet, soybean, rice, corn, hemp) do not require a light stage before flowering. Each stage of plant development takes place at certain lengths of daylight. Neutral plants (sunflower, buckwheat, asparagus, raspberry, tomato, cucumber) bloom and bear fruit regardless of the length of the day. High temperatures can affect the plant directly, causing its destruction, or indirectly, through the soil. The high temperature of the soil affects the root system, by drying the soil, the water supply decreases. There is often a mutually unfavorable effect of high temperatures and lack of water. Plant species are more or less adapted to temperature fluctuations and extreme temperatures. Physiological adaptation of plants that tolerate high temperatures includes

changes in three basic processes: increased transpiration, increased salt concentration in cells, and rejection of strong heat rays from the sun. The protective effect of plants against the harmful effects of low temperatures is reflected in the reduction of water circulation from cells to intercellular spaces. Optimal temperatures for the photosynthesis process of most plants range from 25 to 35ºC. Air as an element of the climate has a relatively constant composition, it contains: about 78% nitrogen, about 21% oxygen, about 1% argon and other gases and about 0.03% carbon dioxide. Oxygen and carbon dioxide from the air are of greatest importance to plants. With a gradual increase in CO_2 in the air, from 0.1 to 0.2%, the intensity of photosynthesis increases. Chloroplasts are adapted to the concentration of CO_2, they are smaller if the concentration of CO_2 is lower (eg at higher altitudes). Water is the basic factor for the life of every organism and without it survival is impossible. The main role of water is participation in biochemical and physiological processes in the plant organism. If the plant does not have enough water, physiological processes will be slower or will not take place. The plant receives water through the root system through the process of osmosis, and for this process it is necessary that the intracellular concentration is higher than the concentration of water in the soil. Lack of water in plants is caused by drought or increased transpiration and slows down plant growth (Stevanović and Janković, 2001; Molnar et al., 2003; Oljača, 2008; Pavlović and Radović, 2014; Ristić and Komatina, 2014; Šarčević-Todosijević et al., 2019a).

Soil is a surface layer, which is created by the combined action of the atmosphere, hydrosphere and biosphere in the process of pedogenesis. Fertile soil must have a good structure. The negative consequences of conventional agriculture are: the degradation of agricultural land, the consequences of the use of artificial fertilizers, pesticides, antibiotics and growth stimulants, the use of GMOs and climate change (Molnar et al., 2003; Popović, 2015; Stevanović et al., 2019). Agricultural production is still not possible without the use of pesticides, which include more than ten thousand preparations based on 600 chemical compounds. During the intensive application of pesticides, they accumulate in the soil, and through vegetable crops, they enter the food chain and reach the human organism and exhibit biological effects. In addition, pesticides enter groundwater, river flows, and drinking water. The maximum permissible amounts of pesticides and their decomposition products, which can be present in food without causing health damage to the human organism, have been established, and these amounts must not be exceeded during the application of pesticides (Đukić at al., 2007, Stajkovac et al., 2009; Bagi and Bodnar, 2012; Đorđević et al., 2021, Šarčević-Todosijević et al., 2022).

Intensive production requires large investments in plant production. New varieties that achieve high yields require intensive agricultural techniques, balanced and correct fertilization and proper and timely protection against diseases, pests and weeds. From the perspective of soil protection, preventive protection measures are especially important: crop rotation, use of declared seeds, use of more resistant varieties, etc. Field crops during the growing season and grains in storage are attacked by a large number of pests, insects and rodents. Protection is carried out by monitoring their presence in the soil, on plants and in warehouses during the growing season. Soil insecticides should only be used if analyzes of soil samples indicate that insect populations may threaten the

crop. Insecticides are introduced into the soil by sowing crops or treating seeds with insecticides (Glamočlija et al., 2015). If pesticides were not used for one year, diseases, harmful insects and weeds would reduce world food production by 25-30%, and losses of stored products would increase by 15%. Due to the negative impact of certain pesticides on the environment and human health, more and more pesticides are being withdrawn from use, which represents a challenge for plant protection. The risk of plant diseases remains the same or increases due to climate change, and it is necessary to develop biological methods of controlling phytopathogens and pests, i.e. biopesticides (Laćarac, 2021). Reducing the use of pesticides, along with the intensification of the preventive and biological protection measures, are the basic goals of sustainable agriculture. By applying biopesticides and allelopathic substances, as biological preparations for protecting plants from harmful organisms, the mechanisms of ecologically safe protection of plants from pests are encouraged. Antagonistic microorganisms show growth suppression of various phytopathogens, with small or no negative side effects on the environment (Đukić et al., 2007; Popović et al., 2019; Stevanović et al., 2019; Đorđević et al., 2021; Šarčević-Todosijević et al., 2019b; Šarčević-Todosijević et al., 2022). Methods of integral protection of plants, with the application of various biological agents, biopesticides, are the basis for the improvement of plant-based and health-safe food production.

CONCLUSION

Ecology is the science that studies relationships in an ecosystem. A particularly important part of ecology is agroecology, which applies ecological principles in the management of sustainable agroecosystems. Within the agroecosystem, it is very important to know the effect of ecological factors on the members of biocenosis, especially cultivated plants and soil microorganisms, because the productivity of the agroecosystem depends on them. Thanks to this knowledge, the possibility of sustainable management of agroecosystems increases, as well as the protection of all components of the environment, especially soil. In order to protect plants with less risk, it is desirable to introduce biopesticide preparations as a measure in agricultural production.

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[1]Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija;
[2]VZSŠSS "Visan", Beograd, Srbija;
[3]Zavod za hidrometeorologiju i seizmologiju, Podgorica, Crna Gora;
[4]Univerzitet J.J. Strosmaiera u Osijeku, Fakultet Agrobiotehničkih nauka, Hrvatska
[5]Institut za proučavanje lekovitog bilja "Dr. Josif Pančić", Beograd, Srbija;
[6]Univerzitet Metropolitan, Tadeuša Košćuška 63, Beograd, Srbija;
[7]Akademija tehničkih strukovnih studija, Beograd, Srbija;
[8]Univerzitet u Novom Sadu, Institut Biosens, Novi Sad, Srbija;
*Odgovorni autor: ljsarcevic@gmail.com; drvvpopovic@gmail.com

ZNAČAJ AGROEKOLOGIJE U ZAŠTITI VODE I ZEMLJIŠTA

Apstrakt

Ekosistem je centralni objekat proučavanja ekologije, dok je centralni objekat proučavanja agroekologije agroekosistem. Agroekologija primenjuje ekološke principe u upravljanju održivim agroekosistemima. Unutar agroekosistema, veoma je značajno poznavati dejstvo ekoloških faktora na članove životnih zajednica, naročito gajene biljke i mikroorganizme zemljišta, jer od njih zavisi produktivnost agroekosistema, mogućnost održivog upravljanja agroekosistemima, kao i zaštita svih komponenti životne sredine, a naročito vode i zemljišta.

Ključne reči: agroekologija, ekosistem, agroekosistem, ekološki faktori, zaštita vode i zemljišta.

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