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Activity of soil biota in the modern soil cover of Ujar, Kurdamir, and Salyan regions

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Abstract

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Studying the current state of biological activity in soils across different seasons of the year is crucial for environmental assessment of the territory. For the first time in the Republic of Azerbaijan, vermicomposts were prepared using sawdust and earthworms (*Eisenia fethida*) and introduced into agroecosystem landscapes of beans (*Phaseolus vulgaris*), wheat (*Triticum aestivum*), and corn (*Zea mays*). The article presents studies that reflect some results of soil bioactivity. The results of soil studies conducted using modern methods in selected biotopes of the Kurdamir, Salyan, and Ujar regions can be utilized by young researchers as a valuable source of information. It was found that the energy efficiency of vermicompost applied in doses of 3 and 6 t/ha varies from 1.7 to 3.1 units. The use of vermicompost in an amount of 1.5 t/ha contributed to an increase in energy efficiency to 3.8 units. The use of sawdust + cow manure affected the growth of the studied plants and the amount of chlorophyll in the leaves. When adding sawdust, it increased to 16.6, and when adding vermicompost, it increased to 17.8.

Keywords: environmental indicators; biological processes; vermicompost; soil fertility; bioactivity

Introduction

In recent decades, due to the urgent need for recycling agricultural and household organic waste, vermicomposting technology has been widely adopted, providing a deeper processing of conventional composts prepared from garbage (Davies and Linderman, 1991). Soil salinization occurs under the influence of both natural and anthropogenic factors, causing significant harm to agriculture. Globally, approximately 20% of irrigated lands are salinized (Petrochenko et al. 2019). The use of vermicompost contributes to a significant increase in the productivity of field crops. In the future, it is essential to utilize composts as one of the environmentally friendly methods for enhancing the productivity of arable areas on these lands (Moyin-Jesu, 2007). Several new preparations are currently used in the cultivation of vegetable crops, including vermicompost, which is produced by processing various organic wastes with the help of earthworms. The positive effect of vermicompost on the growth and productivity of agricultural plants is widely recognized (FAO, 2006). A large number of publications have been devoted to studying the influence of vermicomposts obtained from processing organic waste on crops. It has been established that vermicomposts are non-toxic in crop production and do not harm the environment or plants. Economically, vermicompost is cheaper than peat (Nasirova and Verdiyeva, 2023). The preparation of vermicompost using earthworms is not only inexpensive but also allows for achieving high biological activity. The rise of agricultural and industrial production, as well as the development of science and technology, has, in many cases, a negative impact on ecosystems. This important issue focuses on people and the environment, air, soil, and water – issues considered fundamental to the existence of all life.

The protection and restoration of nature should become the core activity of society. In recent years, the preparation of nutrient-rich composts from organic waste has become widespread (Macnunlu et al. 2025). The role of organic fertilizers in intensifying agriculture requires the development of new organic fertilizer resources. The use of polluting waste as an organic fertilizer has become widespread. In this regard, the use of vermicomposts was of great importance. Compared to manure, the toxicity of vermicomposts is significantly lower. Since pollution by organic waste is both a social problem and a key environmental issue, the preparation of vermicomposts from these wastes and their use for various crops is a relevant and urgent issue in the country. Given the relevance of the problem, our study investigated the effect of vermicomposts on the development of legumes, cereals, and corn.

The study area is located in the central part of the Shirvan Plain, and groundwater occurs at a depth of 2-3 meters. Gray-meadow soils of agrocenoses have been altered as a result of long-term anthropogenic impact (Ismayilov et al., 2025). They contain an irrigation horizon 75-90 cm thick and are characterized by varying particle size distribution (Ismayilova et al. 2025). The content of particles larger than 0.01 mm ranges from 10.7% to 68.1%. Total carbonates range from 9-17%, humus – from 1.75-3.96%, the sum of absorbed bases – 10.74-36.85 mmol (eq)/100 g, pH – 7.7-8.4. These territories have potentially fertile soils for both crop and livestock production. It is for this reason that the first soil studies in Azerbaijan were carried out in the Kur-Araz lowland (Nasirova et al., 2025; Mustafayeva et al., 2024).

Data and Methods

The object of study is grey-meadow soils, which are long-term irrigated with turbid water, supplying 2000–4000 kg/ha of water-soluble salts (FAO, 2006). The research was conducted in a field experiment with vegetation in vessels without bottoms (vessel diameter: 50 cm). The study begins with a developmental field analysis. 100 ml of substrates are taken into special containers, and a mass of 1 cm^3 is weighed as the samples dry regularly. Drying is done in a microwave oven. A phytotoxicity test to evaluate vermicomposts was carried out, and the results were determined by oven drying at 600°C for 72 hours, according to the method described by F. Zucconi and M. Forte. Plastic boxes measuring 100x50x-30cm were used (Zucconi et al. 1981). Three-centimeter holes are made in the walls and floors of the boxes. The holes are closed with a fine wire mesh, and cow dung and sawdust (in an 80:20 volume ratio, respectively) are pressed into them. Additionally, cow dung and earthworm press (in an 80:20 volume ratio) are also pressed into them. Moreover, raw materials are poured. The boxes are kept in the shade to create optimal temperature and humidity. Soil samples were collected and analyzed to determine their physicochemical and biological properties using methods generally accepted in ecology and soil science (Khodakivska et al. 2017). Mapping was used to select sampling sites. Classification diagnostics were performed according to the soil genetic classification system. The process is followed for about three months, and the vermicompost is considered ready. Its agrochemical and physicochemical properties were studied

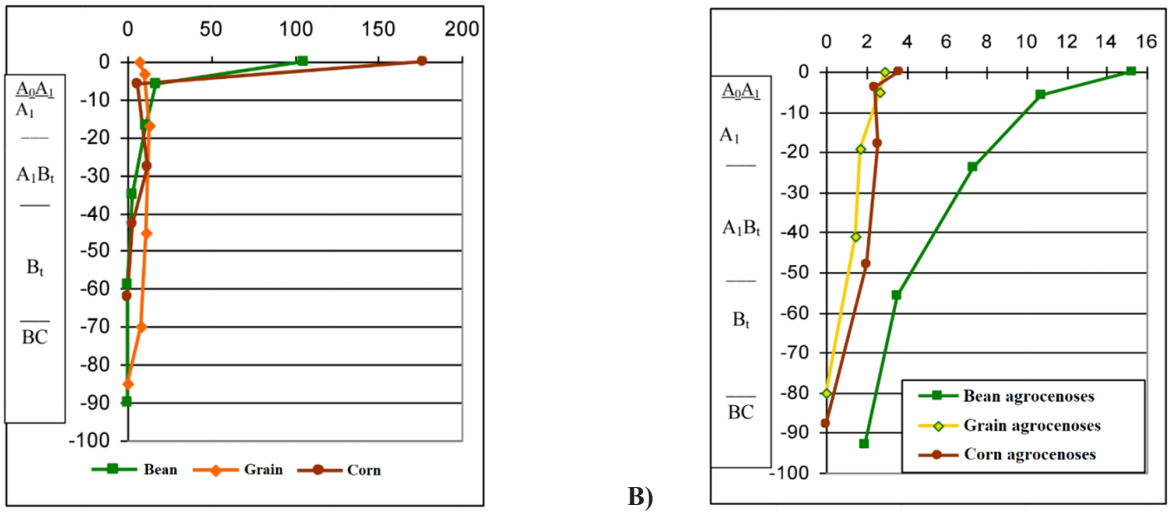

Fig. 1. Comparative analysis of the soil enzymes in different biotopes
Profile distribution of invertase (A) and catalase (B) activity in soils under Bean, Grain, Corn agrocenoses.
Source: Authors' own elaboration

to determine the usefulness of vermicompost as an organic fertilizer. For adequate gas exchange, air-filled pores should comprise at least 15% of the substrate in which plants are grown; however, in reality, porosity for plants should ideally be 20-35% of the substrate volume (Rowell, 1994; Shukurov et al. 2025).

Results

The soils of the Salyan, Ujar, and Kurdamir districts, which have had a significant impact on the development of agriculture in Azerbaijan in recent years, were chosen as the object of study. The author for the first time recommended

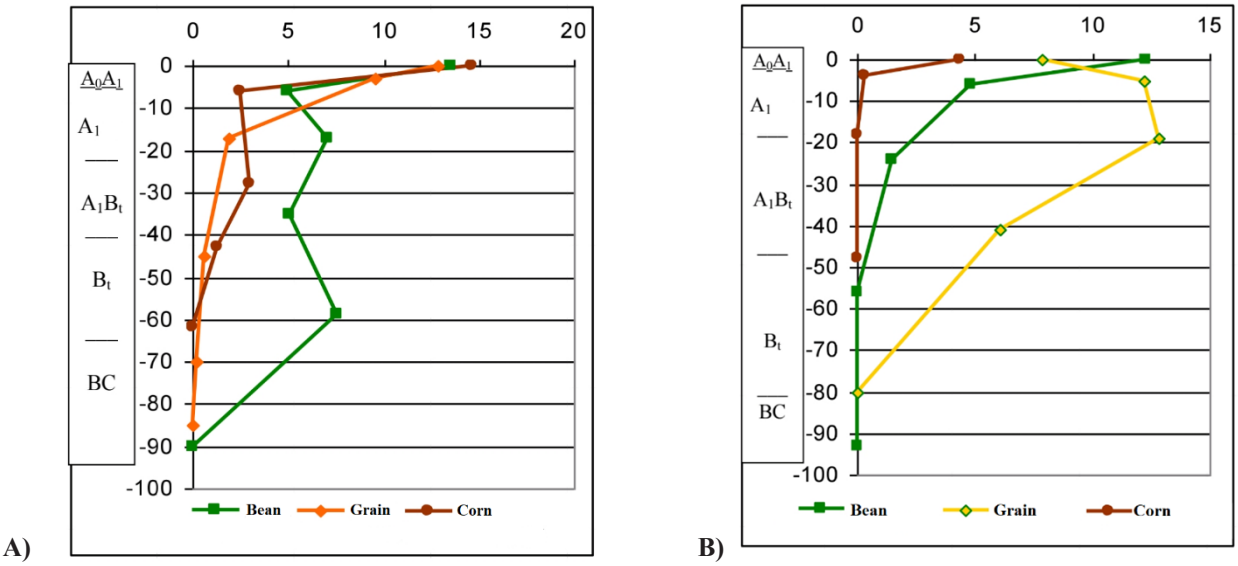

Fig. 2. Comparative analysis of the soil urease enzyme in different biotopes
Profile distribution of urease enzyme activity in control (A) and urease enzyme activity after vermicompost (B) in soils under bean, grain, and corn agrocenoses.
Source: Authors' own elaboration

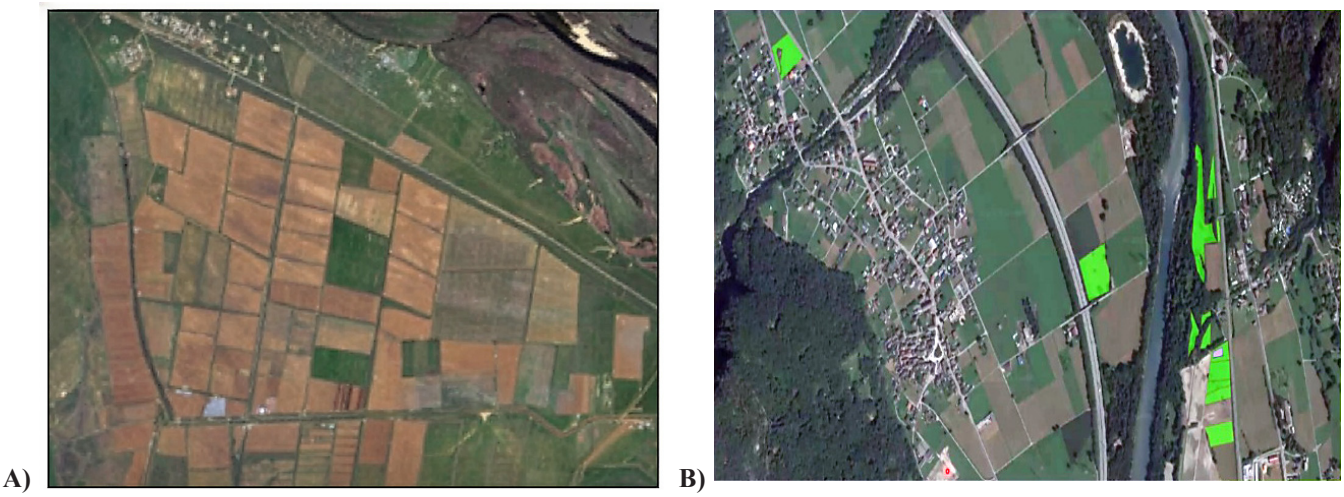

Fig. 3. a. Multispectral image of irrigated lands (Salyan region) obtained from Landsat-5 5 satellite on 16/06/2023; b. Orthophotography of the areas where land sections are placed
Source: Authors' own elaboration

the preparation and use of vermicomposts, which can contribute to increasing the productivity of agricultural land in these fixed fields. The study used 20 plants (beans, corn, and grains) in triplicate. Beans were planted on May 18, at a planting density of 9 plants per square meter. Root feeding of plants with silicon-containing preparations was carried out twice during the growing season (at the beginning of flower bud formation and at the beginning of flowering). Differences in the activity of invertase and catalase enzymes along the profile of soil pits sown with fields of beans, grains, and corn are shown (Figure 1. A; B).

Differences in urease enzyme activity were shown along the profile in soil sections planted in bean, grain, and corn fields. Profile distribution of urease enzyme activity in control and after vermicompost (Figure 2. A; B).

Since the lands of the Salyan region have been used for arable farming for many years, the influence of anthropogenic factors is felt here at first glance. Multi-spectral satellite imagery and orthophotography of the territories show the current state of irrigated lands (Figure 3 A; B).

Sample sites, agricultural areas and borders of Kurdamir, Salyan and Ujar regions are shown in map (Figure 4).

It has been determined that 18.93% of the high-quality group lands in the lowland are used for arable farming (Figure 5 A). More than half of the territory is affected by erosion to varying degrees, with weak erosion being the most common (Figure 5 B).

During the study period, not a single earthworm died in any of the waste. The maximum biomass of earthworms is achieved through vermicomposting with cow dung, and the minimum is observed in a mixture of cow manure and sawdust. The maximum mass of worms was observed in the seventh week, using cow dung waste. The use of sawdust + cow manure affected the growth of the studied plants and the amount of chlorophyll in the leaves. When adding sawdust, it increased to 16.6, and when adding vermicompost,

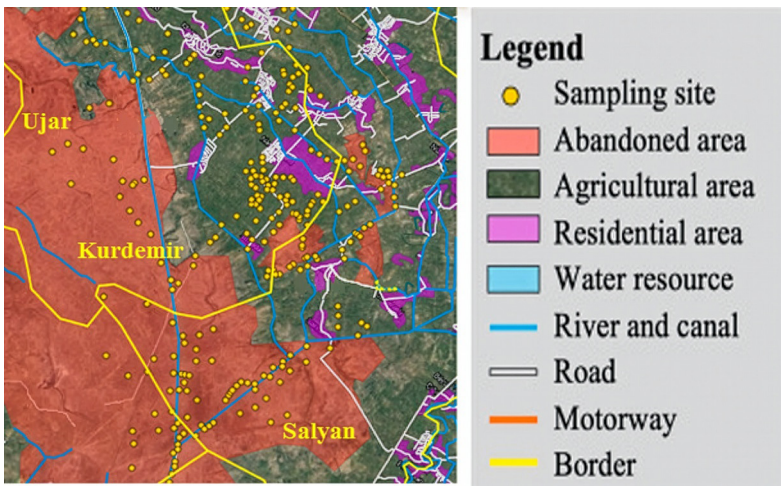

Fig. 4. Satellite map of the study area, location of soil sampling sites, and land use classification of the Ujar, Kurdamir, and Salyan regions in Mugan Plain, Republic of Azerbaijan
Source: Authors' own elaboration

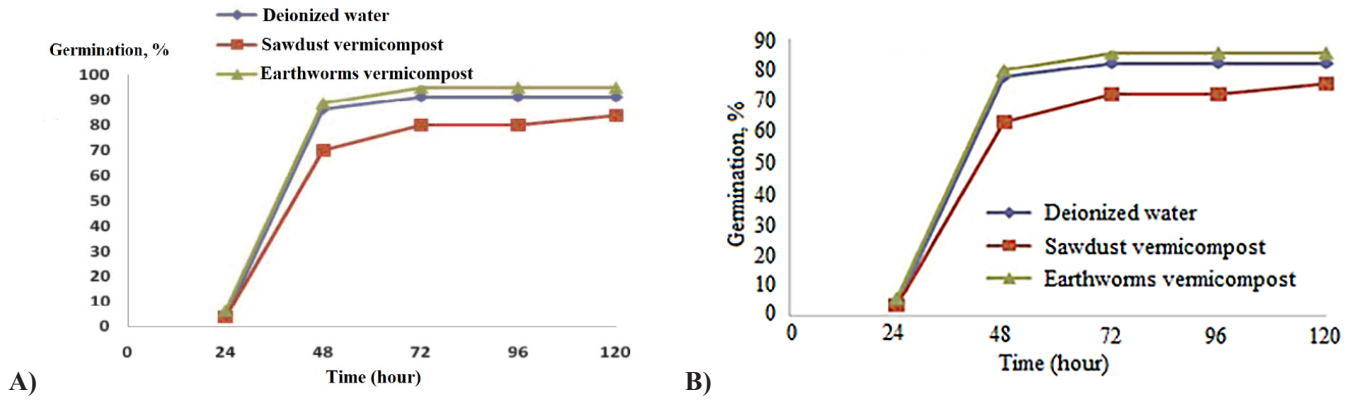

Fig. 5. Percentage of germination of bean seeds in sawdust extracts and vermicompost of *Eisenia foetida* press
Source: Authors' own elaboration

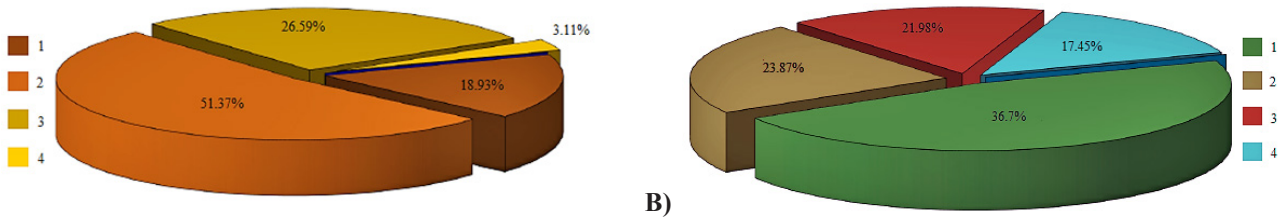

Fig. 6 A. Distribution of Arable soils in the Salyan region by QG (Quality Groups):
1 – good-quality soils; 2 – medium-quality soils; 3 – high-quality; 4 – soils low-quality soils
B. Land Erosion in the Salyan region:
1 – Moderately eroded; 2 – Weekly eroded; 3 – Severely eroded; 4 – Not eroded
Source: Authors' own elaboration

it increased to 17.8. It was found that 9.1 was present in the control variant before the study (Figure 5).

Conclusion

The variants with the addition of sawdust and earthworms to the substrate showed an increase in the amount of macro- and microelements compared to the control; the maximum amount of macro- and microelements was observed in substrates containing 60% sawdust or 60% earthworms. It has been established that the amount of nutrients in vermicomposts obtained from earthworms and sawdust has increased. The results showed that an increase in the amount of vermicompost led to an increase in the overall density of the substrate, a decrease in air-filled porosity, volumetric capacity, and humidity. However, among the options for combating these effects, no significant difference was observed. The results showed that sawdust and sugarcane waste vermicompost using earthworm *(Eisenia fetida)* preparation is important, and no toxicity to plants has been observed. The highest corn yield achieved over the years of research was 31.0 c/ha, resulting from the combined use of mineral fertilizers and vermicompost. The yield increase was higher in the same variant and amounted to 10.0 c/ha. The addition of vermicompost in optimal doses will increase the level of soil fertility and improve the nutritional regime, as well as the physical and mechanical properties of the soil, especially in unstable climatic conditions and eroded soils. Also, the systematic use of vermicompost helps to increase the yield and quality of grain. It was found that the energy efficiency of vermicompost applied in doses of 3 and 6 t/ha varies from 1.7 to 3.1 units. The use of vermicompost in an amount of 1.5 t/ha contributed to an increase in energy efficiency to 3.8 units.

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