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The Effect of Organic Fertilizers on Nutrient Absorption in Different Agrocenoses of Brown Meadow Soils of Shirvan

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Abstract. *The cultivation of agricultural crops involves intensive interactions between humans and nature, often resulting in soil degradation and reduced fertility. This study examines the impact of organic fertilizers on the fertility and agrochemical properties of brown meadow soils in the Shirvan Plain of Azerbaijan. The main objective was to evaluate the effectiveness of organic fertilizers, particularly manure, in improving soil characteristics and nutrient availability under irrigated vegetable crops. Field experiments and laboratory analyses were conducted to assess soil properties at different depths, including humus content, nitrogen, phosphorus, potassium, density, and porosity. The results demonstrated that the application of organic fertilizers significantly increased humus content and essential nutrients, improved soil structure, and enhanced microbial activity. The formation of water-resistant aggregates was also observed, contributing to greater soil stability. Overall, the findings indicate that the consistent use of organic fertilizers supports the restoration of soil fertility and promotes sustainable agricultural development.*

Keywords: *soil fertility, organic fertilizers, humus, nutrients, soil properties*

Introduction

In 2016, in order to develop the non-oil sector in the national economy of the country, a "Strategic Roadmap" on the production and processing of agricultural products was developed in the Republic of Azerbaijan. Based on the principles of sustainable development, this document aims to strengthen food security, increase the production potential of agricultural products, and improve the quality of education and scientific support during 2016–2020.

The Shirvan Plain is located in the northern part of the Kura-Araz lowland and stretches along the left bank of the Kura River, from the Bozdag mountain range to the desert zone. The irrigation and reclamation system of this plain is mainly associated with the Mingachevir reservoir, which regulates the water regime of the Kura River. The Shirvan zone is divided into mountainous and lowland areas.

The total area of the region is 1,134 thousand hectares, of which 652 thousand hectares are used in agricultural production. The sown area is 247 thousand hectares, including 175 thousand hectares under irrigation. However, up to 70% of the lands in the Shirvan Plain are currently not used in agriculture due to insufficient water resources, repeated soil salinization, and other limiting factors.

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According to long-term observations, the first autumn frosts occur in late November to early December, while the last spring frosts are observed between April 4 and 7. The duration of frost-free days is 240–260 days. During the study years, meteorological indicators were close to long-term averages. Climatic conditions play a crucial role in the formation and differentiation of landscapes and directly influence soil properties and agricultural productivity (Paustian et al., 2016).

In this context, the study of soil properties and the role of organic fertilizers in irrigated agricultural systems becomes particularly important. The impact of organic fertilizers on the structural composition and physical properties of soils under irrigated vegetable crops in brown meadow soils of the Ujar region has not been sufficiently studied. Soil structure, particularly the formation of water-resistant aggregates, significantly affects soil density and porosity (Deru et al., 2023).

Atmospheric precipitation is one of the key factors influencing plant development (Lehmann & Kleber, 2015). Due to insufficient rainfall in the Shirvan region, agricultural lands are artificially irrigated, which contributes to the accumulation of moisture in the soil. During hot periods, this moisture partially compensates for losses caused by intensive evaporation. Soil processes and plant development are closely related to air humidity (Lal, 2015).

K.A.Alekperov and A.G.Zeynalov determined that in brown soils the humus content in deep layers is low and amounts to 1.5−2.5%, and the carbonate content in deep layers is 15−20%. Brown meadow soils develop in the central part of the plain, while carbonate soils develop in the depressions. According to R.Kh.Mamedov, the humus content in these soils is 2−3%, corresponding to 300-400 tons per hectare. In brown meadow soils, humus content ranges from 2–3%, corresponding to 300–400 tons per hectar. Humus plays a key role in soil fertility as it contains essential nutrients, improves physical and chemical properties, and enhances biological activity (Lal, 2016; Jafarov, 2023).

The formation of humus occurs in two stages: decomposition of complex organic compounds and synthesis of humus substances from intermediate products (Deru et al., 2023). Organic fertilizers, including manure, peat, and green manure crops, contribute to increasing humus content, improving soil structure, and enhancing microbial activity (Allam et al., 2022; Sedlář et al., 2023).

Therefore, the main objective of this study was to determine the optimal dose of organic fertilizers applied to vegetable crops in brown meadow soils of the Shirvan Plain and to assess their impact on soil fertility, nutrient uptake by plants, and nutrient utilization efficiency.

Materials and Methods

The study was conducted on brown meadow soils in the Shirvan Plain, specifically in the Ujar region, under irrigated conditions. The research focused on vegetable crops cultivated in this area.

Soil samples were collected from different depths of the soil profile, including 0–20, 20–40, 40–60, and 60–80 cm layers, to evaluate the mechanical and physical properties of the soil.

The study included the investigation of soil-climatic conditions of the research area, as well as the analysis of agrochemical, agrophysical, and hydrophysical properties of the soil. Particular attention was given to soil structure, density, porosity, and the formation of water-resistant aggregates.

Organic fertilizers were applied to assess their effect on soil fertility, nutrient dynamics, and plant nutrient uptake. The influence of these fertilizers on soil structural parameters and nutrient utilization efficiency was evaluated based on observed changes in soil properties and plant development (Tong et al., 2022).

Results and Discussion

The main property of soil is its fertility. Fertility is the soil's ability to provide air, water, and nutrients for the normal survival and fruiting of plants.

Table 1
Mechanical and physical composition of soils in the experimental plot

Depth, cm	Number of water-resistant units, %							Physical properties	
	>7	7–5	5–3	3–1	1–0,25	>0,25	<0,25	Density, q/cm^3	Porosity, %
0–20	7,0	9,4	10,4	15,1	20,8	63,5	36,5	1,00	57,00
20–40	7,0	10,0	9,9	13,0	22,0	48,0	33,0	1,13	51,25
40–60	6,8	8,8	8,0	10,0	19,8	44,0	35,0	1,23	50,05
60–80	6,1	7,0	6,5	–	–	36,0	30,6	1,39	45,50
				–	–	31,0	24,5	1,64	44,55

Table 1 shows that the number of relatively large aggregates with particles from 7 mm is 70%, with particles within 7–5 mm – 9.4%, 5–3 mm – 10.4% and 3–1 mm – 15.1%.

It is known that the role of organic fertilizers in the formation of aggregates resistant to water is great. Silt particles and organic compounds combine to increase the number of aggregates resistant to water. This process occurs most intensively in a humid environment. At the same time, during this period, with an increase in the activity of microbiological processes, the relationship between soil aggregates increases. Therefore, such soils are characterized by a rich content of aggregates with higher resistance to water (Fan et al., 2023).

It is known that the development of vegetable crops and their yields depend on the amount of nutrients in the soil. Knowing the potential fertility of the soil, it is possible to determine the variety and rate of organic fertilizers used for tomatoes. Properly selected fertilizers promote the transfer of soil nutrients into a form that is easily assimilated by plants.

Organic fertilizers, along with enriching the soil with essential nutrients for plants, also improve its overall agrochemical properties. The agrochemical features of the brown meadow soils of the Ujar region in the study area are given in Table 2.

Table 2
Agrochemical characteristics of brown meadow soils of the Ujar district

Depth, cm	Ph (water)	Humus, %	Nitrogen General, %	Nitrogen Assimilated N-NH_4 mg/kg	Phosphorus General, %	Phosphorus Mobile P_2O_5 mg/kg	Potassium General %	Potassium Exchange K_2O mg/kg
0-20	7,2	2,73	0,25	33,4	0,15	16,2	2,62	241,0
20-40	7,5	2,00	0,13	28,5	0,12	14,4	2,36	240,0
40-60	7,7	1,66	0,11	21,7	0,07	11,8	1,23	125,2
60-80	7,8	0,55	0,05	13,2	–	8,7	1,15	100,7

Organic fertilizers, including manure, are of great importance for increasing soil fertility, improving its physicochemical properties, as well as increasing plant productivity and quality (Acar et al., 2025).

To increase soil fertility, siderate plants are considered one of the best remedies. Sideral crops are considered the best way to increase soil fertility. Siderates are plants whose green mass enriches the soil with organic substances and nitrogen. Siderates have long been used in agricultural practice (Lehmann, 2020).

Conclusion

The application of organic fertilizers in brown meadow soils of the Shirvan Plain significantly influenced the availability of nutrients for plant uptake. In the treatment with 30 tons of manure, the content of ammonium nitrogen in the arable and sub-arable layers ranged from 16.21 to 13.20 mg/kg, nitrate nitrogen from 4.95 to 3.97 mg/kg, mobile phosphorus from 15.33 to 13.00 mg/kg, and exchangeable potassium from 225.00 to 211.00 mg/kg.

The results indicate that organic fertilizers not only increase the content of essential nutrients in the soil but also improve its overall agrochemical properties. This confirms the effectiveness of organic fertilizers in enhancing soil fertility and supporting sustainable agricultural production in the region.

Declaration of Competing Interests

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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