



THE EFFECT OF HALOPHYTE PLANT CULTIVATION ON THE AGROCHEMICAL PROPERTIES OF SOIL

Saliyeva Aygerim Maxashovna

1st-year Master's student in Agrochemistry specialty,
Karakalpakstan Institute of Agriculture and Agrotechnologies

<https://doi.org/10.5281/zenodo.15674437>

Abstract. Halophyte plants play a vital role in improving the agrochemical properties of saline soils. They reduce soil salinity, increase organic matter, improve nutrient availability, and support microbial activity. This article highlights their impact, showing how halophytes contribute to soil fertility and sustainable agriculture in salt-affected areas.

Keywords: halophytes, saline soils, soil fertility, organic matter, sustainable agriculture.

Introduction. Soil degradation due to salinization is a pressing global issue, particularly in arid and semi-arid regions. As soil salinity increases, the productivity of agricultural land declines, ultimately threatening food security. However, the introduction of halophyte plants—species adapted to high-salinity conditions—offers a potential solution. Halophytes not only survive in saline environments but also contribute to improving the agrochemical properties of soils. This article explores the influence of halophyte plants on soil agrochemistry, including nutrient content, organic matter, pH regulation, and microbial activity. Furthermore, it presents examples from both natural and experimental studies, demonstrating how halophytes can be integrated into sustainable land management strategies [5, 31-39].

To begin with, one of the most essential agrochemical characteristics of soil is its salinity level, which directly affects water absorption by plant roots. Excess salts in the root zone lead to osmotic stress, reducing crop yield and, in severe cases, completely inhibiting plant growth. Halophytes are particularly valuable in this context due to their ability to absorb, store, or excrete salts. For example, halophytes like *Atriplex nummularia* and *Salicornia europaea* take up high concentrations of sodium and chloride from the soil. These salts are either stored in the vacuoles of plant cells or excreted through specialized salt glands. As a result, the overall salt content in the root zone decreases over time. Furthermore, when halophyte biomass is periodically harvested and removed, a significant portion of the absorbed salts is physically exported from the system, thus preventing re-salinization of the soil. Additionally, halophytes can stimulate leaching by improving soil structure through root activity. The penetration of their roots into compacted soils enhances water infiltration and drainage,



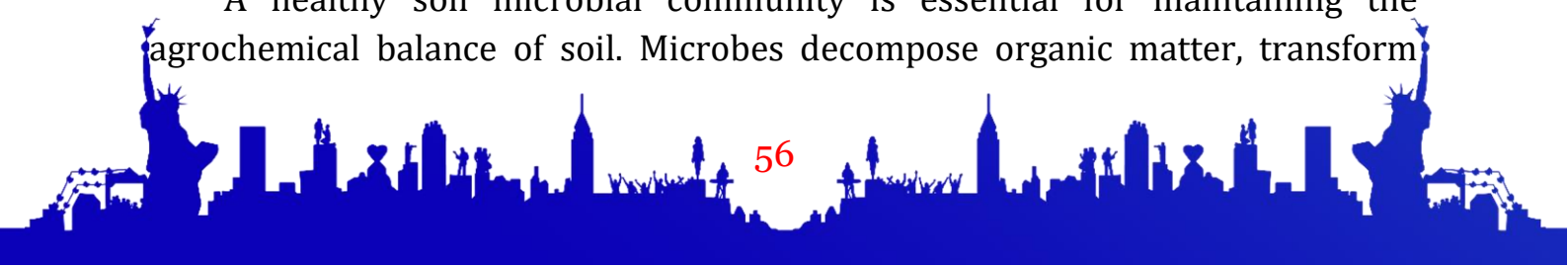


helping to flush excess salts below the root zone. In areas like the Punjab region in Pakistan, where saline soils dominate, researchers observed that planting *Atriplex spp.* for three years resulted in a 20–30% decrease in electrical conductivity (EC), an important indicator of salinity.

Besides salt reduction, halophytes significantly influence the organic matter content of soils. Organic matter, composed of decomposed plant and microbial residues, is critical for nutrient cycling, soil fertility, and structure. As halophytes grow, they contribute to biomass both above and below ground. When leaves and stems fall or roots decay, they add carbon-rich material to the soil. For instance, studies in the Aral Sea basin, one of the most saline and degraded regions in Central Asia, demonstrated that growing *Salicornia europaea* increased soil organic carbon by up to 30% over a two-year period. This increase in organic matter led to improved aggregate stability, moisture retention, and soil porosity. Moreover, the decomposition of halophyte residues promotes the proliferation of soil microorganisms, which are vital for nutrient transformation. As microbial activity intensifies, processes such as nitrification, denitrification, and decomposition of complex organic materials become more efficient, further improving the agrochemical environment.

In saline soils, alkalinity is often a problem. High pH levels (above 8.5) can lock up nutrients such as phosphorus, iron, and manganese, making them unavailable to plants. However, halophytes can gradually alter pH conditions through root exudates—organic acids and other compounds released during root respiration. For example, *Tamarix articulata*, a tree-like halophyte species, releases organic acids into the rhizosphere that help solubilize bound phosphorus and micronutrients. A study in semi-arid regions of Rajasthan, India, showed that after three years of *Tamarix* cultivation, the average soil pH dropped from 9.1 to 8.0, which significantly improved nutrient uptake for subsequent crops. Additionally, nitrogen dynamics are influenced by the microbial interactions promoted by halophytes. Some species, such as *Sesbania sesban* and *Casuarina equisetifolia*, form symbiotic relationships with nitrogen-fixing bacteria like *Rhizobium* or *Frankia*. These bacteria convert atmospheric nitrogen (N_2) into plant-available forms, enriching the soil in the process. The resulting increase in soil nitrogen not only benefits the halophyte plants themselves but also improves conditions for crop rotation and intercropping [3, 169-178].

A healthy soil microbial community is essential for maintaining the agrochemical balance of soil. Microbes decompose organic matter, transform





nutrients, and enhance soil structure. In saline conditions, however, microbial diversity and activity are often severely reduced. Halophytes play a critical role in restoring microbial life by supplying root exudates and organic residues that serve as energy sources for microbes. According to research conducted in the Yellow River Delta in China, plots planted with *Salicornia bigelovii* exhibited a 35% increase in microbial biomass compared to unplanted saline controls. Soil respiration rates—a proxy for microbial activity—were also significantly higher, indicating more robust microbial processes. Furthermore, halophytes contribute to diversifying the soil microbiome. Their presence creates unique microhabitats that support bacteria, fungi, and actinomycetes adapted to saline environments. These microbes not only survive in high-salt conditions but also produce substances such as exopolysaccharides, which bind soil particles and enhance aggregate formation, improving soil physical and chemical properties.

Conclusion. In summary, halophyte plants exert a considerable influence on the agrochemical properties of saline and degraded soils. Through mechanisms such as salt uptake, organic matter enrichment, pH moderation, and enhancement of microbial activity, halophytes improve soil fertility and support sustainable agricultural practices. With strategic application, halophytes can serve as nature-based allies in promoting soil health, agricultural productivity, and ecological resilience.

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