



The effect of *Euphorbia helioscopia* L. (Al-Ushar) on soil physical and chemical properties in White Nile State

Dr. Gamar Eldawla Abdelmotalib Ahmed¹, Dr. Masheir Ibrahim Baleil Ibrahim², Dr. Mohammed Salem Abd Elfadil³

¹ Associate Professor, Department of Plant Nutrition, College of Education, University of White Nile, kosti, Sudan

² Assistant Professor, White Nile Center Scientific Research (WNCSSR), kosti, Sudan

³ Associate Professor, Department of Chemistry, College of Education, University of Imam Mahdi, kosti, Sudan

DOI: <https://doi.org/10.66856/ijmrd.2026.13.4.13395>

Abstract

This tree plays a vital environmental and agricultural role in improving the physical and chemical properties of Sudanese soil, particularly in areas with sandy or degraded soils prone to desertification. The study aimed to examine the physical and chemical properties of soil where *E. helioscopia* grows. Parameters analyzed included electrical conductivity (EC; dS m⁻¹), pH, soil texture components, cation and anion ratios, carbonate minerals, organic matter (g kg⁻¹), and the content of available nutrients (mg kg⁻¹). Soil samples were collected from the root zones of plants at growth sites as well as from sites lacking vegetation; nine soil samples from various locations were analyzed in the laboratory. The results revealed highly significant differences in the soil supporting *E. helioscopia* growth, showing a reduction in salinity levels, acidity, cations (Mg²⁺, Ca²⁺, K⁺, Na⁺), and carbonate minerals. Furthermore, the results demonstrated a highly significant effect of *E. helioscopia* growth on increasing soil levels of bicarbonates, organic matter, and available nutrients (K, N, P). The study clearly indicates that the growth of *E. helioscopia* has a substantial impact on the chemical and physical properties of the soil. Although the *Umm Haleeb* (or *Ushar*) tree is sometimes classified as an invasive shrub in neglected areas, from a Sudanese ecological perspective, it is considered a vital natural resource for rehabilitating degraded soil; it transforms arid, sandy environments into land that is more cohesive, retains more moisture, and is richer in the essential chemical elements needed to support biodiversity and agriculture.

Keywords: *E. helioscopia*, soil, chemical properties, physical properties

Introduction

Is an erect, perennial woody shrub belonging to the spurge family (Euphorbiaceae); its branches are dichotomously branched, with older branches taking on a light red hue. The leaves are alternate, linear-lanceolate, and the flowers are unisexual, growing in cyathia (cup-like inflorescences) that bear multiple flowers. The plant is considered toxic due to its content of various chemical compounds, such as terpenes, alkaloids, flavonoids, cyanidin, delphinidin, and saponins. It is a perennial herb reaching a height of 50 cm that grows in sandy and gravelly soils; livestock do not graze on it. The plant is classified as toxic. It is worth noting that the names *al-Labbeen**, *al-Labbeenah**, and *Umm al-Laban** are applied to a diverse group of plants that share the common characteristic of secreting a white, milky sap. The plant is known by various local names, such as *al-Ghazalah**, *al-Jalwah**, *Kharzat al-Dubb**, *Umm al-Laban**, *al-Malbanah**, *al-Labbeen**, and *al-Labbeenah**. The *Umm Haleeb* plant (scientifically known as *Euphorbia* or the milk bush/*Umm al-Laban**) plays a pivotal ecological role in reclaiming degraded lands and improving the fertility of dry, nutrient-poor soils. ^[1, 2] *Euphorbia helioscopia* is a winter annual plant belonging to the Euphorbiaceae family; the genus comprises numerous species distributed worldwide, particularly in tropical regions. *E. helioscopia* contains bioactive chemical compounds, specifically di- or tri-terpene esters ^[3]. Various species within this genus have been studied for their medicinal properties—including antiviral, anti-inflammatory, antibacterial, and antileishmanial activities ^[4] Certain antiviral agents derived from *Euphorbia* species

have been purified and developed into pharmaceutical drugs ^[5]. In the field of therapeutics, extracts from various *Euphorbia* species have proven successful in treating viral skin diseases notably, research has demonstrated that *E. helioscopia* extracts possess potent antiviral activity ^[6]. The plant's green parts and seeds hold medical significance, being used to treat psoriasis, rheumatism, and paralysis. The leaves and stems serve to alleviate fever and expel intestinal worms, while the plant itself possesses anti-cancer properties ^[7]. Additionally, the roots are used as a remedy for intestinal worms ^[8], and the milky sap has topical applications for treating skin rashes; as for the seeds, when mixed with roasted pepper, they become effective in treating cholera, although the seed oil itself acts as a laxative. Contact of the milky sap with the skin or mucous membranes—such as the eyes, nose, or mouth—can cause severe pain and irritation; furthermore, it is considered a naturally occurring carcinogen. This tree is of immense importance for the reclamation and improvement of arid soils. Reclamation of degraded land Thanks to its exceptional ability to withstand drought and thrive in harsh environments, it is used to cultivate and rehabilitate poor, dry soils unsuitable for other crops. Improving soil structure: Its root network breaks up compacted soil and increases aeration, thereby enhancing efficiency and the capacity to retain water and moisture for longer periods. Soil stabilization and erosion control: It helps bind sandy and loose soil, protecting it from erosion caused by strong winds or flash floods in semi-desert regions. Stimulating microorganisms: Upon decomposition, its dry organic matter nourishes the soil and creates a favorable

environment for beneficial microorganisms that boost the fertility of decertified land. Natural pest resistance: The white milky sap it secretes contains toxic chemical compounds that act as a natural insecticide, reducing the spread of harmful pests and parasites in the surrounding soil [9, 10]. Studying the distribution of these plants and their specific soil requirements is of particular importance, as this distribution is influenced by interacting environmental factors, including the presence of other co-occurring plant species [11]. Plants growing in a given environment differ in their capacity to absorb mineral elements and in the efficiency with which they utilize the absorbed nutrients; these differences influence inter-plant competition and determine the survival of only those plants adapted to the prevailing environmental conditions. This research aims to study the physical and chemical properties of the soil where this plant grows and to compare them with the characteristics of nearby soils lacking such vegetation, in order to determine the plant's impact on the soil properties with which it interacts.

Materials and Methods

The research was conducted in White Nile State—specifically the North Kosti area—where the chemical and physical properties of the soil were studied at various locations during the autumn season.

Vegetative growth measurements (at the flowering stage):

1. Measure plant height (cm) from the soil surface to the growing tip at the flowering stage.
2. Count the number of branches per plant at the flowering stage (main and secondary branches).
3. Determine the fresh weight (g/plant) at the flowering stage; then, dry the samples in a well-ventilated room until a constant weight is reached and record the dry weight (g/plant).

Soil Samples

Samples were collected from the root zones of growing *E. helioscopia* plants at various locations and analyzed at the laboratories of the Department of Soil Science, Faculty of Agriculture, University of Khartoum.

Soil Analysis

First: Physical Analyses

Relative distribution of soil particle sizes:

Mechanical analysis of soil samples was conducted using the pipette method.

Second: Chemical Analyses

Chemical properties of the soil samples were determined using the saturated paste extract: Soil reaction (pH):

Measured using a pH meter. Electrical Conductivity (ECe):

Measured using a conductivity bridge. Organic matter:

Determined using the Walkley-Black method. Lime (calcium carbonate):

Determined gravimetrically.

Third: Soluble Cations and Anions in Soil Solution:

- **Soluble calcium:** Determined by titration with EDTA using an appropriate indicator.
- **Soluble magnesium:** Determined by titration with EDTA.
- **Soluble potassium:** Determined using a flame photometer

- **Soluble sodium:** Determined using a flame photometer.
- **Carbonates and bicarbonates:** Determined by titration with 0.02 N sulfuric acid.

Fourth: Available nutrients:

- **Available nitrogen:** Determined using a Micro-Kjeldahl apparatus.
- **Available phosphorus:** Determined using the Olsen method.
- **Available potassium:** Determined using a flame photometer.

Data were statistically analyzed using the t-test for treatments.

Results and Discussion

Table (1) reveals significant differences (at the 0.01 level) regarding the effect of plant presence on reducing soil salinity; the mean value was 4.22 dS/m in the control treatment, compared to 1.23 dS/m in areas where germination occurred. This is corroborated by the presence of specific soil ions (Mg^{2+} , Na^+) at high concentrations in soils where germination failed, versus lower concentrations in soils where germination was successful; increased plant density in the germination zone correlates with a reduction in salinity levels. The presence of these ions—such as sodium (Na^+)—can be toxic and induce physiological disorders in certain plants. Furthermore, the failure of germination in highly saline soils may be attributed to osmotic effects that reduce water availability to the plant, compounded by the presence of high—and potentially toxic—ion concentrations in the plant's immediate environment.

Soil pH

Table (1) reveals significant differences (at the 0.001 level) between the control and the germination sites. This clearly influences nutrient availability—which is greater at the germination sites—thereby promoting the growth of these plants' seeds in this soil.

Soil Texture Components

Table (1) shows significant differences (at the 0.001 level) between the control and the germination sites regarding soil texture components. However, the fact that plant growth varies across different soil locations may be attributed to mechanisms of soil particle aggregation. Key among these mechanisms is the secretion of gelatinous organic substances from plant roots, which act as binding agents for inorganic soil materials; additionally, root pressure, respiratory carbon dioxide, and secreted mineral substances likely play a major role in soil particle aggregation, thereby fostering the growth of *E. helioscopia* in this soil matrix.

Cations and Anions (HCO_3^- , K^+ , Na^+ , Mg^{2+} , Ca^{2+}) (mmol L^{-1}):

The results presented in Table (1) indicate significant differences regarding exchangeable cations absorbed by *E. helioscopia* plants growing at these sites. Specifically, significant differences were observed in the uptake of calcium and magnesium (at the 0.01 level) and sodium (at the 0.001 level), while the difference for potassium was significant at the 0.05 level. This may be attributed to the

fact that **E. helioscopia**—growing in specific environments—demonstrated a distinct capacity for absorbing these elements (exchangeable cations) and efficiency in utilizing the absorbed nutrients; this resulted in reduced levels of these elements in the soil where the plants grew compared to other sites. This is further corroborated by the observation that higher plant density at the growth sites led to a reduction in the levels of these elements (K, Na, Mg, Ca). Regarding bicarbonate (HCO_3^-), significant differences (at the 0.001 level) were observed, specifically an increase in its concentration at the growth sites.

Carbonate minerals ($\text{g}\cdot\text{kg}^{-1}$):

Table (1) indicates significant differences (at the 0.001 significance level) between the germination sites and the control sites regarding the effect of plant growth on soil carbonate mineral content; the values were $214.83 \text{ g}\cdot\text{kg}^{-1}$ for the germination sites and $227.67 \text{ g}\cdot\text{kg}^{-1}$ for the control sites. This may be attributed to the critical role calcium plays in the relationship between roots and their growth medium. It is well known that calcium-rich soils (control sites) support the growth of plants that differ markedly from those found in soils with lower calcium content—such as *E. helioscopia*.

Organic Matter ($\text{g}\cdot\text{kg}^{-1}$):

Table (1) indicates the effect of *E. helioscopia* plant growth on soil organic matter content (significant at the 0.001 level); the content was $9.04 \text{ g}\cdot\text{kg}^{-1}$ in the control soil and $14.44 \text{ g}\cdot\text{kg}^{-1}$ in the soil where the plants grew. Furthermore, the organic matter in the soil supporting *E. helioscopia* varied depending on the plant source itself. This variation may explain the plants' growth in these soils, as they had previously enriched the soil with organic residues prior to their own germination and development. Increased organic matter in soils supporting plant growth can enhance the amount of plant-available water in clay soils by separating fine soil particles and facilitating the drainage of excess water. It also releases plant nutrients through decomposition and increases the Cation Exchange Capacity (CEC), thereby improving the soil's ability to retain nutrients. Additionally, organic acids resulting from organic matter decomposition help solubilize mineral elements from the soil. Collectively, these factors provide *E. helioscopia* seeds with soil conditions favorable for growth.

Available Phosphorus ($\text{mg}\cdot\text{kg}^{-1}$):

Table 1 indicates significant differences (at the 0.001 level) regarding the growth of *E. helioscopia* plants and the level of available phosphorus at germination sites; the concentration was $109 \text{ mg}\cdot\text{kg}^{-1}$ at germination sites, compared to $77.33 \text{ mg}\cdot\text{kg}^{-1}$ at control sites. The increase in available phosphorus in the soil solution may be attributed to differences in the type of growing plants and soil type; this is corroborated by the increased fresh and dry weights of the plants at the germination sites.

Available Nitrogen ($\text{mg}\cdot\text{kg}^{-1}$):

Table 1 shows significant differences (at the 0.001 level) in the effect of plants at germination sites versus control sites on soil available nitrogen content. Available nitrogen measured $73.0 \text{ mg}\cdot\text{kg}^{-1}$ at germination sites, whereas it dropped to $65.33 \text{ mg}\cdot\text{kg}^{-1}$ at sites without germination. This suggests that nitrogen availability at such levels may contribute to stimulating the growth and distribution of

these plants' seeds—a conclusion supported by the increased fresh weight of the plants at the germination sites.

Available Potassium ($\text{mg}\cdot\text{kg}^{-1}$):

Table 1 demonstrates a significant effect (at the 0.001 level) of *E. helioscopia* growth on the level of available soil potassium; the concentration was $212.67 \text{ mg}\cdot\text{kg}^{-1}$ at germination sites, compared to $182.00 \text{ mg}\cdot\text{kg}^{-1}$ at sites without germination. Increased levels of readily available potassium at germination sites may promote the growth and spread of such plants in soils with these characteristics. This is evidenced by the increase in the plant's fresh and dry weight at the germination site.

Table 1: T-test for coefficients

Parameters	The Rate		t-value	
	Comparison	Parameters		
4.670**	4.22	1.23	(Ds.m ⁻¹)EC	
220.216***	7.86	7.77	pH	
35.420***	455	467	(g.Kg ⁻¹)	Clay
32.525***	434	435.5	(g.Kg ⁻¹)	Silt
40.694***	152	143.5	(g.Kg ⁻¹)	Sand
4.876**	13.63	4.99	mmole.L ⁻¹	Ca++
3.487**	7.68	1.67	mmole.L ⁻¹	Mg++
5.572***	7.08	2.66	mmole.L ⁻¹	Na+
2.397*	2.78	0.17	mmole.L ⁻¹	K+
111.820***	5.42	5.54	mmole.L ⁻¹	HCO ₃
61.003***	227.67	214.83	g.Kg ⁻¹	Carbonate minerals
13.397***	9.04	14.34	g.Kg ⁻¹	Organic matter
			mg.Kg ⁻¹	Available phosphorus
18.636***	77.33	109.0	mg.Kg ⁻¹	Available nitrogen
46.363***	65.33	73.0	mg.Kg ⁻¹	Available potassium
35.832***	182.0	212.67	mg.Kg ⁻¹	Carbonate minerals

Tabulated t-value at each significance level

2.306 = 0.05 *

3.355 = 0.01 **

5.041 = 0.001 ***

References

1. France. Indre and loire. *Euphorbia helioscopia* L. <http://herbarium.Freehostia.com2->, 1995.
2. Hecker E. New toxic, irritant and cocarcinogenic diterpenoid esters from *Euphorbiaceae* and from *Thymelaeaceae*. Pure Applied Chem.,1977;49:1423-1431.
3. Ramezani M, Behravan J, Arab M, Amel Farzad S. Antiviral activity of *Euphorbia helioscopia* Extract. Journal of Biological Sciences,2008;8(4):809 – 813. ISSN 1727-3048.
4. Tao HW, Hao XJ, Liu PP, et al. Cytotoxic macrocyclic diterpenoids from *Euphorbia helioscopia*. Arch Pharm Res,2008;31(12):1547-1551.
5. Ramezani M, Behravan J, Arab M, et al. Antiviral activity of *Euphorbia helioscopia* extract. Journal of Biological Sciences,2008;8(4):809-813.

6. Abdelgaleil AAM, Kassem SMI, Doe M, Baba M, Nakatani M. Diterpenoids From *Euphorbia paralias* . Phytochemistry,2001;58:1135-1139.
7. Jackson ML. Soil Chemical analysis. Englewood, N. J. prentice Hall Inc, 1973.
8. Lin C, cheng H, yang C, Lin T. Antioxidant and antiviral activities of *Euphorbia thymifolia* L. J.Biomed. Sci.,2002;9:656-664.
9. Madureira AM, Ascenso JR, Valdeira L, Duarte A, Frade JP, Freitas G, et al. Evaluation of the antiviral and antimicrobial activities of triterpenes Isolated from *Euphorbia Segetalis*. Net .prod. Res.,2003;17:375-380.
10. W, Guo YW. Three new jatrophane-type diterpenoids from *Euphorbia helioscopia*. Planta medica,2005;71:283-386.
11. Zhang W, Guo YW. Chemical studies on the constituents of the Chinese medicinal herb *Euphorbia helioscopia* L. Chem Pharm Bull,2006;54(7):1037-1039.