The Effect of Natural and Organic Enhancers on Some Fertility and Physical Characteristic of Bean Plants

Reem Alsaffar[1], Noor Almola[2], Arqam Alomari[3]*

[1]Soil and water Resources Sciences College of Agricultural and Forestry University of Mosul, Mosul, Iraq.
ORCID iD: https://orcid.org/0009-0005-3252-070X, Email: reemalsaffar46@uomosul.edu.iq
[2]Soil and water Resources Sciences College of Agriculture and forestry university of Mosul, Mosul, Iraq.
ORCID iD: https://orcid.org/0009-0009-7151-8513, Email: noorjamalalmola@uomosul.edu.iq
[3]Foods Sciences Department, College of Agriculture and Forestry, College of Agriculture and Forestry, University of Mosul, Mosul, Iraq.
ORCID iD: https://orcid.org/0000-0002-8635-3434, Email: arqam.alomari@uomosul.edu.iq

*Correspondence: arqam.alomari@uomosul.edu.iq

Data of the Article

First Received: 20 June 2025 | Last Revision Received: 25 July 2025
Accepted: 01 August 2025 | Published Online: 20 August 2025
DOI: https://doi.org/10.5281/zenodo.16949051

Keywords

Bean Plant,
Organic Residues,
Perlite.GC-Mass.HPLC.

Organic wastes are considered an eco-friendly fertiliser that promotes high and sustainable crop output by stimulating root development, microbiological activity, and boosting soil characteristics. Furthermore, perlite is a moisture-retentive substance incorporated into soil or plants to diminish evaporation and ensure optimal water accessibility for plant roots. The primary objective of this study was to assess the impact of synthetic and natural soil conditioners on the various chemical and physical properties of bean plants. The experiment had two soil types: sandy soil and sandy loam soil. Four concentrations of organic residues were applied: 0%, 2%, 4%, and 6%. Furthermore, two concentrations of perlite were evaluated: 0%, 0.2%, and 0.5%. The statistical analysis software SPSS was employed to analyse the results. Soil physical tests were performed, accompanied by chemical analysis of soil and vegetation. Tissues and seeds from the broad bean plant were analysed using Gas Chromatography-Mass Spectrometry (GC-MS) and High-Performance Liquid Chromatography (HPLC). The study's findings demonstrated that a perlite concentration of 0.5% markedly enhanced the physical qualities of both soil types in comparison to the maximum concentration (6%) of organic waste. In contrast, the 6% organic wastes treatment significantly improved the chemical characteristics and nutrient content of the soil relative to the 0.2% perlite treatment for both soil types. Moreover, the HPLC and GC-MS studies indicated that the sandy loam soil containing 6% organic waste and 0.5% perlite produced the highest values regarding the type and content of phenolic and chemical components.

1. Introduction

The faba bean (Vicia faba L.) is a significant source of protein and energy in human nutrition, classified as a winter legume crop (Khudhair, 2018). Nitrogen fixation is also crucial, as it improves soil properties (Hacıseferoğulları et al., 2003). Organic fertilisation is essential for enhancing crop quality and output. The appropriate application of organic fertilisers guarantees elevated and stable crop yields by enhancing soil properties, promoting microbial activity, and facilitating root development (Duru, Daniel, & Ogbulie, 2018; Seker, 2003). In recent years, various studies have sought to diminish water use in agriculture by applying chemical and natural substances to plants or soil to enhance water availability for plant roots and minimise evaporation. These compounds, referred to as moisture-retaining agents, encompass perlite (FAO, 2020). Perlite comprises little white granules measuring 1 to 5 mm in diameter, produced by heating volcanic siliceous rocks to temperatures between 900 and 1000°C. This process enlarges the granules by 4 to 20 times their initial size, generating numerous air pockets capable of absorbing water up to 430% of their volume, so making it available to plant roots as required. Agricultural perlite demonstrates superior water absorption, enhances soil aeration and drainage, and consequently improves plant root ventilation. It possesses a significant ability for holding water and nutrients for prolonged durations, hence diminishing the need for irrigation and fertilisers. Perlite demonstrates a high cation exchange capacity and sustains a neutral pH range of 6.5 to 7.5, so offering an optimal environment for plant development. It functions as a sterile substrate devoid of weed seeds and pathogens, being inorganic and resistant to breakdown or decomposition. Moreover, perlite serves as an insulating medium, safeguarding plant roots from drastic temperature variations while ensuring a clean, odourless, and lightweight composition. This study examines the effects of organic residues and perlite, both natural and chemical enhancers, on the fertility and physical properties of faba bean plants, considering the substantial influence of fertilisers on yield quantity, quality, and physiological growth aspects, particularly with environmentally friendly organic fertilisers.

2. Materials and Methods

2.1. Location of the Study

Two distinct soil types with varying textures were used for the investigation. One sample is sandy soil from the Rashidiya region, northeast of Mosul city, and the other is sandy loam from the Furqan area, south of Mosul city, taken during the autumn season (2023-2024) from a depth of 0-30 cm. The soil samples were sieved through a 2 mm mesh after grinding. Perlite and ovine excrement were the two types of soil amendments utilised. Moreover, a 2 mm sieve was employed to pulverise and screen these adjustments. The amendments were incorporated into the study soils at several rates: 0%, 2%, 4%, and 6% for sheep dung, and 0.2% and 0.5% for perlite. The amendments were meticulously integrated with the soil and positioned in containers with a capacity of 5 kilogramme.

The bulk density of the soil in the pots was kept near the field bulk density, recorded at 1.53 Mg/m^3 for sandy soil and 1.44 Mg/m^3 for sandy loam soil. The soil was irrigated to field capacity for both soil types and all treatments after assessing field capacity with a pressure plate device and a membrane pressure technique. The moisture content at field capacity was 1.12% for sandy soil and 1.29% for sandy loam soil. Water was introduced to sustain field capacity for three months to facilitate the breakdown of both sheep dung and perlite. The water content was assessed and regulated by weighing the pots every 3 to 4 days.

Physical Analyzes in Soil: The physical analyses of the study soil included the estimation of the following:

1. Particle Size Distribution: The hydrometer technique, as described by Dhull et al. (2022), was employed to ascertain the particle size distribution.

2.Bulk Density: The following formula was used to get the bulk density, which was determined for undisturbed samples using the core method (Khudhair, 2018).

$$Pb = Ms/Vt$$

3.Particle Density: According to Hacıseferoğulları et al. (2003), the pycnometer method was used to assess the particle density.It was computed using the formula that follows:

$$p_s = p_w(w_s - w_a) / [(w_s - w_a) - (w_{sw} - w_w)]$$

4.Soil Porosity: Soil porosity was calculated after determining the bulk and particle densities (Duru et al., 2018). using the following formula.

$$f = 1 - (p_b / p_s)$$

5.Surface Crust: Surface crust hardness was estimated to be using a penetrometer as described by Seker (2003).

6. Hydraulic Conductivity: Hydraulic conductivity was estimated to use the constant head method for undisturbed soil using the following formula $Q/At=K(\Delta H/L$

2.2. Chemical Analyzes in Soil:

1. Electrical Conductivity (EC) and Soil Reaction (pH): Hacıseferoğulları et al. (2003) state that the particle density was evaluated using the pycnometer method. It was calculated using the following formula:

2. Organic Matter and Calcium Carbonate: Organic Matter: Using potassium dichromate solution and titration with ammonium ferrous sulfate. Calcium Carbonate: By titration with sodium hydroxide as described by FAO (2020).

3. Available Nitrogen in Soil: Available Nitrogen was measured in a 5:1 extract using: Nitrogen

ISSN-Internet 2197-411x OLCL 862804632

Extraction: With 2N KCL solution. Ammonium Ion: Using magnesium oxide (MgO) by distillation after evaporation. Nitrate Ion Using Devarda alloy and then distillation with a micro-Kjeldahl apparatus according to El-Gayar, Negm, & Abdrabbo (2019).

4. Available Phosphorus in Soil: Phosphorus was measured in a 20:1 extract using the modified Olsen method with:0.5 Molar Sodium Bicarbonate. Colorimetric Measurement Using a spectrophotometer at a wavelength of 882 nanometers (Kai et al., 2016).

5. Available Potassium in Soil: Potassium was measured using: Flame Photometry: Using a flame photometer as described by Fonteh et al. (2017).

Harvesting and Sample Preparation: On 14/3/2024, the plants in each treatment were harvested (stems and leaves) using a hand sickle. They were then placed in large bags and weighed using an electric scale. Subsequently, the grains were manually separated from the rest of the plant parts and placed in bags, which were then introduced into an oven at a temperature of 72°C for 48 hours.

Digestion of Plant Samples: The plant materials were subjected to wet digestion utilising concentrated sulphuric acid and perchloric acid (H2SO4 – HClO4). Precisely, 0.5 grammes of the pulverised plant samples were measured, and 10 millilitres of concentrated sulphuric acid were incorporated. The samples were allowed to sit for 24 hours, after which they were positioned in a furnace, and perchloric acid was introduced in drops. The extract was quantitatively transferred to a 50-milliliter volumetric flask, and distilled water was added to the calibration mark (El-Gayar, Negm, & Abdrabbo, 2019).

Determination of Nitrogen, Phosphorus, and Potassium in the Vegetative Part: El-Gayar et al. (2019) introduced a technique for nitrogen estimation. The procedure entails the distillation of the botanical specimen via a Kjeldahl device. This procedure is conducted in an alkaline environment using a strong base, such as NaOH, followed by titration with a standard acid, such as sulphuric acid (H2SO4), in the presence of an appropriate indicator, such as a mixed indicator. Phosphorus was quantified using a method that produces a yellow solution through the application of ammonium molybdate-vanadate in nitric acid. This was conducted with a spectrophotometer at a wavelength of 410 nm, as detailed in the book "Soil, Plant, and Water Analysis." Potassium was quantified using the flame photometric method as outlined by Fonteh et al. (2017).

Extraction of Phenolic Compounds Using HPLC: The Soxhlet device was employed to ascertain crude fat content. The desiccated leaf sample was positioned in a cellulose extraction thimble, and petroleum ether solvent was employed at a temperature of 40-60°C for a duration of five hours under heating. Subsequently, the solvent was evaporated, and the sample was weighed. The weight variation of the sample pre- and post-extraction was utilised to ascertain the fat % (Duru, Daniel, & Ogbulie, 2018).

Identifying Phenolic Substances with the HPLC Method: The analysis was performed in the environmental and water laboratories of the Ministry of Science and Technology, adhering to a pre-established technique. The high-performance liquid chromatography (HPLC) system, model SIKAM/SYKAM (produced in Germany), utilised a carrier phase of methanol, distilled water, and formic acid in a 70:25:5 ratio. The separation of phenolic compounds was accomplished on a C18-ODS column (25 cm × 4.6 mm), with detection performed by a UV detector at a wavelength of 280 nm. The carrier phase flow rate was sustained at 1.0 ml/min.

Gas Chromatography –Mass Spectrophotometer Technology (GC-Mass): 1 **µL** of the crude extracts were fed into the GC-MS device at 260 °C while the column was operating. The temperature ramp looked like this: After two minutes at 60 °C, it was raised to 300 °C at a rate of 10 °C per minute, and then it was kept at 300 °C for six minutes. 240 °C, 240 °C for the ion source, 70 eV for the ionization mode electron impact, 0.2 s scan time, and 0.1 s scan interval were the requirements for the mass detector. Fragments between 40 and 600 Da were gathered.

3. Results and Discussion

3.1. The Results of Physical and Chemical Examinations of soil Under the Study

Table (1) delineates various physical and chemical properties of the examined soils. The data indicated that the initial soil possesses a substantial sand concentration (up to 910 g/kg), categorising it as predominantly sandy. The second soil type, sandy loam, is characterised by a balanced mix of clay, silt, and sand. The observed bulk density values differed between the two soils, measuring 1.53 g/cm^3 for the first soil and 1.44 g/cm^3 for the second soil. The disparity in bulk density values is evident in porosity, which is measured at 41% for the first soil and 44% for the second soil. Both soils displayed initial moisture content values of 11% and 13%, respectively. As a result, the hydraulic conductivity values were 0.10 and

0.09 cm/min for sandy and sandy loam soils, respectively. Consequently, to optimise agricultural utilisation of sandy soils, enhancements are required, including the incorporation of organic and industrial amendments to improve moisture retention and minimise water loss and movement beyond the root zone. The table also demonstrates that the hardness degree values for the study soils were 1.56 and 2.9 dyn.cm^{-2}. $^{-2}$. While there was no significant difference in the two soils' electrical conductivity (EC) and soil reaction (pH) values, as well as in the amount of organic matter and calcium carbonate, with organic matter values of 1.35% and 3.26% for the first and second soils, respectively, and calcium carbonate values of 19.4% and 22.2%, respectively.

Table 1: Physical and Chemical Characteristics of the Study Soil.

Studied Qualities	Sandy Loam Soils	Sandy Soils	Unit
Sand	600	910	g/kg
Silt	300	60	g/kg
Clay	100	30	g/kg
Bulk Density	1.44	1.53	Megagrams/m^3
Particle Density	2.6	2.65	Megagrams/m^3
Porosity	44	41.01	%
Moisture Content	1.29	1.12	%
Water Conductivity	0.08	0.1	Poise·min^{-1}
Degree of Hardening	2.9	1.56	D·m^{-2} (Dane/m^2)
Soil Reaction (pH)	7.4	7.1	—
Electrical Conductivity (EC)	0.47	0.5	dS/m (Decisiemens/m)
Organic Matter	3.26	1.35	%
Calcium Carbonate	22.2	19.4	%
Nitrogen	29	19	mg/L
Phosphorus	0.79	0.52	mg/L
Potassium	176	34	mg/L

Table (3-2) and Figure (1) depict the values of apparent and bulk density, porosity, hardness, and water conductivity for sandy and sandy loam soils subsequent to the incorporation of organic amendments. The apparent density values exhibited minimal variation, with the addition of 0.5% perlite resulting in the lowest value of 1.40 g/cm^3, in contrast to the untreated sandy soil, which measured 1.53 g/cm^3. Sandy loam soil had a reduced value when treated with perlite at a 0.5% addition level, achieving a density of 1.33 g/cm^3, in contrast to the untreated soil with amendments, which had an apparent density of 1.44 g/cm^3. Apparent density values exhibited variations with the incorporation of perlite, as an increase in the amount of amendments resulted in a drop in apparent density for both soils.

Moreover, organic content rendered the soil structure friable and pliable, resulting in an increase in volume at the cost of unit mass, which ultimately led to a reduction in apparent density values. The results align with those from (Hacıseferoğulları et al., 2003; Seker, 2003; Pansu and Gautheyrou, 2006; Farid et al., 2021), which indicated that the incorporation of organic material leads to a reduction in apparent density values. The apparent density values diminished with the addition of additions for both soil types, with a more significant reduction observed in sandy loam soil compared to sandy soil, which only exhibited a decrease in values when untreated with supplements.

Table (2) and Figure (2) demonstrate that the porosity values of the examined soils increased with the addition of synthetic and organic amendments. The maximum values were attained with the incorporation of perlite (0.5%) at the highest addition rate, resulting in porosity values of 47.52% for sandy soil and 49.56% for sandy loam soil. In both soil types, porosity values improved with the rising proportion of organic amendments, attaining 44.16% and 48.85% for sandy and sandy loam soils, respectively, at a 6% addition rate. This results from the elevated organic matter concentration in the soil, which has favourably influenced porosity levels. These findings corroborate (Seker, 2003; Duru et al., 2018), which determined that variations in apparent density values resulting from organic amendments indicate alterations in soil structure. Table 2 Figure 2 also depicts the hardness values, indicating that sandy soil exhibited lower values in comparison to sandy loam soil with the incremental addition of natural and synthetic amendments. Hardness values varied from 0.23 to 0.69 d/cm^2 at the maximum application rate of organic and synthetic supplements, respectively, in contrast to the control treatment, which exhibited a value of 1.56 d/cm^2 for sandy soil. In sandy loam soil, hardness values varied from 0.34 to 1.1 d/cm^2 with the maximum application of organic and synthetic amendments, respectively, in contrast to the control treatment, which exhibited a value of 2.9 d/cm^2. Organic residues demonstrated superiority over perlite in enhancing soil hardness by effectively forming optimal water films through variations in moisture content, resulting in reduced surface hardness. Conversely, evaporation may negate this impact by causing moisture loss from the soil. Overall, the amendments enhanced soil attributes more effectively than the control soil when comparing the alterations in the specified physical characteristics. The alterations in physical attributes examined were more significant with synthetic adjustments than with organic amendments. While organic amendments yielded favourable values for the examined physical parameters in comparison to untreated soil (control soil), these findings align with (El-Gayar et al., 2019; FAO, 2020). Perlite enhances physical properties by diminishing the bond strength between soil particles by the formation of water films around them. Plants may subsequently penetrate their roots more easily, enabling them to retain availability and absorb water and nutrients more efficiently. The bulk density of the soil diminishes due to the pathways created by plant roots that facilitate water movement. This enhances vegetative growth traits, resulting in higher yields and improved soil structure and stability, hence increasing soil porosity. This porosity is a dependable indicator of perlite's ability to improve the soil's overall chemical and physical composition. Furthermore, including perlite, characterised by its extensive surface area, enhances the soil's capacity to retain moisture near plant roots. As the quantity of addition escalates, so does its impact. The addition of perlite leads to less soil evaporation, enhanced water infiltration, and consequently an increase in both stored and accessible water in the soil, resulting in elevated yield and its components. This results in improved vegetative and floral development, therefore augmenting the output. These results align with the findings of Srivastava and Singh (2002) and Kai et al. (2016).

Table 2: Effect of Adding Enhancers on the Physical Qualities of the Study Soil.

		(1)Result2Water Conductivity Poison.Min -1	(1)Result2Water Conductivity Poison.Min -1	(1)Result3Water onductivity Poison. Min -1
		Mean	Mean	Mean
Type of soil and enhancers	Sandy Prelite Comparison	.100	.100	.100
	Sandy with 10% Prelite	.064	.065	.069
	Sandy with 20% Prelite	.065	.063	.061
	Sandy with 2% Organic Residues	.060	.058	.059
	Sandy with 4% Organic Residues	.042	.044	.040
	Sandy with 6% Organic Residues	.031	.036	.035
	Sandy Clay Loam Prelite Comparision	.059	.060	.061
	Sandy Clay Loam with 10% Prelite	.050	.055	.057
	Sandy Clay Loam with 20% Prelite	.045	.046	.050
	Sandy Clay Loam with 2% Organic Residues	.090	.090	.090
	Sandy Clay Loam with 4% Organic Residues	.066	.065	.061
	Sandy Clay Loam with 6% Organic Residues	.055	.059	.054

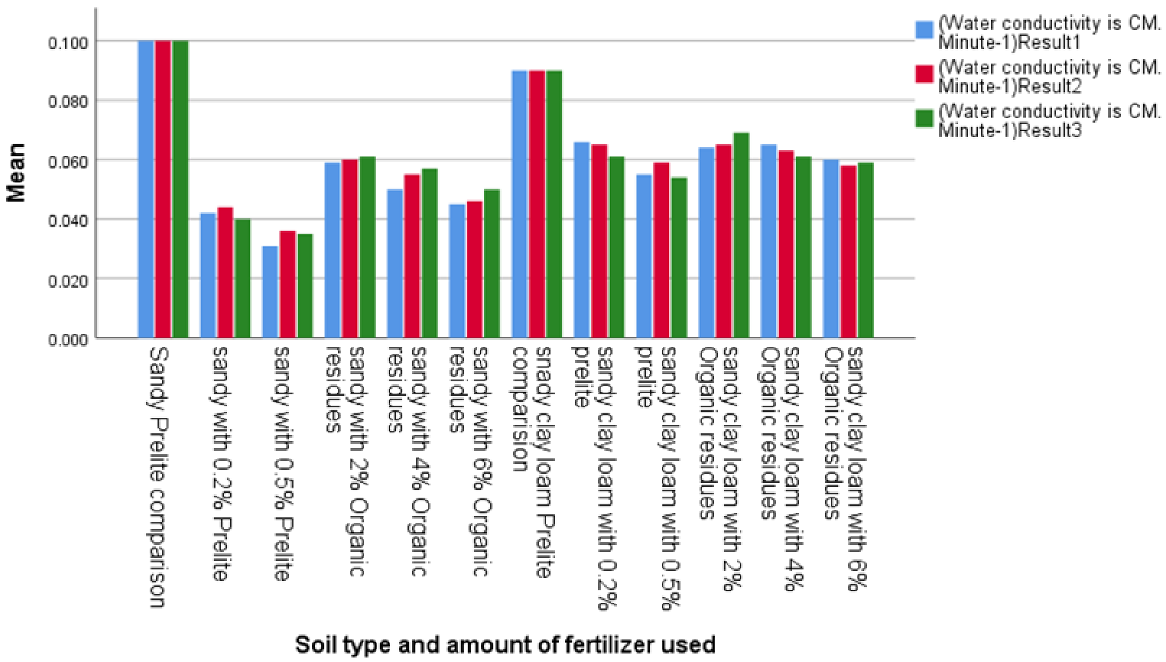

Figure 1: Clustered Bar Mean of (Water conductivity is CM. Minute^{-1}) Result1, Mean of (Water conductivity is CM. Minute^{-1}) Result2, Mean of (Water conductivity is CM. Minute^{-1}) Result3.

Table 3: Effect of Adding Enhancers on the Physical Qualities of the Study Soil.

		The Bulk Density is Micrograms.M-3	The Degree of Hardening in Dain .M-2	Porosity%
		Mean	Mean	Mean
Type of soil and enhancers	Sandy Prelite Comparison	1.530	1.560	43.010
	Sandy with 10% Prelite	1.500	.310	44.100
	Sandy with 20% Prelite	1.460	.240	42.200
	Sandy with 2% Organic Residues	1.430	.450	45.200
	Sandy with 4% Organic Residues	1.420	.300	45.030
	Sandy with 6% Organic Residues	1.390	.210	47.230
	Sandy Clay Loam Prelite Comparision	1.440	2.900	45.000
	Sandy Clay Loam with 10% Prelite	1.410	2.700	45.230
	Sandy Clay Loam with 20% Prelite	1.380	1.100	45.200
	Sandy Clay Loam with 2% Organic Residues	1.360	.770	46.630
	Sandy Clay Loam with 4% Organic Residues	1.360	.620	45.350
	Sandy Clay Loam with 6% Organic Residues	1.320	.320	50.190

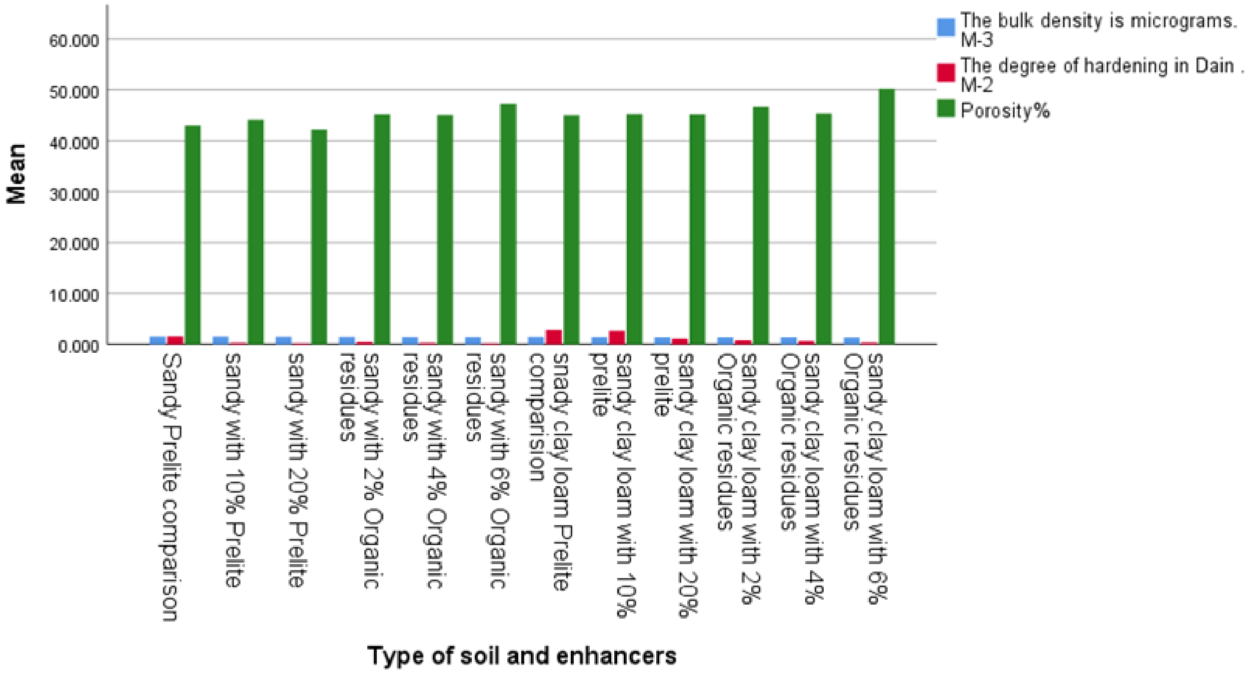

Figure 2: Clustered Bar Mean of the Bulk Density is Micrograms·M^{-3}, Mean of the Degree of Hardening in Dain·M^{-2}, Mean of Porosity %.

Table 4 Figure 3 depicts various chemical features of the studied soils following the incorporation of organic additions and perlite, for a duration beyond two months to guarantee the thorough decomposition of these supplements (Farid et al., 2021). The soil pH and electrical conductivity values for both soils remained unchanged with the addition of amendments or with increased volumes of those amendments. The calcium carbonate values fluctuated with the incorporation of both changes. The maximum concentrations of calcium carbonate were recorded in sandy and sandy loam soils with a 0.5% perlite addition (29.4% and 36.1%, respectively), compared to the control treatment without additives, which yielded (19.4% and 22.2%). This difference is attributed to the enhanced capacity of both soil types to improve specific physical properties, particularly specific surface area, resulting in a greater ability of light-textured soils to adsorb calcium, thereby causing variations in its concentrations with increased additive amounts. The organic matter content in both soils was significantly elevated compared to untreated soils, with sandy and sandy loam soils exhibiting the greatest levels of 5.17% and 7.46%, respectively, when organic amendments were added at the maximum rate of 6% (Pansu and Gautheyrou, 2006). The study demonstrated that perlite exhibited greater calcium carbonate values compared to organic amendments, although organic amendments surpassed perlite in organic matter values for both soils and at the greatest application rate. The studied soils exhibited diversity in increasing organic matter content, which enhances numerous physical and chemical properties of light-textured soils. Moreover, Table 5 and Figure

4 demonstrate that the 6% organic residue addition treatment surpassed the control treatment, which lacked any addition, regarding NPK content in both soil types. The highest values recorded were 499, 21.87, and 78 mg/l for sandy loam, and 446, 14.57, and 58 mg/l for sandy soils, respectively, compared to 176, 0.79, and 29 mg/l for sandy loam, and 34, 0.52, and 19 mg/l for sandy soils, respectively.

Table 4: Effect of Adding Enhancers on the Chemical Qualities of Soil.

		PH	EC	Calcium Carbonate %	Organic Mater%
		Mean	Mean	Mean	Mean
Type of Soil and enhancers	Sandy Prelite Comparison	7.140	.500	19.400	1.35
	Sandy with 10% Prelite	7.300	.800	29.300	1.33
	Sandy with 20% Prelite	7.100	.900	29.200	1.43
	Sandy with 2% Organic Residues	6.900	.500	24.100	2.14
	Sandy with 4% Organic Residues	7.700	.700	25.300	4.40
	Sandy with 6% Organic Residues	7.400	1.100	28.100	5.12
	Sandy Clay Loam Prelite Comparision	7.400	.400	2.220	3.26
	Sandy Clay Loam with 10% Prelite	7.900	.400	36.100	3.35
	Sandy Clay Loam with 20% Prelite	7.200	1.300	36.000	3.80
	Sandy Clay Loam with 2% Organic Residues	7.400	.800	36.200	7.06
	Sandy Clay Loam with 4% Organic Residues	7.900	1.700	35.200	7.33
	Sandy Clay Loam with 6% Organic Residues	7.800	1.800	36.900	7.45

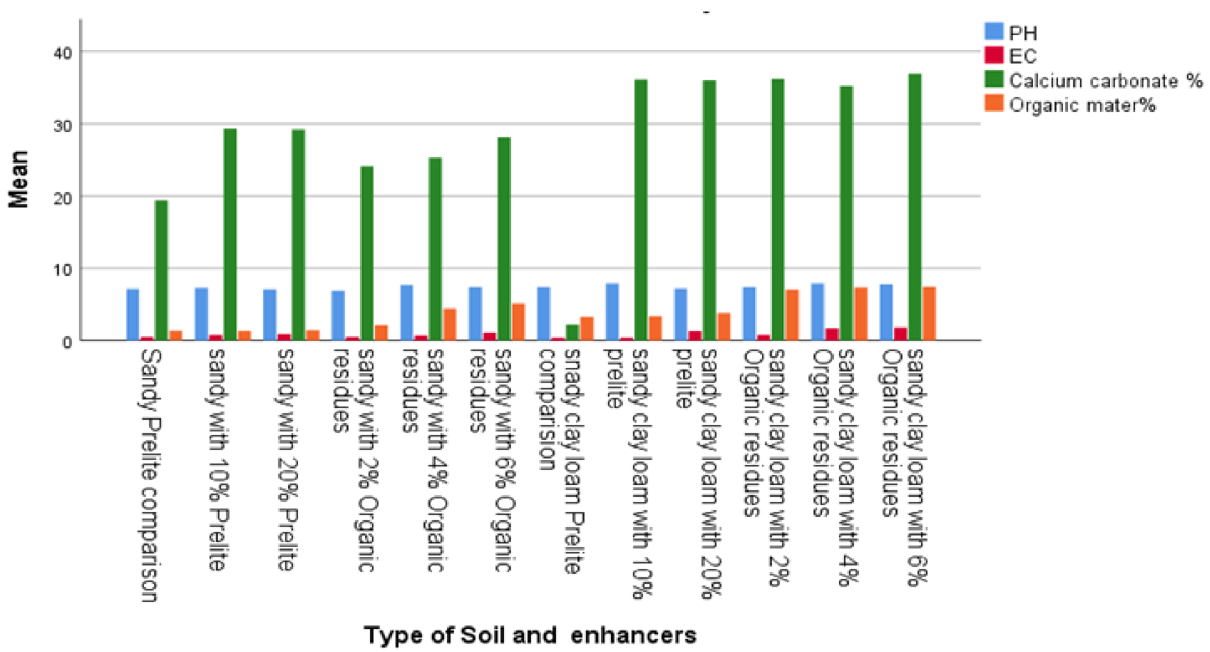

Figure 3: Clustered Bar Mean of PH, Mean of EC, Mean of Calcium carbonate %, Mean of Organic Matter % by Type of soil and Enhancers by INDEX.

Table 5: Effect of Adding Enhancers on the Chemical Qualities of Soil.

		N ppm	P ppm	K ppm
		Mean	Mean	Mean
Type of enhancers	Sandy Prelite Comparison	19.00	.79	34.00
	Sandy with 0.2% Prelite	56.00	1.26	76.00
	Sandy with 0.5% Prelite	66.00	1.50	80.00
	Sandy with 2% Organic residues	42.00	5.27	100.00
	Sandy with 4% Organic Residues	52.00	7.90	164.00
	Sandy with 6% Organic Residues	55.00	10.75	240.00
	Sandy Clay Loam Prelite Comparision	29.00	.52	139.00
	Sandy Clay Loam with 0.2% Prelite	67.00	1.37	168.00
	Sandy Clay Loam with 0.5% Prelite	79.00	2.22	304.00
	Sandy Clay Loam with 2% Organic Residues	51.00	6.85	332.00
	Sandy Clay Loam with 4% Organic Residues	56.00	12.12	372.00
	Sandy Clay Loam with 6% Organic Residues	69.00	13.66	450.00

ISSN-Internet 2197-411x OLCL 862804632

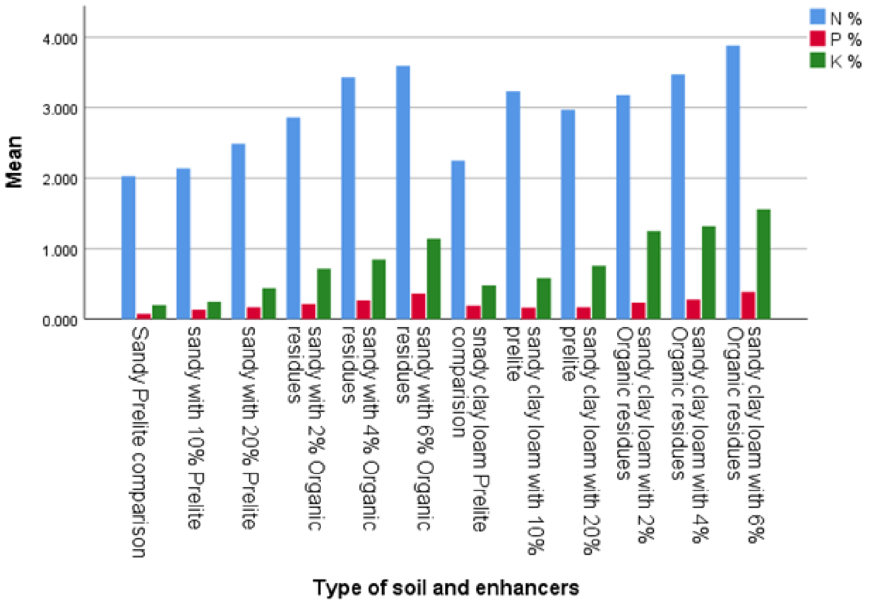

Figure 4: Clustered Bar Mean of N %, Mean of P %, Mean of K %.

Table No. (6) and Figure (5) demonstrate that the treatment with 6% residues yielded the greatest values of 3.72, 0.381, and 1.82% for sandy loam soil, in contrast to the treatment without addition, which produced values of 2.25, 0.192, and 0.48%. In contrast, the 6% organic residues treatment yielded values of (3.62, 0.275, 1.12%) for sandy soil, and the treatment without addition produced values of (2.05, 0.075, 0.2%) correspondingly. Organic fertilisation treatments surpass the control treatment due to their function in nutrient release, enhancement of soil biological properties, and increased availability of both micro and macro elements. These elements influence overall plant activity, hence enhancing the plant's vegetative yield. This aligns with the findings of Farid et al. (2021). Furthermore, organic fertiliser possesses the capability to chelate mineral elements owing to the efficacy of its active groups, specifically fulvic and humic acids.

Table 6: Effect of adding Enhancers on the Nutrient Content of the vegetative part of Broad Bean Plants.

		N %	P %	K %
		Mean	Mean	Mean
Type of soil and enhancers	Sandy Prelite Comparison	2.030	.075	.200
	Sandy with 10% Prelite	2.140	.133	.250
	Sandy with 20% Prelite	2.490	.170	.440
	Sandy with 2% Organic Residues	2.860	.214	.720
	Sandy with 4% Organic Residues	3.430	.270	.850
	Sandy with 6% Organic Residues	3.590	.366	1.140
	Sandy Clay Loam Prelite Comparision	2.250	.192	.480
	Sandy Clay Loam with 10% Prelite	3.230	.166	.580
	Sandy Clay Loam with 20% Prelite	2.970	.170	.760
	Sandy Clay Loam with 2% Organic Residues	3.180	.235	1.250
	Sandy Clay Loam with 4% Organic Residues	3.470	.280	1.320
	Sandy Clay Loam with 6% Organic Residues	3.880	.388	1.560

The Concentration of Penolic Acids in the Vegetative Part of the Bean Plant by using HPLC Technique:From Table No. (7), Figure (6-8-9-10-11-12) the results of high-performance liquid chromatography analyzes (HPLC) of vegetative part of Bean plant were showed the superiority of the addition treatment of 6% residues for mixed sandy soil, which gave the highest value (25.8,29.8) mg /L for both (caffeic acid) and (Calic acid), respectively, compared to the treatment without addition, which gave (13.5, 18.7)mg /l, respectively, as well as the table showed that the addition treatment of 6% organic residues for sandy soil the highest value (15.9, 20.6) mg /L compared to the treatment without addition, which gave values of (8.1, 12.4) mg /L for both (caffeic acid) and (Calic acid), respectively, and these results were proportional to the increased concentration Nutrients nitrogen, phosphorus, potassium and other chemical qualities because phenolic acids are important in plant growth.

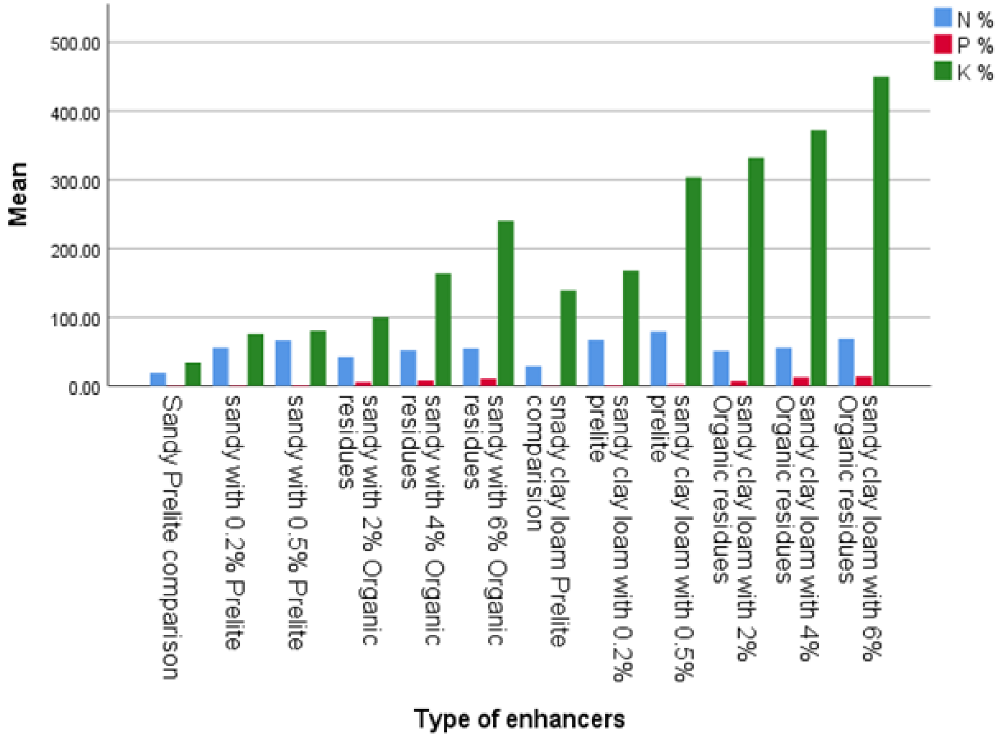

Figure 5: Clustered Bar Mean of N %, Mean of P %, Mean of K %.

Table 7: Concentration of Phenolic Acids in the Vegetative Part of the Bean plant by using HPLC Technique.

		Sample No.	Gallic acid	Qurcetine	Rutin	Apigenin	Caffeic acid
		Mean	Mean	Mean	Mean	Mean	Mean
Type of soil	Sandy comparison	1.00	8.10	5.10	7.10	3.10	12.40
	6% sand residue	2.00	15.30	9.20	13.20	5.90	19.60
	0.5 % Sand perlite	3.00	11.20	7.10	8.90	5.60	15.90
	Mixed Comparative	4.00	13.50	8.90	11.40	6.90	18.70
	6% mixed residue	5.00	25.10	15.10	20.10	12.30	29.90
	0.5% perlite blend	6.00	19.10	11.50	14.50	8.60	20.40

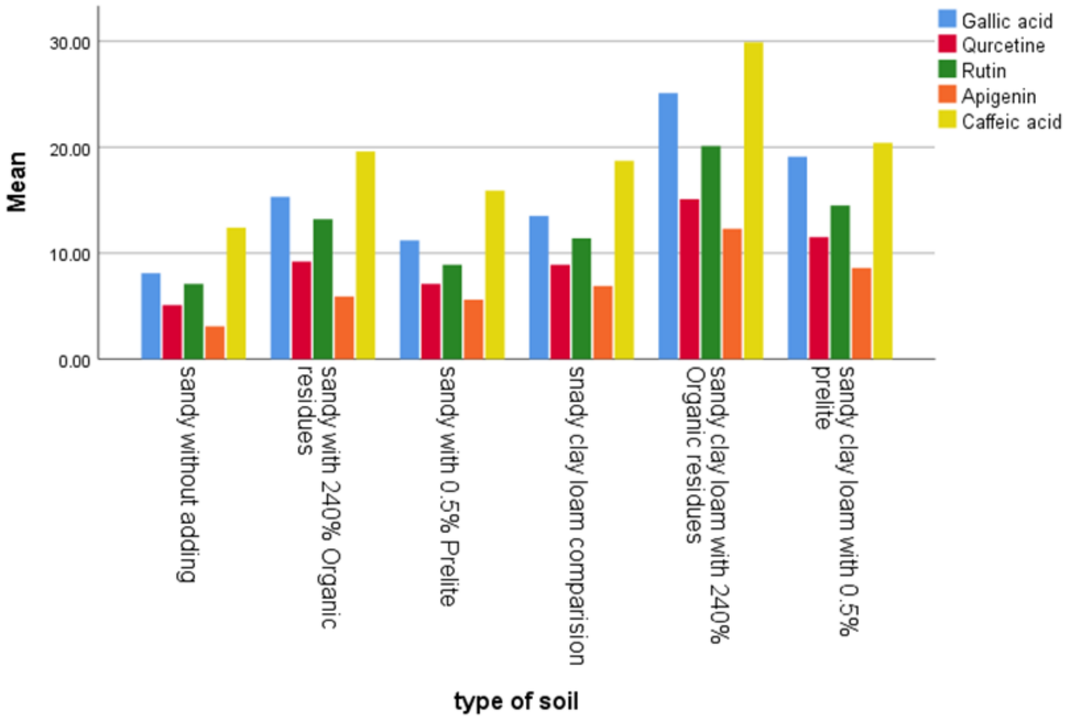

Figure 6: Clustered Bar of Gallic acid, Mean of Qurcetine, Mean of Rutin, Mean of Apigenin, Mean of Caffeic acid by Type of Soil by INDEX.

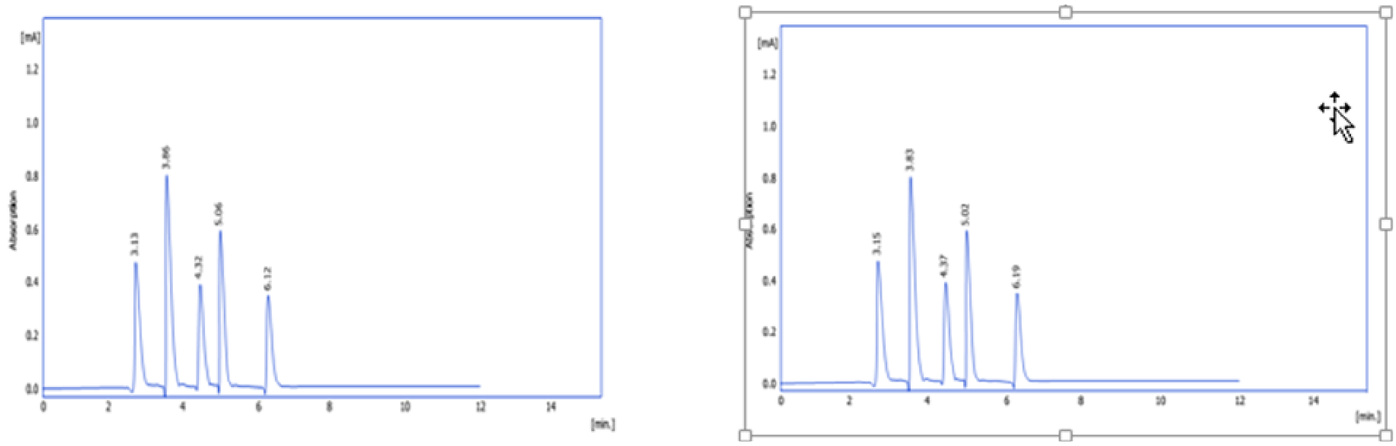

Figure 7: Chromatographic Comparison between Sandbox Companion and Sandy Soil with 6% Organic Residues, Showing Phenolic Compound Separation And Retention Times.

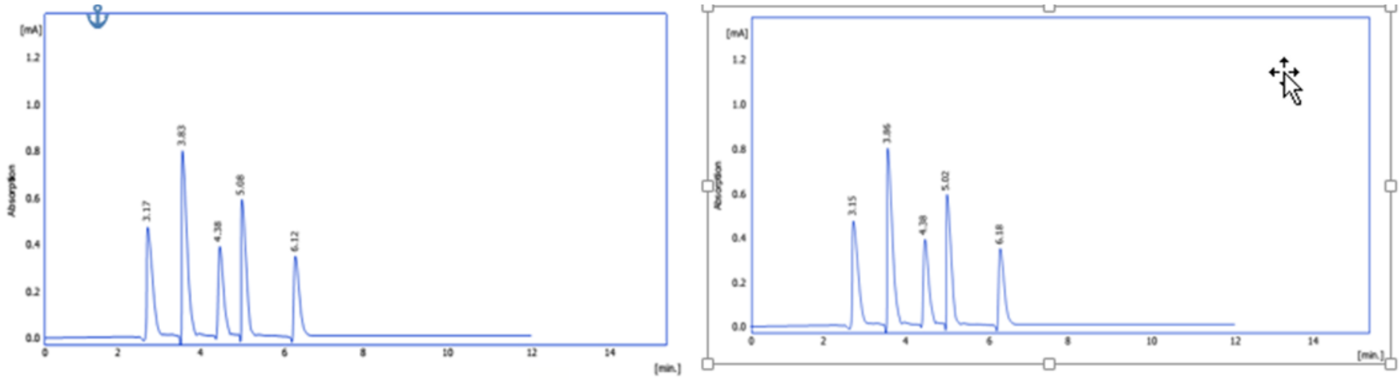

Figure 8: Chromatographic Comparison of Phenolic Compounds in Soils Treated with 0.5% Perlite: Shows Mixed Sand with 0.5% Perlite, and Shows Sandy Soil with 0.5% Perlite, Highlighting Differences in Retention Times and Peak Intensities.

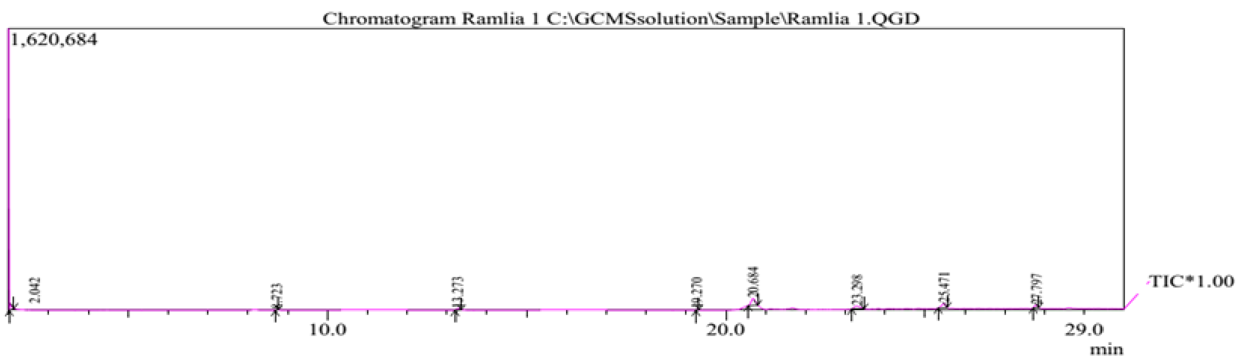

Figure 9: Sandy Soil (comparison) (Bean seeds).

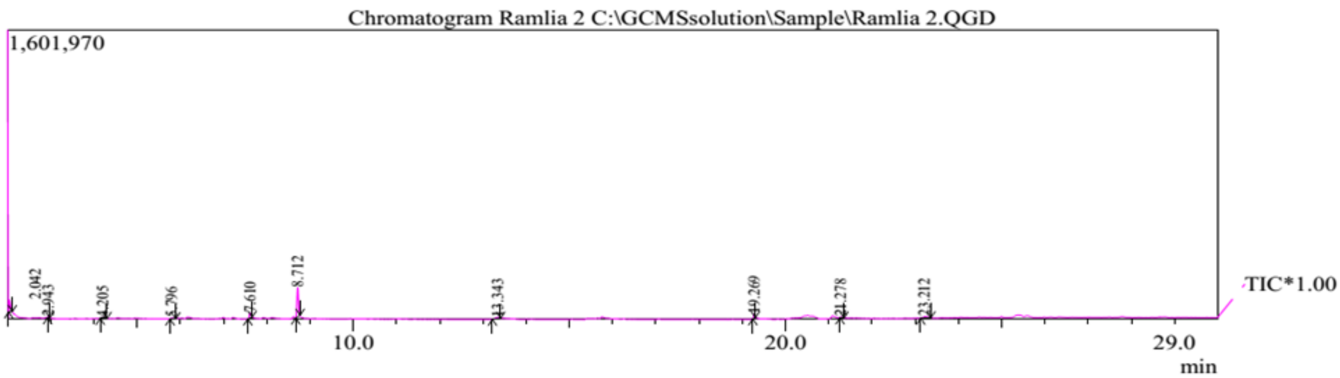

Figure 10: Sandy Soil (residue) (Bean seeds).

ISSN-Internet 2197-411x OLCL 862804632

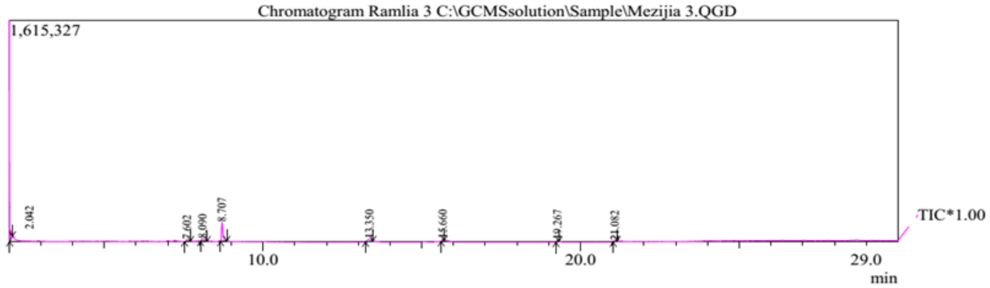

Figure 11: Mixed Sandy Soil (comparison) (Beans seeds).

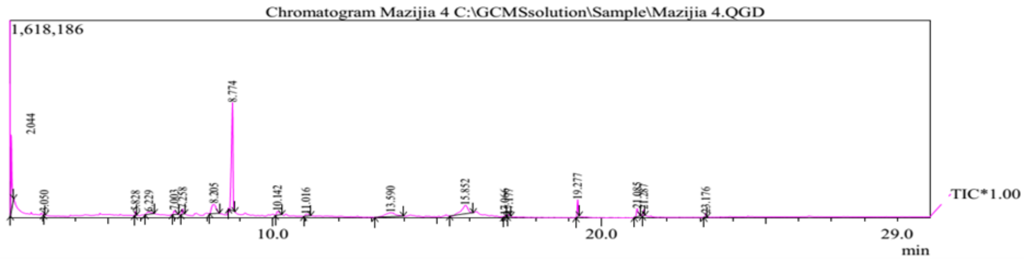

Figure 12: Mixed Sandy Soil (6% residues) (Bean seeds).

4. Conclusions

Our study concluded that the application of environmentally sustainable organic enhancers (organic residues) yielded the highest nutrient levels in both soil and plant content, along with an elevation in the concentration of phenolic acids and chemical compounds, as analysed through high-performance liquid chromatography (HPLC) for vegetative samples and gas chromatography-mass spectrometry (GC-MS) for seed samples. This, in turn, resulted in an enhancement of plant production from a chemical pe.

4.1. Acknowledgment

The College of Agriculture and Forestry and the chancellorship of the University of Mosul are credited by the authors as providing all the necessary support to carry out this investigation.

References

Dhull, S. B., Kidwai, M. K., Noor, R., Chawla, P., Rose, P. K. (2022). A review of nutritional profile and processing of faba bean (Vicia faba L.). *Legume Science, 4*(3), e129. doi: https://doi.org/10.1002/leg3.129

Duru, C. C., Daniel, U. I., & Ogbulie, J. N. (2018). Impacts of Organic Wastes on Water Quality of Woji Creek in Port Harcourt, Nigeria. *Journal of Applied Sciences and Environmental Management, 22*(5), 625-630. doi: https://doi.org/10.4314/jasem.v22i5.3

El-Gayar, S., Negm, A., & Abdrabbo, M. (2019). Greenhouse Operation and Management in Egypt. In A. M. Negm (Ed.), *Conventional Water Resources and Agriculture in Egypt* (pp. 489-560). Springer International Publishing. doi: https://doi.org/10.1007/698_2017_230

FAO. (2020). *Soil Testing Methods – Global Soil Doctors Programme - A Farmer-to-Farmer Training Programme.* Food and Agriculture Organization of the United Nations, Rome. doi: https://doi.org/10.4060/ca2796en

Farid, I. M., El-Ghozoli, M. A., Abbas, M. H. H., El-Atrony, D. S., Abbas, H. H., Elsadek, M., Saad, H. A., El Nahhas, N., Mohamed, I. (2021). Organic Materials and Their Chemically Extracted Humic and Fulvic Acids as Potential Soil Amendments for Faba Bean Cultivation in Soils with Varying CaCO3 Contents. *Horticulturae, 7*(8), 205. doi: https://doi.org/10.3390/horticulturae7080205

Fonteh, M. L., Fonkou, T., Fonteh, M. F., Njoyim, E. B. T., & Lambi, C. M. (2017). Spatial Variability and Contamination Levels of Fresh Water Resources by Saline Intrusion in the Coastal Low Lying Areas of the Douala Metropolis-Cameroon. *Journal of Water Resource and Protection, 9*(2), 215-237. doi: https://doi.org/10.4236/jwarp.2017.92015

Hacıseferoğulları, H., Gezer, İ., Bahtiyarca, Y., & Mengeş, H. O. (2003). Determination of Some Chemical and Physical Properties of Sakız Faba Bean (Vicia Faba L. Var. Major). *Journal of Food Engineering, 60*(4), 475-479. doi: https://doi.org/10.1016/S0260-8774(03)00075-X

Kai, T., Mukai, M., Araki, K. S., Adhikari, D., & Kubo, M. (2016). Analysis of Chemical and Biological Soil Properties in Organically and Conventionally Fertilized Apple Orchards. *Journal of Agricultural Chemistry and Environment, 5*(2), 92-99. doi: https://doi.org/10.4236/jacen.2016.52010

Khudhair, M. F. (2018). *Soil Physics*. doi: https://doi.org/10.13140/RG.2.2.25306.80327

Pansu, M., Gautheyrou, J. (2006). *Handbook of Soil Analysis: Mineralogical, Organic and Inorganic Methods*. Springer. doi: https://doi.org/10.1007/978-3-540-31211-6

Seker, C. (2003). Effects of Selected Amendments on Soil Properties and Emergence of Wheat Seedlings. *Canadian Journal of Soil Science, 83*(5), 615-621. doi: https://doi.org/10.4141/S02-080

Srivastava, A. K., Singh, S. (2002). Soil analysis based diagnostic norms for Indian citrus cultivar. *Communications in Soil Science and Plant Analysis, 33*(11-12), 1689-1706. doi: https://doi.org/10.1081/CSS-120004816