The Effect of Gabbroic Rock on Vegetative Growth, and Nutrient Status of Sesame

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ABSTRACT--- ***The paper aims at evaluation of finely crushed gabbro from Sinai, Egypt as a cheap soil conditioner to increase food crops production. Gabbro from different localities was collected and characteristic using XRD and XRF. The results from XRD analysis of samples of gabbro from Wadies Nesreen, Saal, El Akdar and Ferian revealed the abundance of amphibole (hornblende Ca (Mg, Fe, Al) (Al, Si)8O22(OH)2, actinolite {Ca2} {Mg4.5-2.5Fe0.5-2.5} (Si8O22) (OH)) and calcic-plagioclase (labrador-bytownite) as the main components. Quartz, clinochlor and mica are recognized in addition to olivine and pyroxene.***

XRF data revealed the abundance of a number of macro- micronutrients that are essential for plant growth (notably calcium, magnesium, and trace elements: iron, manganese, zinc, and copper) and relatively low amounts of phosphorus and potassium. The average of the sum of the 4 basic cations (Ca, Mg, K, and Na in cmol/kg of crushed gabbro) provided a sound basis for determining the effective cation exchange capacity (ECEC) of the fraction. The cultivation of sesame in the saline sandy clay loam soil without gabbroic rock was failed. This failure attributed to the sensitivity of sesame to salinity. The height of sesame plants cultivated with ground gabbro excited 5 feet tall which revealed high fertility and high moisture content. This fertility could be attributed to the ground gabbroic rock as soil conditioner.

Keywords--- gabbro, saline soils, sesame

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1. INTRODUCTION

South Sinai, an arid to extremely arid region, is characterized by an ecological uniqueness due to its diversity in landforms, geologic structures, and climate that resulted in a diversity in vegetation types, which is characterized mainly by the sparseness and dominance of shrubs and sub-shrubs and the paucity of trees and a variation in soil properties. Soils of South Sinai, as desert soils (Aerosols), are characterized by spatial heterogeneity, where soil properties vary over quite small distances. The causes of this heterogeneity include variation in plant cover, vegetation composition, slope, and topography. Soils of the South Sinai are gravelly in wadis and plains, rocky at mountains in surface, sand to loamy sand in texture, alkaline, non saline to saline. They are characterized by low content of essential nutrients and CEC.

Gabbro is a coarse-grained, dark-colored, intrusive igneous rock is equivalent in composition to basalt. The difference between the two rock types is their grain size. Basalt are extrusive igneous rocks that cool quickly and have fine-grained crystals. Gabbroic rocks are intrusive igneous rocks that cool slowly and have coarse-grained crystals. Chemically, the gabbroic rocks show a narrow range for SiO_2 from 46.69 to 52.35 wt.%, a moderate range for Al_2O_3 from 12.08 to 16.1 wt.%, but wide ranges for Fe_2O_3 (9.12–14.81 wt.%), MgO from 5.54 to 11.34 wt.% and CaO from 12 to 13%.

The gabbroic rocks of Sinai occur in several areas such as Wadi Melhega, Wadi El Bida, Wadi Nesreen , Wadi Ferian , Wadi El Akhdar, Wadi Sa'al and Wadi El Mahash.

The crushed basement rocks could improved the texture and structure of sandy soils and consequently improved the growth of plant. This improvement may be attributed to change the soil to finer one, soil bulk density, total porosity, void ratio, pore size distribution, moisture retained at different suctions. Soil properties related to the water movement i.e. infiltration rate, hydraulic conductivity and mean pore diameter were also improved. Thus, the vegetative growth of plant improved Mervat et al. [1].

A large numbers of the users of rocks dust. Coventry et. al. [2], Mervat et al. [3] and Mervat et al., [4] have found significant improvements in crop production that they have attributed to the beneficial effects of these dust. The anecdotal evidence includes; faster plant growth, hardier plant foliage, Greater plant resistance to pests and diseases, increased friability of the soil, increases productivity of saline soils and more vigorous soil animal populations, increased capacity of the soil to retain, in the root zone of the plants, moisture and nutrients applied as fertilizers, improved crop yields and produce quality, improved sandy soil texture.

Silicate-based rocks as conditioners have been used to modify the properties of soils and thereby improve the productivity of highly weathered tropical soils for more than 70 years [5]- [11]. Gillman [12] and Mervat [4] concluded that, "a single large application of the silicate-based rocks cinders may obviate the need to apply Ca and Mg for many years, as well as reduce the leaching losses of applied NH4 and K over a similarly long period. Zdrilic and Dumitru [9] studied the complex interactions that occur when rock dust is added to the soil. Harly [13] concluded that, the type of rock dust, the nature of the soil to which the dust is applied, and rates of weathering and mine breakdown are extremely important factors in the effective use of rock dusts. Harley and Gilkes [20] recommended the use of rock dust as a slow release fertilizer for it is not readily leached from the soil, it is acceptable to 'organic' farmers, it is affordable in developing countries and it can reduce stockpiles of quarry mining by-products.

The study aims at enhancement of sesame crop productivity in saline soils using gabbro dust as soil conditioner.

2. METHODOLOGY

2-1 Gabbro

Representative samples were collected from different localities namely; Wadi Nesreen, Wadi Ferian , Wadi El Akhdar and Wadi Saal. The mineralogy of representative samples was determined by means of a Philips Powder Diffractometer Model PW 1170 employing CoKα radiation on randomly oriented specimens. All samples were scanned over the 2θ degree range 4–60. Quantitative analysis of the major elements of gabbro was determined by X-ray Fluorescence Spectroscopy using Philips PW l300. 10 g each of the sample was mixed together and further ground to powder. 8 g of the mixed powdered was mixed with 2 g of Herzog organic binder. The organic binder contains 90% cellulose and 10% wax. The mix was further ground and homogenized using a mill. The homogenized samples were placed in an aluminum cup and hydraulically pressed into pellets under a very high pressure of 20 tons for 60 s. This was done to ensure sample integrity under the vacuum and a consistent surface to receive the X-ray.

2-2 Soils

Soil samples from 0 – 10 cm layer were collected from Sinai to determine the physical and chemical properties.

Quality characteristics of soil such as pH, Electrical Conductivity(EC), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (NaO), Potassium (K_2O), Bicarbonate (HCO_3^-),Chloride(Cl^-), total Organic Carbon, available Nitrogen (N), available Phosphorus (P) and available Potassium (K) were determined as per standard methods (Table 1) and classification of soils shown in Table 2.

Table 1. Methods used for quality analysis of soil samples

Quality characteristics	***M*ethod used**
pH	pH meter
Electrical Conductivity (EC)	conductivity meter
Ca^{2+}, Mg^{2+}, Na^+, K^{2+}	Ion Chromatography
HCO_3	Neutralizing with standard HCl
Cl-	Ion Chromatography
Total Organic Carbon	C-S analyzer
Nitrogen (N)	Kjeldal method
Available Phosphorus (P_2O_5).	Olsen's method (Spectrophotpmetric
Available Potassium (K_2O)	Flame photometer

Measurement of CEC (according to Gillman and Sumpter (1986a,1986b)[14,15] of soils to measure the ability of the soil to retain cations on the colloidal surface and supply them to the soil solution for uptake by plants.

2-3 Cation Chemistry /Crushed gabbro–Incubated Soils

Approximately 70 kg of the soil was collected from the 0 - 10 cm depth. The bulk sample was air-dried and sieved to 2 mm. One size grade of gabbro (<2 mm particle size) was thoroughly mixed into the surface soil samples from Sinai (saline sandy soil) at application rate equivalent to (36 gm gabbro / 1kg soil), Manure (240g/kg soil) added to the soil for 40 days under moisten condition in the field.

2-4 Determination of soluble and bound cation of incubated soils

This study describes the procedures for measuring the soluble and bound cations as well as the cation exchange capacity (CEC) of soils. Clay minerals in fine-grained soils carry a negative surface charge that is balanced by bound cations near the mineral surface. These bound cations can be exchanged by other cations in the pore water, which are referred to as soluble cations. The CEC generally is satisfied by calcium (Ca), sodium (Na), magnesium(Mg), and potassium (K), although other cations may be present depending on the environment in which the soil exists. This test method was developed from concepts described previously in Rhoades (1982)[16]. In soils with appreciable gypsum or calcite, dissolution of these minerals will release Ca in solution that may affect the measurement.

The soluble salts from the mineral surface are washed off with de-ionized water and then the concentration of soluble salts within the extract is measured. The bound cations of the soils are measured by using a solution containing Ba ion that forces the existing cations in the bound layer into solution. The total concentrations of bound and soluble cations in this solution are measured using ion chromatograph.

2-5 Chemical, physical and texture composition of soil

These parameters of soil from Sinai governorate were measured based on Standard methods shown in Table 2.

Table 2. Classification of soil quality

Quality characteristics	Unit	Standard value (Range)	Catogray of Soils
pH	-	Up to 4.50 4.51-5.00 5.01-5.50 5.51-6.00 6.01-6.50 6.51-7.30 7.31-7.80 7.81-8.50 8.51-9.00 >9.00	Extremely acidic Very strongly acidic Strongly acidic Moderately acidic Slightly acidic Neutral Slightly alkaline Moderately alkaline Strongly alkaline Very strongly alkaline
Electrical Conductivity (Salinity)	mS/cm	Up to 1.00 1.01-2.00 2.01-3.00	Average Harmful to germination Harmful to crop
Organic Carbon	%	Up to 0.20 0.21-0.40 0.41-0.50 0.50-0.80 0.81-1.00 Above 1.00	Very less Less Medium On an average sufficient Sufficient More than sufficient
Available Nitrogen (N)	kg/ha	Up to 50 50-100 101-150 151-300 Above 300	Very less Less Good Better Sufficient
Available Phosphorus (P_2O_5)	kg/ha	Upto-15 16-30 31-50 51-65 66-80 >80	Very less Less Medium On an average sufficient Sufficient More than sufficient
Available Potassium (K_2O)	kg/ha	Up to 119 120-180 181-240 241-300 301-360 >360	Very less Less Medium Average Better More than sufficient

2.6 Field experiments

Field experiments were carried out to study the effect of gabbroic rock in healing Sinai sandy clay soil and increase the productivity of sesame. Gabbroic rock from Wadi Nesreen; W. Saal; W.Akhdar and W. Ferian were used for increase productivity of Sinai sandy soil (EC 14.50 Mmols/cm) in terms of improvement of vegetative growth, water consumption and nutrient uptake of sesame.

2-7 Treatment

Gabbro from previous Wade's <2 mm (36 gm gabbro / 1kg soil), Manure (240g/kg soil) added to all the previous soil (Sinai soil incubated with gabbro and manure for 40 days under moisten condition in the field. ½ kg KSO4 and ½ kg urea were added to Sinai soil, super phosphate added while flipping the soils. Urea and potassium sulfate added during the irrigation (18/6/2015- 4/10/2015), irrigation carried out based on the necessity of the soils (control and soils + gabbro).

3. RESULTS AND CONCLUSIONS

3.1 Mineralogy

The mineralogical composition of the studied samples revealed the abundance of amphibole (hornblende Ca (Mg, Fe, Al) (Al, Si)8O22(OH)2, actinolite {Ca2} {Mg4.5-2.5 Fe0.5-2.5} (Si8O22) (OH)) and calcic-plagioclase (labrador-bytownite) as the main components. Quartz, clinochlor and mica are recognized by their characteristic reflections peaks at 3.3, 14 and 10Å. Traces of pyroxene (augite) and olivine (Fayalite) are recognized. On the other hand, W. Ferian contains quartz among the major rock forming minerals, plagioclase (andesite), mica (biotite) and amphibole (actinolite) are also recognized. Olivine minerals are rarely encountered. Traces of augite and enstatite are recorded. An accessory mineral is titanite, and a metallic mineral is magnetite.

3.2 Chemical analysis

Chemical analysis of gabbroic rocks from W. Ferian conferred the abundance of SiO_2 and K_2O, in contrary low CaO, Fe_2O_3 and MgO content compared with the chemical analysis of the gabbroic rocks from the other localities.

3.4 Cation exchange capacity (CEC)

Cation exchange capacity of <2.5mm size of crushed gabbro from different localities were measures using BaCl technique. The average of the sum of the 4 basic cations (in cmol/kg of crushed gabbro) provided a sound basis for determining the effective cation exchange capacity (ECEC) of the fraction (Table 3)

Table 3 Cation exchange capacity of soil treated with different gabbroic rocks from Sinai; incubation (6 weeks)

Cmol/kg	**Soil**	**Gabbro <2 mm, 35gm/Kg**			
		Nesreen	**Saal**	**Akdar**	**Ferain**
Na	0.79	3.52	2.22	2.51	3.09
K	0.51	5.88	5.44	3.02	2.95
Mg	4.05	4.46	4.27	3.71	5.74
Ca	15.9	8.28	7.8	6.86	6.77

3.5 Characterization of Soil

Data presented in Tables 4-6 shown chemical composition, micronutrient and texture of soil from Sinai governorate. Based on classification of soils, Sinai soil is of high salinity (14.5 ds/m), this salinity causes severe problem with 25 to 50% yield loss excepted. The soil has high exchangeable sodium percent and low saturation percent 25% means sandy soil with low water retention. Studies soil also has high sodium adsorption ratio 16.57% as well as high exchangeable sodium percent. Moderately alkaline soil, contain low organic carbon, low K and P, and high N. Moderate micronutrient except Zn (very high). Essentially salts are NaCl + CaSO4 + MgSO4.

Table 4 Chemical analysis and physical properties of saline soil

Soil	Soil pH 1:2.5	EC (dS/m)	SP	Anions meq/l				Cations meq/l				O.M %
				$CO_3^{=}$	HCO_3^-	Cl^-	$SO_4^{=}$	Ca^{++}	Mg^{++}	Na^+	K^+	
Sinai	7.88	14.50	25	-	0.5	143.7	4.8	40.6	16.7	80.6	2.1	0.19

Table 5 Micronutrient in studied soil

mg/kg						
Mn	**Zn**	**Cu**	**Fe**	**K**	**P**	**N**
3.15	22.48	1.10	4.77	123.2	2.95	194

Table 6 Texture of studied soil

Soil	Sand %	Silt %	Clay %	Textures	OM %	B D g/m3	SAR mmol/l	TDS ESP	TDS ESP
Sinai	52.44	5.4	42.12	Sandy Clay loam	0.19	1.4	16.57	15.05	20.5

3-6 The growth responses of the sesame plant to the application of grind gabbroic rock, fertilizes (NPK) and manure

Sesame is characterized by a slow growth rate in the first 30 days while the root is growing faster than the leaves and stems. Table 7 and Figure 1 shown the rate of growth of sesame under irrigation treated with four types of gabbroic rock. In the first 34 days, the plants reach almost 1 foot in height. It will double to 2 ft. in the next 11 days, triple to 3 ft. in the following 8 days, and quadruple to 4 ft. in the following 9 days. At this point, the sesame will begin to canopy and the rate of growth will level off. In rainfed conditions, the final plant heights are lower, but the pattern of very slow growth followed by fast growth during the reproductive phase exists under all conditions (Sesaco guide, [17]. From Figure 1 and Table 7, it's clear that sesame planted with ground gabbroic rocks from Wadi Nesreen had lowest height compared with the others. On the other hand, the cultivation of sesame in the saline sandy clay loam soil without gabbroic rock was failed. This failure attributed to the fact that, sesame is sensitive to salinity. The height of sesame plants in this study excited 5 feet tall which revealed high fertility and high moisture content (Sesaco guide, [17]. This fertility could be attributed to the ground gabbroic rock as soil conditioner.

Table 7 Rate of growth of sesame

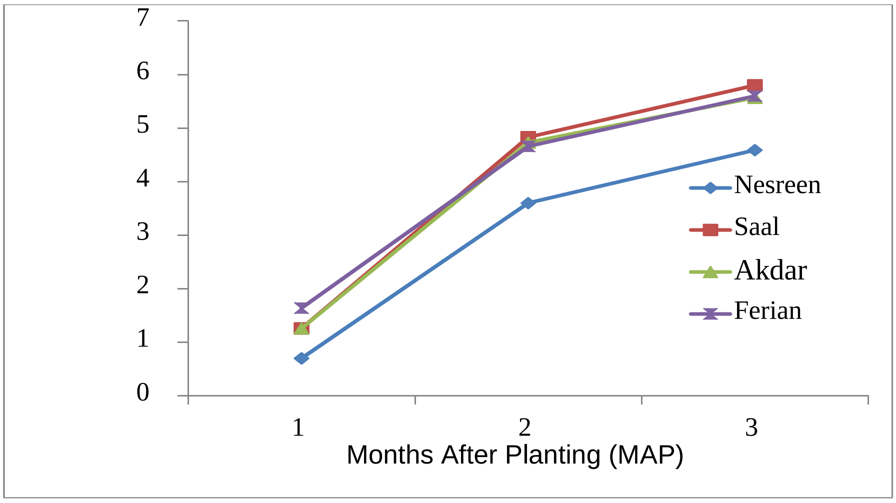

Fig. 1Rate of sesame growth

Table 7 Rate of growth of sesame

Soil	Sesame	Gabbro			
		Nesreen	**Saal**	Akdar	Ferian
Sinai	1 Month	0.70 Ft.	1.26 Ft.	1.26 Ft.	1.64 Ft.
	2 Month	1.7-3.63	3.6-4.83	3.6-4.73	3.2-4.66
	3 Month	3.77-4.59	4.26-5.8	4.59-5.57	3.8-5.6

Tables 8 and 9 shown the sesame growth in term of Phenotypes. Phenotypes are categorized in terms of branching style, number of capsules per leaf axil and maturity class. Branching is the first character with the following values: uniculm (1), few (4), or many (7). Capsules per leaf axil is the second character with the following values: single (1) or triple (3). Maturity class is the third character and is in terms of days from planting until physiological maturity. The values are very early (V - fewer than 85 days), early (E - 85 to 94 days), medium (M - 95 to 104 days), late (L – 105 to 114 days) and very late (T – more than 114 days). According to the previous classification, the sesame planted with grind gabbroic rocks as soil conditioners are of branching values ranged between uniculm to few (3). Capsules per leaf axil are ranged from single to triple in the majority, maturity class is medium.

Cultivation of sesame in sandy loamy saline soil with ground gabbroic rocks from Sinai at early July recording high values of plant height (ft.), number of capsules/plant, capsules length (inch), numbers of nodes as well as the grains yields (kg/ha) compared with data of Hamza and Abd El Salam [18] who planted sesame in sandy saline soil in Wadi El Natroon at 20th March, 9th April, 29th April and 19th May. They concluded that, under early sowing date, the plant had enough vegetative growth, adequate photosynthetic activities and assimilates than sowing later in the season. Similar trend was obtained by Mulkey et al. [19], Nath et al. [20], Alam Sarkar et al. [21]. Conversely, Olowe [22], Ogbonna and Umar-Shaaba [23] as well as, Ali and Jan [24] mentioned that the late planting dates (20 June to 1 August) were the optimum ones.

Table 8 Sesame growth

Phase/Stage	**End point of stage**	**Days after Planting**			
Vegetative		**Nesreen**	**Saal**	**Akdar**	**Ferian**
Germination	Emergence	0-6	0-5	0-5	0.5
Seedling	Third pair true leaf length equals second	6-30	5-25	0-25	5-26
Juvenile	First buds	30-40	25-35	25-35	25-35
Pre reproductive	50% open flowers	40-46	35-40	35-40	35-40
Reproductive					
Early bloom	5 node pairs of capsules	41-50	41-48	41-48	41-48
Mid bloom	Branches and minor plants stop flowering	50-75	49-74	48-78	48-78
Late bloom	90% of plants with no open flowers	75-90	74-80	74-80	74-80
Ripening	Physiological maturity(PM)	81-110	81-102	81-102	81-102
Drying					
Full maturity	All seed mature	110-115	102-110	102-110	102-110
Initial dry down	First dry capsule	113-123	110-120	110-120	110-120
Late dry down	Full dry down	124-134	110-120	110-120	110-120

Our traits demonstrated the potential of application of the ground gabbroic rocks as soil conditioner for healing salinity of sandy soil from Sinai. These rocks contain calcium and magnesium to substitute Na cations and alter the exchangeable cation status of cations-deficient soil (Table 10). From the time of germination, most of the plants treated with ground gabbroic rocks appeared to be strong, producing their first set of leaves at a time (Fig. 2) when seedlings in controls were still emerging. generally, control stopped germination. This happened due to toxicity effect of Na^+ and Cl^-.

Table 9 The phases and stages of sesame development

Character	**W. Nesreen**	**W. Saal**	**W. Akdar**	**W. Ferian**
Branching Style	Few	Few	Few	Few
Number of Capsules per Leaf Axel	1-3	1-3	1 -3	1 -3
Seed Color	Buff	Buff	Buff	Buff
Yield (kg/ha)	1778	2898	2144	2632
Days to Flowering	47	43	43	40
Days to Flower Termination	84	81	81	81
Days to Physiological Maturity	95	90	90	90
Days to Direct Harvest	131	127	127	127
Height of Plant (ft.)	3.8-5.6	4.6-5.6	4.3-5.8	3.8- 4.59
Height of First Capsule (ft.)	1.96	0.98	1.24	1.05
Number of Capsule Nodes	18-22	20-30	24	24-37
Average Internodes Length within Capsule Zone (in)	2.1	2.75	1.96	1.57
Capsule Length (in)	0.78	1.18	0. 98	1.77
Seed Weight per Capsule (g)	0.155	0.164	0.167	0.160
Seed Weight – 100 Seeds (g)	0.2595	0.2736	0.2789	0.2670

Table 11 and Fig. 3 showed the effect of ground gabbroic rock as soil conditioner on vegetative growth of sesame compared with control. Reclamation or improvement of saline soils requires the removal of part or most of the exchangeable sodium and its replacement by the more favourable calcium ions in the root zone. This accomplished by local available resources and the kind of crops to be grown on the reclaimed soils. These available resources could increase the availability of nutrients in soil. Diab et al., [25]and El-Aaser et. al., [26] stated that soil amendments have the capability to improve the physical and chemical properties of soil and in turn its nutrients supplying power. The dissociation of crushed gabbro and release of cations especially calcium and magnesium for the replacement of exchangeable sodium could counteract the effect of alkali salts within a plant (Table 10).

Also, calcium is essential for many plant functions, some of them are prepare cell division and elongation, enzyme activity and starch increase may be due to calcium, it's an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant.

Seeding stage 30/7/2015

Medium bloom stage 30/8/2015 Late bloom stage 20/9/2015 Late

Dry down stage 25/10/2015 Sesame Control

Fig. 2 Sesame growth stages

Table 10 Cation exchange capacity of soil treated with different gabbroic rocks from Sinai; incubation (6 weeks) and after harvest of sesame

Cmol/kg	**Soil**	**Gabbro <2mm, 36g/Kg**			
		Nesreen	**Saal**	**Akdar**	**Ferian**
Na	0.79	3.52	2.22	2.51	3.09
K	0.51	5.88	5.44	3.02	2.95
Mg	4.05	4.46	4.27	3.71	5.74
Ca	15.9	8.28	7.8	6.86	6.77
Cmol/kg	Soil	Gabbro <2 mm, 36 g/Kg soil			
		Nesreen	**Saal**	**Akdar**	**Ferian**
Na		**After Sesame Harvest**			
	0.79	2.58	1.98	2.05	2.48
K	0.51	2.46	2. 51	2.52	3.19
Mg	4.05	5.48	2.43	3.02	3.8
Ca	15.9	17.55	16.84	16.11	16.33

Table 11 Effect of ground gabbroic rock on vegetative growth of sesame

Treatment Gabbroic rock	**Soil Type**	**Plant (Kg)**	**Grains (Kg)**
Nesreen	**Sinai**	0.54	0.120
Saal		0.48	0.200
Akdar		0.66	0.120
Ferian		0.58	0.120
Control		0	0

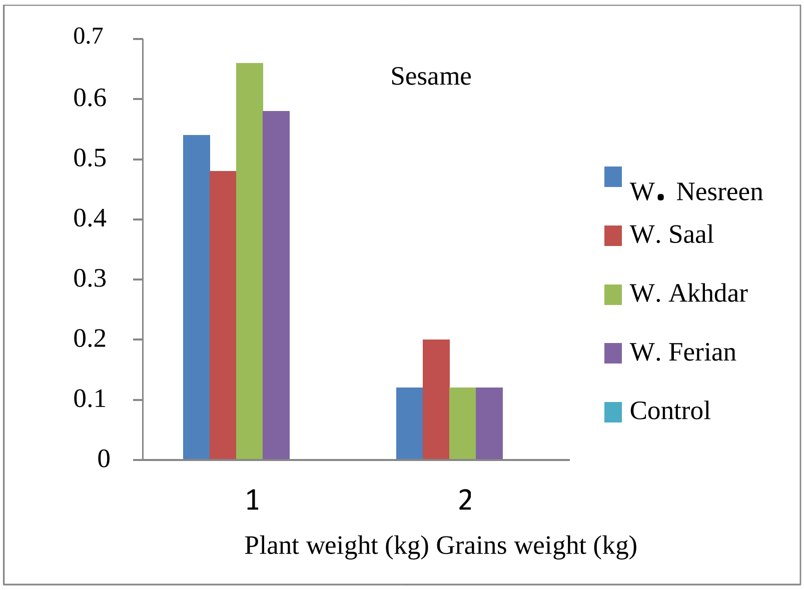

Fig. 3 The effect of ground gabbroic rock as soil conditioner on vegetative growth of sesame

Data in Table (12) showed that soil electrical conductivity decreased as a result of decreasing salinity of soils due to treatment with grind gabbroic rock, it is more pronounced in sandy loam soiL treated with W. Saal gabbroic rock. The highest value was 5.25 for W. Nesreen rock +NPK+ manure. Lowest one was 0.64 for W. Saal rock +NPK+ manure. The concentration of soluble calcium plus magnesium in saline soils decreased as a result of gabbroic rock treatment. The calcium plus magnesium ions, as compared with soil, decreased between 91 and 98% for soil treated with ground gabbroic rock. Soluble sodium and chloride content in the studied soil are decreased (Table 12). In sandy soil + gabbro + NPK+ manure, the rate of decrease in the soluble sodium and chlorite content ranged between 52 and 97% for sodium and 70 to 97% for chlorite. All micronutrients in soils treated with gabbroic rock are increased after sesame harvest especially Fe, Mn, K and P (Table 13).

Table 12 Chemical and physical properties of sandy saline soil after harvest of sesame

Soil	pH 1:2.5	EC (dS/m)	SP	Anions meq/l				Cations meq/l				O.M %
				$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	Na^+	K^+	
Sinai	7.88	14.50	25	-	0.5	143.7	4.8	40.6	16.7	80.6	2.1	0.19
Nesreen	7.99	5.25	30	-	0.3	42.8	4.7	4.1	2.6	38.5	2.8	1.75
Saal	7.89	0.64	25	-	0.2	3.2	1.1	1.1	0.3	2.2	0.8	1.77
Akdar	7.87	0.67	35	-	0.2	3.4	1.2	1.2	0.3	2.3	0.9	1.78
Ferian	7.9	4.8	27	-	0.1	33.6	4.1	3.6	1.5	30.9	2.0	1.77
Control	-	-	-	-	-	-	-	-	-	-	-	-

Table 13 Micronutrient in soil after harvest

mg/kg							
Soil	**Cu**	**Mn**	**Zn**	**Fe**	**K**	**P**	**N**
	1.10	3.15	22.48	4.77	123.2	2.95	194
Nesreen	2.43	12.6	8.4	15.32	668	12.55	179
Saal	2.10	12.43	8.48	21.35	659	17.17	147
Akdar	1.08	7.8	6.4	18.20	745	15.9	112
Ferian	1.18	8.53	5.93	15.96	572	11.41	105
control	-	-	-	-	-	-	-

3-6 Nutrient and nutrient uptake of sesame plant

Tables 14 and 15 shown the level of essential major and minor elements of sesame. Calcium, potassium and magnesium, are macronutrient elements and possesses higher concentration as compared to four minor elements i.e., iron, zinc, manganese and copper. However, the value of calcium was found higher as compared to the majority of the minor elements, this may be due to their genetic character. Potassium is one of the most important elements, which can play key role in majority of the biological process, including electrolysis, therefore its high concentration needed to all living organism. Sesame is one of the important food commodities that contain large quantity of potassium in all varieties ranges. Magnesium possess second one highest position in all tabulated metals. The heavy metals/essential trace metals play vital role in most of the metabolic process during growth and development of biological tissues, when available within permissible level but below and above the recommended value have adverse effect for life. Among four essential microelements; the highest concentration of Zn was detected, which vary variety to variety in the same agriculture plot in range of 12-28 mg/kg. Concentration of copper ranged between (5-34 mg/kg). Whereas the concentration of manganese was detected in the range of 10-14 mg/kg. Iron is the only element that possesses lowest level (0.09-0.11 mg/kg) among all elements. These analytical values of soils tell that the soils treated with gabbroic rock as cheap soil conditioner are rich of these elements, which possesses many folds' higher concentration of mentioned elements absorbed by the plant and deposited in sesame grains (Singarave et al., [27]. The increased sesame yield with the application of crushed gabbroic rock along with NPK might be attributed to the rapid mineralization of N, P and K from inorganic fertilizers and steady supply of these nutrients to the crop at the critical stages as opined by (Subramaniyan et al. [28]. In addition, Zn and Mn through activation of various enzymes and increased basic metabolic rate in plants facilitated the synthesis of nucleic acids and hormones, which in turn enhanced the seed yield due to greater availability of nutrients and photosynthesis.

Table 14 Micro and macro nutrient of sesame

Treatment	Dry weight gm	%					mg/kg				
		P	N	Ca	Mg	K	Cu	Mn	Fe	Zn	B
Nesryeen	540	0.05	1.04	1.22	0.20	2.74	5.9	12.4	0.05	13.3	15.6
Saal	480	0.06	0.84	1.30	0.22	2.83	5.1	10.1	0.09	28.2	19.4
Akdar	660	0.12	0.91	0.44	0.23	2.65	18.2	14.6	0.10	14.5	6.1
Ferian	580	0.1	0.71	0.91	0.2	1.94	34.9	11.9	0.11	12.1	9.5
Control	-	-	-	-	-	-	-	-	-	-	-

Table 15 Nutrient uptake of sesame

Treatment	Dry weight gm	mg/plant					g/plant				
		P	N	Ca	Mg	K	Cu	Mn	Fe	Zn	B
Nesreen	540	0.27	5.61	6.59	1.08	14.79	0.031	0.067	0.00027	0.071	0.084
Saal	480	0.29	4.03	6.24	1.05	13.58	0.024	0.048	0.00043	0.135	0.093
Akdar	660	0.8	6.0	2.9	1.51	17.49	0.120	0.096	0.0006	0.095	0.040
Ferian	580	0.58	4.11	5.27	1.16	11.25	0.202	0.069	0.0006	0.070	0.055
Control	-	-	-	-	-	-	-	-	-	-	-

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