Increasing Productivity of Bean by Healing Salinity of Soils

Mervat said Hassan[1] and El Toney M. El Toney[2]
[1]Central Metallurgical R&D Institute, Cairo ,Egypt

[2]Ain Shams University, Cairo, Egypt

ABSTRACT— ***About one third of the cultivated land in Egypt is suffering from high sodicity, water logging, depletion of nutrient cations and deterioration of soil structure. Therefore, growing conditions for plants become more stressful. The article aims at application of crushed basalt as a cheap soil conditioner to increase cereal crops production Basalt from El Arish (Sinai) and Fayium collected and systematically characterized using X-ray diffraction and X-ray Fluorescence Equipments. Samples from the saline soils and soils adjacent to the ore localities collected and characterized. The basalt crushed and ground to different sizes to determine the most effective grain size. The studied basalt consists essentially of plagioclase in addition to olivine and pyroxene minerals. The mineralogy of basalt based mainly on the degree of alteration. The phyllosilicates minerals as well as calcite and zeolite raised as the degree of alteration increased. Also, the elementary data of basalt as well as loss in weight varied with the degree of alteration. The chemical data revealed that, the basalt can provide a number of macro- and micro-nutrients (notably calcium, magnesium, sulphur, and the trace elements: iron, manganese, zinc, and copper). studied soils are saline, slightly to moderately alkaline, contain sufficient organic carbon, high K and low other nutrients. Essentially salts are NaCl + $CaSO_4$ + $MgSO_4$, moderate to high micronutrient especially Mn and Fe. Bean was cultivated in sandy and clayey saline soils incubated with crushed basalt and manure for 5 weeks. .*** **The influences of crushed basalt of different sizes and doses in improving the vegetative growth of bean were investigated.**

Keywords— Saline soils, Silicate –Based rocks, Bean, Incubation

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1. INTRODUCTION

Salinity in the Nile-Delta increases progressively from less than 4 ds/m in the Southern part to about 16ds/m in the northern coastal area, which is suffering from intrusion of seawater, water shortage and poor quality of irrigation water. Many trials had been applied to healing the salinity. Addition of K to saline soils cultivated with rice plants avoids Na^+ toxicity by maintaining a high level of K^+ in the terms of high level of K^+ uptake against Na^+ [1] and [2]. Abd El Hadi et al.,(2008)[3] studied the effect of potassium sulfate and potassium chloride on the salt affected soils. Significant grain and straw yield increases were obtained by addition of SOP. Low rate of MOP can improve production with a lower performance compared to SOP, while high dose of MOP clearly demonstrate the detrimental effect of chlorine. They concluded that high production requires a large availability of mineral elements during critical stages. Zeidan et al., (2009)[4] studied the effects of irrigation intervals and nitrogenous fertilization with or without addition of compost at a rate of 5 ton/fad. on yield and yield attributes and crude protein content of three wheat cultivars. Irrigation intervals every 15 days gave the highest values for number of spikes / m^2 , number of grains/spike ,spike weight ,grain weight/spike, spike index , 1000 - grain weight , grain and straw yields (ton / fad.) and grain protein content. Meanwhile, nitrogen fertilizer as well as organic compost manure results showed that, increasing nitrogen fertilizer level up to 120 kg N / fad . significantly increased all characters studied . Addition of compost manure with nitrogen fertilizer had insignificant effect on all studied characters comparing with nitrogen levels alone. Irrigation interval every 15 days during growing seasons and application of 120 kg N/ fad gave the highest values of yield , yield components and grain protein content of Sids-1 wheat cultivar under saline soil condition.

The ground rock added to existing soils increases crop yield, boosts crop resistance to disease, pests, drought, frost and improves the condition of the soil thus reducing erosion. The produce grown in this soil has excellent taste and nutritional content, this increases the health of both livestock and humans [5].

Justus von Liebig, developed the “Law of the Minimum”, which is important in understanding how rock dust works. The Law states that plant growth is determined by the scarcest, “limiting” nutrient; if even one of the required nutrients is deficient, the plant will not grow and produce at its optimum. Conventional fertilizer programs focus on macro-nutrients like Nitrogen (N), Phosphorous (p) and Potassium (K). However, further research has proven that if one of the many essential trace elements is deficient in the soil, the plant will not perform at its optimum, affecting yield and immune function. Rock Dust contains rare and abundant micro & macro elements present within intrusive (plutonic) rock formations only, which were the key to locking in all our mineral elements in one place. An extraordinary and unique combination found in very few places on Earth.-

With unique 92+ essential elements, consisting of a broad range of trace minerals along with small amounts of macro elements, the soil nutrients which have been slowly lost through the ages by erosion, leaching and farming are gently regenerated. Rock dust not only improves soil vitality, but also increases plants' overall health while strengthening immunity and pest resistance. Resulting in a completely natural and disease free final product, unique in flavor and mineral composition.

The study aims to added different doses and sizes of basalt to healing the salinity of soils and increases the soils fertility and bean productivity.

2- MATERIALS AND TECHNIQUES

2.1 Basalt

Representative samples were collected from different localities namely; Widdan El Farras (6th October-El Fayium Road) and El Arish (Northern Sinai). 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. A representative specimens were powdered to a size of <4μm. Clay minerals were concentrated by centrifugation, and the <2μm fraction separated. Air-dried oriented mineral aggregates were prepared by pipetting suspensions (~5 mg/cm ^{2}) onto glass slides. Samples were solvated with ethylene glycol and subjected to thermal treatment (550°C for 2 h). Quantitative analysis of the major elements of basalt 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 a range of soils to determine the physical and chemical properties. Samples collected from the following localities:

1. Northern part of the Nile-delta which is suffering from salinity, water stress and poor water quality (clayey soil) e.g. Kefir El Sheikh
2. Western and Eastern part of Nile-Delta (sandy and calcareous soils), e.g. Suez (sandy soil and clayey sand)
3. Clayey soil with low salinity
4. Sandy soil with low salinity

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

***Q*uality 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)[6,7] 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 Basalt –Incubated Soils

Approximately 70 kg of each of the soils was collected from the 0 - 10 cm depth in each soil profile. The bulk samples were air-dried and sieved to 2 mm. The bulk sample was then divided into 45 subsamples each weighing approximately 1.0 kg. Two size grades of Fayium basalt (<4mm and +125um nominal particle size) were thoroughly mixed into each of the surface soil samples from Suez (saline sandy soil) and saline clay soil (Kafre El Sheikh) at application rates equivalent to 0, 75 and 300g/kg. The water content of each soil sample was raised to field capacity with the incorporation of 0.004% copper sulphate solution to eliminate fungus growth. Soils were then incubated for 3 months; in plastic bags in the dark to allow reactions to occur between the soil and the amendment. After the incubation period, samples were air dried to halt the soil processes in preparation for chemical analysis.

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 sandy and clayey 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),

Table 2. Classification of soil quality

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

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)[8]. 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.

2.5 Cultivation of Bean

Field experiments were carried out to study the effect of basalt in healing saline soils and increase the productivity of bean.

2.5.1Conditioners

- Basalt from Fayiume and El Arish : healing the salinity of soils, vegetative growth, water consumption and nutrient uptake of bean plant.

2.5.2 Soils

- Saline Sandy soil from Suez
- Saline clay soil from Kafre El Sheikh
- Natural Clayey soils
- Sandy reclamation soil

2.5.3Treatment

(1 Basalt size +250 um (300gm basalt / 1kg saline sandy soil)
(2 Basalt size<4mm (300gm basalt/1kg saline clayey soil) and + 250um (150gm basalt/1kgm soil)
(3 Basalt size +250 um (300gm basalt / 1kg natural clayey soil)
(4 Basalt size +250 um (300gm basalt / 1kg sandy reclamation soil)
(5 Control
(6 Manure (100g/kg soils) added to all the previous soils
All the soils incubated with basalt and manure for 4 weeks under moisten condition in the field
Every treatment replicate 3 times. Super phosphate added while flipping the soils. Urea and potassium sulfate added during the irrigation

2.5.4 Irrigation

Irrigation carried out based on the necessity of the soils (control and soils +basalt). Potassium sulfate, Urea and pesticides added during the irrigation. (22/10/2012 -7/11/2012-21/3/2013)

2.5.5 Measurements

1- Plant height of bean plant.
2- Number of flowers.
3- Dry weight of bean plants.
4- The total amount of water consumptive used for different treatments and different soil.
5- Macro and micro nutrient content as percentage in bean plant.
6- Plant sample were oven dried at 70 ºC , 0.5 gm from the samples was wet digested by using H_2SO_4 and H_2O_2 for K,P and Fe determinations, K and Na determined using flame emission photometry. Phosphorus was determined using spectrophotometer (*Jones et al.*,1991).
7- Statistical analysis.

3-RESULTS

3.1 Mineralogy of Basalt

Plagioclase is the main mineralogical composition of El Arish and Fayium basalt in addition to clinopyroxene (augite) and orthopyroxene (enstatite). Trace of quartz (SiO_2),mica K(Mg,Fe++)3[AlSi3O10(OH,F)2 and illmenite (Fe++TiO_3) recognized by reflection lines at 3.34, 10 and 2.75Å respectively. Alteration products of basalt,highly oxidized and well-indurated sedimentary breccia consisting of highly vesicular clasts cemented by amorphous silica, calcite, and zeolite. The dark gray interior is slightly altered with the mesostasis replaced by saponite. Sparse vesicles (<2%) are filled with saponite and zeolite. Saponite lines vesicles where both phases coexist, indicating clay formation before zeolite.

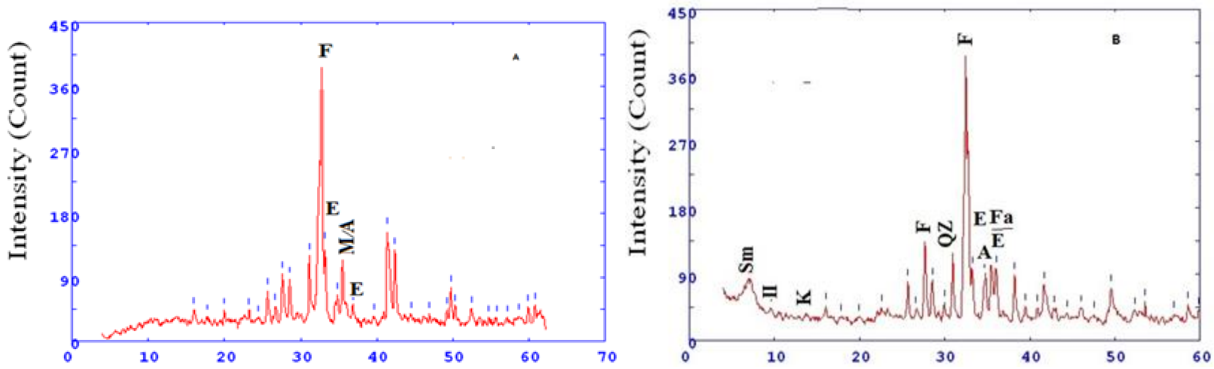

Figure 1: XRD patterns of El Arish basalt; A= Fresh basalt. B= partially weathered basalt; M=Magnetite; Qz=Quartz;II=Ilmenite; Ka=Kaolinite; F=Feldspar; E=Enstatite;A=Augite; Sm=Smectite; Fa=Faylaite

3.2 Chemical Composition of Basalt

Relative to most common igneous rocks, basalt compositions are rich in MgO and CaO and low in SiO_2 and the alkali oxides, i.e., Na_2O + K_2O, consistent with the TAS classification. Table 3 shows the chemical composition of El Arich basalt. SiO_2 content ranged between 50-55%, total alkali ranged between 2.5-5%, meanwhile, MgO ranged from 4-7%, those of CaO ranged from 9-13%. Low loss in weight revealed low degree of alteration compared with the other basalts from different localities. Table 4 shows the chemical composition of basaltic samples from Widdan El Farras, Fayium. In altered samples, SiO_2 ranged between 14-27%, total alkali ranged from 2.3-2.8%, CaO ranged from 17-30%, MgO almost 4%. Loss in weight ranged from 19-35%. The previous data confirmed by XRD pattern of altered basalt from Widdan El Farsa. The alteration products were trioctahedral smectite, chlorite, celadonite and calcite. On the other hand the fresh samples revealed abundance of SiO_2, Al_2O_3,NaO, TiO_2 and low loss in weight

Table 3 Chemical composition of El Arish basalt

Oxides	**Wt.%**	**Wt.%**	**Wt.%**	**Wt.%**	**Wt.%**	**Wt.% *R*epresentative <4mm**
SiO_2	24.88	59.31	27.62	14.23	49.84	52.26
Al_2O_3	0.74	10.11	9.68	5.40	14.77	13.88
Fe_2O_3	23.72	11.53	11.49	7.63	11.91	11.32
MgO	4.69	4.00	3.88	4.06	6.24	5.75
CaO	17.32	8.30	25.06	30.35	8.63	9.56
Na_2O	1.65	2.02	1.70	1.48	2.81	2.64
K_2O	1.08	0.72	0.56	1.41	0.95	0.87
Zn	0.01	0.013	0.011	0.009	0.013	0.013
Ti	0.02	1.05	0.35	0.05	0.74	0.99
Zr	0.02	0.012	0.018	0.016	0.022	0.022
Ni	0.007	0.008	0.007	0.006	0.008	0.008
P	0.38	0.21	0.42	0.69	0.30	0.22
Mn	2.68	0.11	0.72	0.64	0.10	0.11
S	0.02	0.006	0.011	0.012	0.007	0.007
Cl	0.05	0.006	0.023	0.02	0.01	0.001
L.O.I	22.30	1.48	19.12	34.58	2.67	2.36

Table 4 Chemical composition of basalt from Widdan El Farras, Fayium

Oxides	**Wt.% 1**	**Wt.% 2**	**Wt.% 3**	**Wt.% 4**	**Wt.% *R*epresentative <4mm**
SiO_2	49.58	55.31	52.97	47.31	53.04
Al_2O_3	17.46	19.02	17.48	14.75	18.93
Fe_2O_3	12.52	12.61	12.39	12.39	12.22
MgO	5.62	6.90	4.96	4.34	6.43
CaO	12.28	10.70	10.35	9.46	10.59
Na_2O	2.50	3.52	3.53	2.59	2.78
K_2O	0.18	1.25	0.59	0.61	0.58
Zn	0.012	0.014	0.014	0.015	0.013
Ti	1.35	1.04	1.09	0.82	1.16
Zr	0.025	0.025	0.026	0.028	0.021
Ni	0.009	0.01	0.008	0.009	0.0085
P	0.31	0.22	0.26	0.28	0.26
S	0.007	0.006	0.006	0.008	0.007
Mn	0.12	0.13	0.10	0.11	0.12
Cl	0.008	0.008	0.008	0.011	0.010
L.O.I	1.39	0.69	1.94	1.51	1.15

3.3Characterization of Soils

Data presented in Tables 5, 6,7 shown chemical composition, texture and micronutrient of soils from different localities. Based on classification of soils (Table 2), studied soils are saline, slightly to moderately alkaline, contain sufficient organic carbon, high K and low other nutrients. Essentially salts are NaCl + $CaSO_4$ + $MgSO_4$, moderate to high micronutrient especially Mn and Fe.

3.4 Crushed Basalt –Incubated Soils

Tables 8 and 9 showed the properties of studied soils after incubation with Fayium basalt. The salinity of sandy soil from Suez decreased from 6.48 to<1 mS/cm. This decrease in salinity accompanied by decreasing all the cations concentration especially Na (decreases from 229 to 31 meq/.l) and Ca (decreased from 589 to 47meq/l). However, the decrease of salinity of clay soil from Kafre El Sheikh was lower compared with that of sandy soil from Suez. However, pH of both soils increases due to dissolution of basalt and release of cations. The differences in salinity between the two types of soils incubated with basalt revealed the effects of soil texture. Table 9 provides information about the reactivity of basalt with different soils, but does not give any indication on how long lasting the observed effects might be. It is abundantly clear that there has been a significant enrichment of basic exchangeable cations from the basalt applications, though this beneficiation is not distributed evenly across the two soils studied. The increased amounts of nutrient calcium and magnesium are very encouraging, while the augmentation of much needed potassium is outstanding in many cases.

The growth responses of the bean plants to the application of grind basalt and fertilizes (KPN) to two saline soils as well as naturally clayey soil and reclaimed sandy soil have been analyzed and shown in Tables 10 and 11 and Figures 3,4 and 5. Clearly, the strongest growth responses have been produced by the addition of basalt El Arish + fertilizers to all the soils (Figs. 3, 4 and 5) compared with that of basalt El Fayium + fertilizers as well as the controls. An increase was observed in plant growth from the highest of sandy saline soil to the lowest reclamation sandy soil. The greatest plant growth at the time of harvest was in the basalt El Arish+ sandy saline soil.

From the time of germination, most of the plants treated with basalt appeared to be stronger, producing their first set of leaves at a time when seedlings in controls were still emerging. Those treated with basalt and fertilizers showed much less intense foliar symptoms of nutrient deficiency at juvenile growth stages, and no such symptoms at harvest. Barren spots and stunted plants appeared in bean crops growing on saline soils (controls). Moderate salinity, however, particularly if it tends to be uniform throughout the field, can often go undetected because it causes no apparent injuries other than restricted growth. Leaves of plants growing in salt infested areas may be smaller and darker blue-green in colour than the normal leaves. Symptoms of specific element toxicities, such as marginal or tip burn of leaves, occur as a rule only in woody plants. Chloride and sodium ions and boron are the elements most usually associated with toxic symptoms. Non-woody species may often accumulate as much or more of these elements in their leaves without showing apparent damage as do the woody species.

4- DISCUSION

By crushing the basalt, the crystal structures are broken which generates incompletely bonded charged atoms on the crystal surface [9]. Highly reactive fracture surfaces on crushed minerals rapidly attract any available ions in an attempt to neutralize the high positive or negative surface charges. Reorganization of the crystal surfaces may dislocate cations from surface sites into positions of charge balance [9]. When the charged, fractured surface encounters
water, the high charge gradient causes an increase in the dissociation constant of water that is near the charged mineral surface relative to that of the bulk water [10]. Under such circumstances, water rapidly dissociates:

$$H_2O \; H^+ + OH^-$$

The OH^- anions bond with incompletely bonded, positively charged atoms (cations), and the H^+ cations bond with O atoms, producing surface hydroxide functional groups taking the form MOH, where M refers to a cation at a surface site of the solid mineral structure [11]. Additionally, cations previously balancing charge on mineral surfaces are rapidly replaced by H^+ and lost to the soil solution [12].

Crushing the primary mineralogical components of basalt generates large amounts of variable charge on the surfaces of the fine mineral particles. Hydrated volcanic glass, which constitutes some a part of the basalt, presents an extremely large area of variable charge surface because the surface is mostly internal. In alkaline environment, the freshly fractured surfaces of the crushed minerals would provide an initial rapid supply of basic, plant nutrient cations to soil solution when charge-balancing surface cations are exchanged for H^+ ions from solution. In addition, clay minerals in terms of smectite , kaolinite and illite have formed by alteration of the hydrated volcanic glass in the basalt towards the base of the deposits, permanent charge 2:1 layer silicates typically have high CEC because the layered structure provides a large area of internal surface of permanent negative charge [13].

Therefore, during this study, the utilization of crushed basalt for healing the saline soils and increasing the productivity as well as increasing productivity of natural clayey soils and reclaimed sandy soils, I say this healing and improving in the productivity related to increased the negative charge in the soil, increased basic cation supply, improved cation exchange capacity of these soils, which enhances the capability of the soil to retain cations and to supply cations to plants,

Table 5 Chemical analysis and physical properties of saline soils

Samples	**Large elements ppm**			**Anions meq/l**				**Cations meq/l**				**$CaCO_3$%**	**Total dissolved salt (1:5)E.C Mlmos/cm**	**pH**
	K	**P**	**N**	**SO_4**	**Cl**	**HCO_3**	**CO_3**	**K**	**Na**	**Mg**	**Ca**			
Suez	164	5.20	50	23.3	221	1.6	0	13.2	229.5	119.3	589.6	12.50	6.48	7.48
Kafre El sheikh	355	6.6	10	38.6	265	3.40	0	20.4	271.6	50.36	52.19	0.8	9.70	7.61
Normal clay soil	234	27.7	50	4	4.8	1.2	0	25	72	25	6.7	1.65	1.1	7.61
Reclaimed sandy soils	218.4	8.4	50	0.1	2.4	0.6	0	0.1	0.1	0.5	2.4	1.65	0.35	7.98

Table 6 Texture of studied soils

Samples	**Sand %**	**Silt %**	**Clay %**	**Textures**	**OM**	**B D g/m^3**	**SAR mmol/l**	**TDS**
Suez	49.8	15	35.2	Clay sandy	3.06	2.29	12.2	4536
Kafre El sheikh	14.8	20	65.2	Clay	1.0	2.00	37.92	6790
Normal clay soil	4.5	27	68.5	Clay	1.2	2.12	6.5	-
Reclaimed sandy soils	98.7	1.3	-	Sand	0.01	2.01	4.5	-

OM =Organic matter; BD=Bulk Density; SAR= Sodium Adsorption Ratio; TDS=Total Dissolved Solids

Table7 Micronutrient in studied soils

Samples	**Concentration (ppm)**			
	Fe	**Mn**	**Zn**	**Cu**
Suez	10.1	8.94	5.97	2.02
Kafre El Sheikh	5.44	8.02	6.96	1.54
Normal clay soil	2.5	7.8	6.3	0.8
Reclaimed sandy soils	4.5	4.7	7.1	0.02

Table 8 Effects of Fayium basalt with different particles size and doses/fertilizer on salinity of sand and clay soils

Meq/l	**Suez soil + Manure**					**Kafr El sheikh soil + Manure**				
	Soil	**Size/Doses**				**Soil**	**Size/Doses**			
	Suez	**+125 µm/ 75gm**	**+125 µm/ 300gm**	**<4m/ 75gm**	**<4m/ 300gm**	**Kafre El Sheikh**	**+125 µm/ 75gm**	**+125µm/ 300gm**	**<4m/ 75gm**	**<4m/ 300gm**
Na	229.5	32.8	41.2	34.2	36.48	271.6	244	167.3	191.4	196.7
Nh4	-	1.98	2.73	3.3	8.89	7.58	-	3.48	-	-
K	13.2	19.47	15.9	31.2	18.83	20.4	86.8	21.9	29.4	24.77
Mg	119.3	21.97	29.05	22.6	30.04	50.36	16.9	28.46	45.8	34.2
Ca	589.6	47.1	66.5	58.1	99.15	52.12	52.2	34	54.15	35.9
Salinity	6.48	1.08	1.32	1.52	1.16	9.7	5.29	4.8	4.18	4.17
PH	7.48	7.7	7.84	7.78	7.93	7.61	8.04	8.18	8.03	8.1

Table 9 Cation exchange capacity of saline sand and clay soils treated with different doses and particle size of Fayium basalt (3 months)

Cmol/kg	**Soil**	**Sizes/Doses**				**Soil**	**Sizes/Doses**			
	Suez	**+125µm/ 75gm**	**+125 µm / 300gm**	**<4m/ 75gm**	**<4m/ 300g**	**Kafr El Sheikh**	**+125 µm/ 75gm**	**+125 µm /300gm**	**<4mm/ 75gm**	**<4mm/ 300gm**
K	0.04	-	-	-	-	0.36	2.91	1.606	1.53	0.69
Mg	0.29	10.96	9.29	8.51	9.78	1.041	10.631	11.00	13.24	11.33
Ca	1.14	13.86	14.36	9.95	16.11	4.074	13.81	12.83	13.24	9.70

Table 10 Macro and micro nutrient of bean plants.

Treatment	**Soil type**	**Dry weight gm**	**Content %**					**meg/kg**			
			P	**N**	**Ca**	**Mg**	**K**	**Cu**	**Mn**	**Fe**	**Zn**
El Arish basalt	Kafre El Sheikh	26.92	0.16	0.63	1.07	0.17	0.79	10.4	16.5	273.4	28.6
Fayium basalt		40.97	0.06	0.46	1.30	0.07	0.74	13.4	17.4	187.1	26.0
Control		17.66	0.09	0.82	1.51	0.05	0.41	9.1	39.2	1151.1	56.2
El Arish basalt	Suez	49.90	0.04	0.65	1.19	0.03	0.94	7.1	21.9	474.8	27.0
Fayium basalt		40.83	0.04	0.64	1.45	0.19	1.17	12.1	27.8	521.6	26.1
Control		25.70	0.06	0.74	1.32	0.1	1.17	9.9	20.5	345.3	24.1
El Arish basalt	Natural clayey	33.69	0.04	0.59	1.12	0.04	1.04	6.7	16.7	223.0	46.2
Fayium basalt		22.87	0.13	0.76	1.20	0.03	1.15	8.0	29.2	697.8	48.3
Control		14.45	0.10	1.52	2.01	0.30	0.91	8.7	16.4	181.2	71.6
El Arish basalt	Reclamation sandy soil	32.84	0.04	0.67	1.15	0.22	0.75	7.5	23.5	366.9	30.5
Fayium basalt		20.45	0.16	0.78	1.38	0.04	1.10	9.0	45.0	1179.8	76.6
Control		13.39	0.05	0.76	1.05	0.07	1.20	7.7	19.9	395.6	258.0

Table 11 Macro and micro nutrient uptake of bean plants.

Treatment	***Soil type***	***Dry weight gm***	***Content %***					**meg/kg**			
			P	**N**	**Ca**	**Mg**	**K**	**Cu**	**Mn**	**Fe**	**Zn**
El Arish basalt	Kafre El Sheikh	26.92	0.04	0.16	0.28	0.045	0.21	0.0028	0.004	0.07	0.008
Fayium basalt		40.97	0.02	0.18	0.53	0.03	0.30	0.006	0.007	0.07	0.011
Control		17.66	0.015	0.15	0.26	0.01	0.07	0.0016	0.007	0.20	0.01
El Arish basalt	Suez	49.90	0.02	0.32	0.59	0.015	0.46	0.0036	0.011	0.23	0.013
Fayium basalt		40.83	0.02	0.26	0.59	0.07	0.48	0.005	0.012	0.21	0.011
Control		25.70	0.015	0.19	0.33	0.025	0.30	0.0026	0.0053	0.08	0.006
El Arish basalt	Natural clayey	33.69	0.013	0.19	0.37	0.13	0.35	0.0023	0.0057	0.075	0.015
Fayium basalt		22.87	0.03	0.17	0.27	0.01	0.26	0.0019	0.0067	0.15	0.011
Control		14.45	0.01	0.22	0.29	0.04	0.13	0.0013	0.002	0.026	0.01
El Arish basalt	Reclamation sandy soil	32.84	0.013	0.22	0.37	0.072	0.24	0.0025	0.007	0.12	0.015
Fayium basalt		20.45	0.03	0.15	0.28	0.01	0.22	0.0019	0.0092	0.03	0.015
Control		13.39	0.006	0.10	0.14	0.01	0.16	0.001	0.002	0.05	0.003

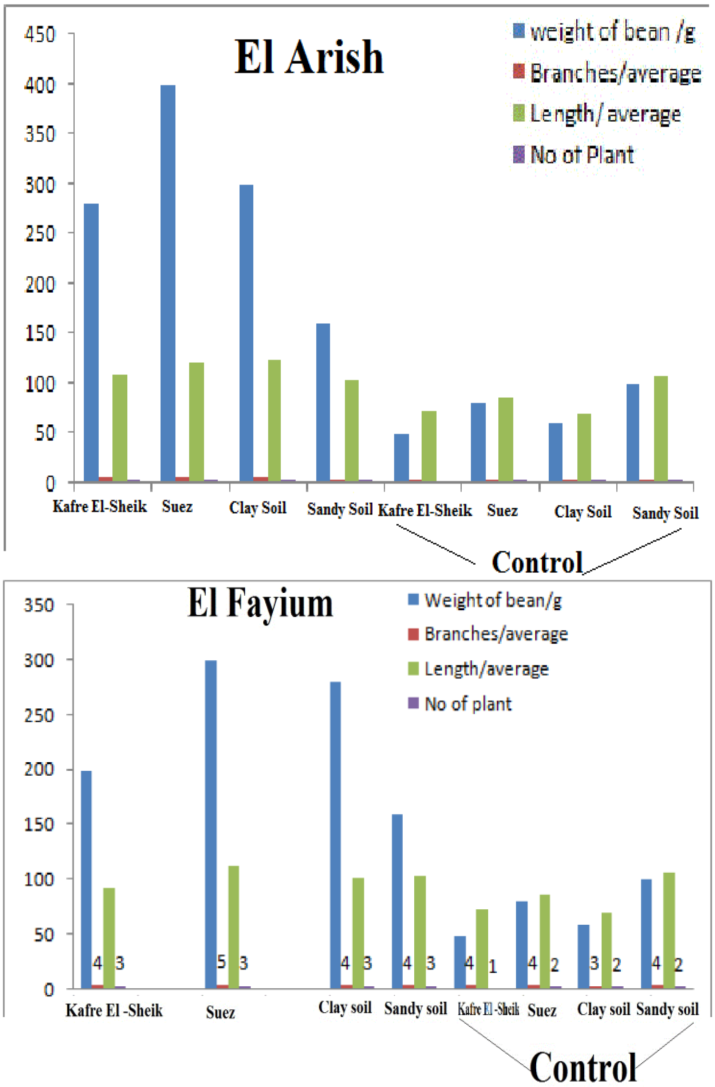

Figure 2: Growth responses of saline and unsaline soils + crushed basalt

Basalt: El Arish Basalt Fayium Control

Soil: Saline clayey soil (Kafre El Sheikh)

Basalt: El Arish Basalt Fayium Control

Soil: Saline sandy soil (Suez)

Basalt: El Arish Basalt Fayium Control

Natural clayey soil

Basalt: El Arish Basalt Fayium Control

Reclamation sandy soil

Figure 3: Productivity of bean of soils (saline and not saline) treated with crushed basalt compared with controls

Figure 4: The field trial of planting bean in saline and not saline soils treated with basalt

5- ACKNOWLEDGEMENT

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