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# Response of Barley Grown on Different Soils to Soil Amendments.

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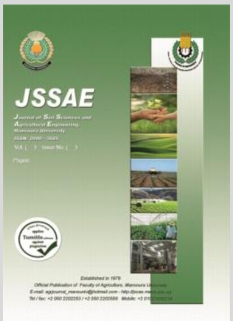


## ABSTRACT

This study was conducted to assess the effect of compost, agricultural gypsum and sugar beet mud (By-product in a sugar beet manufacturing process) on barley plants (*Hordeum vulgare* L) grown in pots containing saline clay or nonsaline sandy soil. For this purpose, three different rates of compost, gypsum and sugar beet mud (0.5, 1 and 1.5%, equivalent to 2.5, 5 and 7.5 g pot$^{-1}$, respectively) were applied to both soils in pots 500 g soil and moisted two weeks before sowing. The used experimental design was a completely randomized design with three replicates for each treatment. Growth parameters (*i.e.* shoot fresh and dry weights (g plant$^{-1}$) and No. of plants pot$^{-1}$) and also elements concentration (*i.e.* N, P, K, Na, Mg and Ca %) were evaluated. The findings indicated that the obtained values significantly increased with the increase of adding rate of all soil amendments under study, where the highest values were realized due to the addition rate of 1.5% followed by 1% and 0.5%, respectively for all growth parameters and elements concentrations, except K% which suffered from antagonism with calcium that is included in the composition of agricultural gypsum and sugar beet mud. Also, barley grown in the control treatment (without any soil addition) appeared extremely nutrient deficient. Soil applications of compost, gypsum and sugar beet mud positively influenced on barley plants grown on saline and sandy soils. Also, sugar beet mud is beneficial for barley plants grown on studied degraded soils due to its high contents from calcium and organic matter.

***Keywords:*** Compost, gypsum, sugar beet mud, saline and sandy soils.

## INTRODUCTION

The organic manures have the possibility of supplying macro and micronutrients, improving soil physical and chemical properties, providing the energy of microflora, increasing the availability of micronutrients and improving soil fertility. Compost addition was observed to have positive influences that aid crop growth and development thereby enhancing the crop phytonutritional components (Togun *et al*, 2003 and Ilupeju *et al*, 2015). The major obstacle of organic manure utilization is the quantities of available plant nutrients are insufficient to meet crop requirements (Mansour, 2012).

Gypsum is a naturally occurring materail that is mined for many purposes. Gypsum has a calcium content of 23% and sulfur content of 19%. It is usually used for treating salt affected soils on the farm. The calcium in the applied gypsum enables sodium displacement on the cation exchange sites of the soil (Gelderman *et al*, 2004 and Bello, 2012).

Organic waste material (sugar beet mud) derived from sugar industry from sugar beet yields better production of crops (Sardar *et al*, 2012). Sugar press mud is the residue of sugar cane industry which results from the processing of sugar cane where sugar beet mud is separated from the crush. The total supply of sugar press mud varies from (1-7) kg from the processing of 100 kg of sugar cane. The sugar press mud is used as a suitable fertilizing agent since it is rich with micro and macronutrients along with organic carbon. It is eco-friendly and protects the plants from various soil-borne diseases (Diaz, 2016).

A saline soil deprives the soil of Ca and S and this reduces the barley productivity thus, the gypsum application and proper draining and adequate leaching are important for optimum production on saline soils (Gelderman *et al*, 2004). Sandy soil is light, warm, dry and suffers from low nutrients that are washed away by irrigation. The addition of organic matter can help to give plants an additional boost of nutrients by improving the nutrient and water holding capacity of the soil, El-Hadidi *et al.* (1998).

The objective of this study is to enhance the growth of barley plants grown under saline and sandy conditions and evaluation of different rates of compost, agricultural gypsum and sugar beet mud to find out the positive effect of these treatments on barley plants because of its important.

## MATERIALS AND METHODS

To achieve the goal of this investigation, a pot experiment was conducted outdoor at the Experimental Greenhouse of the Faculty of Agriculture, Mansoura University, during the winter season of 2019. It was aimed to assess the effect of compost, gypsum and sugar beet mud on barley (*Hordeum vulgare* L .Var .Giza 130) plants grown on saline clay and nonsaline sandy soils. To experiment, plastic pots (15 cm diameter and 15 cm depth) were filled by air-dry soils equaled to 500 g oven-dry soil of the studied two types soils (saline clay and nonsaline

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sandy soils). The compost, gypsum ($CaSO_4.2H_2O$)and sugar beet mud were applied to both two soils and moisted two weeks before sowing at three rates (0.5, 1 and 1.5%, equivalent to 2.5, 5 and 7.5 g pot$^{-1}$, respectively).The used experimental design was a completely randomized design with three replicates for each treatment. On 13th of November, 2019; ten seeds of barley per pot were sown.

Throughout the experiment, soil moisture was kept at field capacity by watering to the constant weight. At three different growth periods (15, 30 and 45days after sowing), straw samples were taken and cleaned, weighed for fresh weight, oven dried at 70°c, weighed for dry weight, ground and saved for chemical analysis, where plants were thinned to 5, 3 and finally 2.

**Analysis of Soil:**

The both soils were analyzed before planting as a routine work according to Dewis and Fertias (1970), Tables 1 and 2 show some chemical and physical characteristics of saline clay and nonsaline sandy soils. Chemical analysis of the compost (plant residues) used are presented in Table (3), while Table (4) shows the components of sugar beet mud and gypsum.

**Table1. Some physical and chemical properties of the first investigated soil (Saline clay soil).**

| Soil chemical properties | | Value | Soil physical properties | | Value |
|---|---|---|---|---|---|
| pH | | 8.100 | Particles size distribution | Sand% | 8.990 |
| EC, dS m$^{-1}$ | | 5.500 | | | |
| $CaCO_3$ % | | 2.900 | | Silt% | 29.96 |
| OM% | | 2.010 | | | |
| ESP% | | 9.300 | | | |
| Soluble Cations (meq 100g soil $^{-1}$) | $Ca^{++}$ | 5.630 | | Clay% | 54.64 |
| | $Mg^{++}$ | 4.220 | | | |
| | $K^+$ | 1.420 | | Texture Class | Clay |
| | $Na^+$ | 16.89 | | | |
| Soluble Anions (meq 100 soil $^{-1}$) | $CO_3^{--}$ | ------ | Saturation percentage (SP)% | | 89.06 |
| | $HCO_3^-$ | 8.440 | Field capacity (FC)% | | 44.53 |
| | $Cl^-$ | 13.56 | Wilting point (WP)% | | 22.30 |
| | $SO_4^{--}$ | 6.160 | Available water (AW)% | | 22.30 |
| Available macro-nutrients (mg Kg soil$^{-1}$) | Nitrogen (N) | 65.59 | Bulk Density ( mg m$^{-3}$) | | 1.240 |
| | Phosphorus (P) | 9.550 | Total Porosity% | | 58.49 |
| | Potassium (K) | 230.9 | | | |
| Available boron (mgKg$^{-1}$) | | 0.450 | | | |

*** Soil pH was determined in soil suspension (1: 2.5).**

**Table 2. Some physical and chemical properties of the second investigated soil (Nonsaline sandy soil).**

| Soil chemical properties | | Value | Soil physical properties | | Value |
|---|---|---|---|---|---|
| pH | | 7.91 | Particles size distribution | Sand% | 90.50 |
| EC, dS m$^{-1}$ | | 0.90 | | | |
| $CaCO_3$ % | | 1.00 | | Silt% | 4.700 |
| OM% | | 0.30 | | | |
| ESP% | | 7.90 | | | |
| Soluble Cations (meq 100g soil $^{-1}$) | $Ca^{++}$ | 0.92 | | Clay% | 4.800 |
| | $Mg^{++}$ | 0.69 | | | |
| | $K^+$ | 0.23 | | Texture Class | Sandy |
| | $Na^+$ | 2.76 | | | |
| Soluble Anions (meq 100 soil $^{-1}$) | $CO_3^{--}$ | 0.00 | Saturation percentage (SP)% | | 34.44 |
| | $HCO_3^-$ | 1.38 | Field capacity (FC)% | | 11.22 |
| | $Cl^-$ | 2.25 | Wilting point (WP)% | | 5.610 |
| | $SO_4^{--}$ | 0.97 | Available water (AW)% | | 5.610 |
| Available macro-nutrients (mg Kg soil$^{-1}$) | Nitrogen (N) | 12.1 | Bulk Density (mg m$^{-3}$) | | 1.590 |
| | Phosphorus (P) | 0.30 | Total Porosity% | | 39.00 |
| | Potassium (K) | 39.3 | | | |
| Available boron (mgKg$^{-1}$) | | 0.09 | | | |

*** Soil pH was determined in soil suspension (1: 2.5).**

**Table 3. Chemical analysis of the plant compost.**

| Characteristics | | Values |
|---|---|---|
| pH 1:5 | | 5.970 |
| EC (1:10) (dSm$^{-1}$) | | 3.160 |
| OM% | | 39.48 |
| Organic carbon% | | 22.90 |
| C/N ratio | | 14.22 |
| Available micronutrients ( mg kg$^{-1}$) | Iron | 54.70 |
| | Manganese | 12.50 |
| | Copper | 3.510 |
| | Zinc | 19.70 |
| Macro-nutrients (%) | Nitrogen | 1.610 |
| | Phosphorus | 0.380 |
| | Potassium | 0.820 |

**Table 4. Sugar beet mud and gypsum components.**

| Characteristics | values |
|---|---|
| Sugar beet mud | |
| $CaCO_3$% | 92.80 |
| OM% | 7.200 |
| Gypsum ($CaSO_4 . 2H_2O$) | |
| Purity (%) | 98.8 |
| pH (1: 5 gypsum : water) | 7.80 |
| EC [1: 5] | 2.56 |
| Ca [g Kg $^{-1}$] | 230 |
| S [g Kg $^{-1}$] | 175 |

**Chemical Analysis:** To determine N, P, K, Ca, Na and Mg percentages barley straw at the three different periods, 0.4 g crude dried kept powder from each plant sample was wet digested with a mixture of concentrated perchloric ($HClO_4$) and sulphuric acids ($H_2SO_4$), then heated until becoming clear solution, then it was transferred into 100 ml measuring flask and kept for chemical determinations (Gotteni *et al*., 1982). Total nitrogen and phosphorus were determined as described by Jones *et al*. (1991) and Peters *et al*. (2003), respectively. Total potassium and sodium were estimated by using the Jenway Flame photometer, Model corning 400 according to the modified method of Jackson, (1967). Total calcium and magnesium were estimated by the atomic absorption spectrophotometer using Perkin Elmer Model 370A as described by Chapman and Pratt (1978).

**Statistical analysis:** Data were statistically analyzed according to Gomez and Gomez (1984) using CoStat (Version 6.303, CoHort, USA, 1998–2004).

## RESULTS AND DISCUSSION

### 1- Growth Parameters.

Data presented in Table (5) show the impact of the studied different rates of compost, gypsum and sugar beet mud (0.5, 1 and 1.5%) on the values of straw yield and No. of plants pot$^{-1}$ of barley plants grown on saline and sandy soils at different growth periods (15, 30 and 45days after sowing). Generally, adding all soil amendments understudy at all investigated rates increased straw fresh and dry weights (g plant$^{-1}$) and No. of plants pot$^{-1}$ of barley plants grown on saline and sandy soils compared to the control treatment (without addition) at different growth periods. On other hand, all aforementioned studied traits of barley plants grown on saline clay soil were higher than those on nonsaline sandy soil. The increasing rate of straw fresh and dry weights (g plant$^{-1}$) and No. of plants pot$^{-1}$ of barley plants grown on saline clay soil is more than in nonsaline sandy soil because of the low absorbed nutrients on exchange complex of nonsaline sandy soil than saline clay soil. Similar results were investigated by El-Sherpiny (2016), who reported that the decreasing rate of fresh and dry weights of barley straw and root in alluvial soil is less than in sandy soil due to the cations and anions adsorbed on surface exchange complex of alluvial soil unlike sandy soil.

**Table 5. Effect of compost, gypsum and sugar beet mud on fresh and dry weights (g plant$^{-1}$) and No. of plants pot$^{-1}$ of barley plants grown on saline clay and nonsaline sandy soils at different growth periods (15, 30 and 45days after sowing).**

| Treatments | After 15 days | | After 30 days | | After 45 days | |
|---|---|---|---|---|---|---|
| | Saline clay soil | Nonsaline sandy soil | Saline clay soil | Nonsaline sandy soil | Saline clay soil | Nonsaline sandy soil |
| Fresh weight (g plant$^{-1}$) | | | | | | |
| Compost (0.5 %) | 3.74 | 2.45 | 5.97 | 2.68 | 12.79 | 2.88 |
| Compost (1 %) | 4.37 | 2.59 | 6.46 | 2.77 | 13.45 | 3.14 |
| Compost (1.5 %) | 4.39 | 2.77 | 6.67 | 2.83 | 14.05 | 3.33 |
| Gypsum (0.5 %) | 2.61 | 1.79 | 4.98 | 1.98 | 10.47 | 2.08 |
| Gypsum (1 %) | 2.95 | 1.83 | 5.28 | 2.05 | 10.98 | 2.17 |
| Gypsum (1.5 %) | 3.05 | 1.98 | 5.34 | 2.11 | 11.52 | 2.25 |
| Sugar beet mud (0.5 %) | 3.47 | 2.16 | 5.44 | 2.19 | 11.85 | 2.28 |
| Sugar beet mud (1 %) | 3.64 | 2.28 | 5.73 | 2.34 | 12.04 | 2.34 |
| Sugar beet mud (1.5 %) | 4.10 | 2.54 | 6.15 | 2.74 | 13.03 | 3.24 |
| Control | 2.54 | 1.32 | 4.15 | 1.94 | 10.48 | 2.04 |
| LSD at 5% | 0.09 | 0.07 | 0.08 | 0.06 | 0.10 | 0.06 |
| Dry weight (g plant$^{-1}$) | | | | | | |
| Compost (0.5 %) | 0.46 | 0.39 | 0.75 | 0.39 | 1.99 | 0.60 |
| Compost (1 %) | 0.52 | 0.43 | 0.96 | 0.48 | 2.17 | 0.64 |
| Compost (1.5 %) | 0.53 | 0.45 | 1.00 | 0.50 | 2.31 | 0.73 |
| Gypsum (0.5 %) | 0.33 | 0.22 | 0.60 | 0.29 | 1.43 | 0.42 |
| Gypsum (1 %) | 0.35 | 0.24 | 0.53 | 0.30 | 1.55 | 0.46 |
| Gypsum (1.5 %) | 0.40 | 0.33 | 0.71 | 0.35 | 1.79 | 0.52 |
| Sugar beet mud (0.5 %) | 0.37 | 0.27 | 0.66 | 0.33 | 1.67 | 0.50 |
| Sugar beet mud (1 %) | 0.44 | 0.34 | 0.73 | 0.38 | 1.83 | 0.54 |
| Sugar beet mud (1.5 %) | 0.50 | 0.42 | 0.80 | 0.44 | 2.07 | 0.62 |
| Control | 0.28 | 0.16 | 0.57 | 0.24 | 1.32 | 0.38 |
| LSD at 5% | 0.05 | 0.04 | 0.12 | 0.04 | 0.06 | 0.04 |
| No. of plants pot$^{-1}$ | | | | | | |
| Compost (0.5 %) | 12.00 | 11.00 | 8.67 | 9.33 | 6.00 | 6.00 |
| Compost (1 %) | 14.67 | 12.33 | 10.00 | 9.00 | 6.00 | 6.00 |
| Compost (1.5 %) | 16.00 | 14.00 | 11.33 | 10.33 | 6.00 | 6.00 |
| Gypsum (0.5 %) | 16.67 | 8.33 | 5.67 | 8.33 | 6.00 | 6.00 |
| Gypsum (1 %) | 11.33 | 8.00 | 8.00 | 8.00 | 6.00 | 6.00 |
| Gypsum (1.5 %) | 11.67 | 10.33 | 8.00 | 8.33 | 6.00 | 6.00 |
| Sugar beet mud (0.5 %) | 11.33 | 9.00 | 7.67 | 7.67 | 6.00 | 6.00 |
| Sugar beet mud (1 %) | 11.67 | 11.00 | 9.00 | 7.33 | 6.00 | 6.00 |
| Sugar beet mud (1.5 %) | 14.00 | 11.67 | 11.33 | 7.67 | 6.00 | 6.00 |
| Control | 9.00 | 6.67 | 5.00 | 6.67 | 6.00 | 6.00 |
| LSD at 5% | 1.52 | 1.39 | 1.39 | 1.16 | n.s | n.s |

Under different compost rates, applying compost to the soil before sowing at rate of 0.5, 1 and 1.5 % pronouncedly affected the straw fresh and dry weights (g plant$^{-1}$) and No. of plants pot$^{-1}$ of barley at all the different growth periods under conditions of both investigated soils. In this respect, all aforementioned traits significantly increased with the increase of adding compost rate, where the highest values were obtained from addition of compost as soil application at rate of 1.5% followed by 1% and 0.5%, respectively. For example, at the second growth period (30 days from sowing), the straw fresh weight (g plant$^{-1}$) of barley plants grown on saline clay soil increased from 4.15 at control treatment (without addition) to 5.96, 6.46 and 6.67g plant$^{-1}$ at (0.5%, 1 % and 1.5 % compost) treatments, respectively, where the increasing rate from control at the best treatment (1.5 % compost) is (37.78%). Also, the straw dry weight (g plant$^{-1}$) of wheat plants grown on saline soil increased from 0.57 at control treatment (without addition) to 0.75, 0.96 and 1.0g plant$^{-1}$ at (0.5%, 1% and 1.5% compost) treatments, respectively, where the increasing rate from control at the best treatment (1.5 % compost) is (43%), thus the data indicate that application of compost at rate of 1.5 % gave the best results than 0.5 and 1 %. Our findings are in harmony with those observed by Zaki, (2016) who stated that; under saline conditions, rice yield increased when compost was added compared with control due to the compost improved soil properties.

Under different sugar beet mud rates, it could be observed for both soils under study that the best addition rate of sugar beet mud conditioner for realizing the highest values of straw yield and No. of plants pot$^{-1}$ of barley plants was found when the addition of sugar beet mud material was added at a rate of 1.5% followed by1% and lately 0.5%, while the lower values were obtained at control treatment (without addition), where the treatments sequence from top to less at the three different growth periods was as follows:

1.5%sugar beet mud> 1% sugar beet mud> 0.5% sugar beet mud > control treatment.

These results are in harmony with the findings of Sanchary *et al.* (2019) who stated that the application of higher doses of processed sugar mill mud causes additions of basic cations to the soil which can later be taken up by plants. Generally, its application will improve the soil organic matter content also. Beside, Kheir and Kamara (2019) who reported that canola seed yield, oil and protein content increased significantly due to application of sugar beet factory lime to soil compared with control.

Under different agricultural gypsum rates, the trend of straw yield and No. of plants pot$^{-1}$ of barley plants grown on saline clay and nonsaline sandy soils at different growth periods (15, 30 and 45days after sowing) looks just like the trend under both compost and sugar beet mud rates, where the treatments sequence from top to less at the three different growth periods under the both soils was as follows:

1.5% gypsum> 1% gypsum > 0.5% gypsum > control treatment.

The present results agree with those obtained by Bello (2012) who reported that significant enhancement is usually expected in the use of gypsum ($CaSO_4.2H_2O$) on saline soils as a sources of calcium and sulfur .With the reclamation of the soil in barley production, the enhancement in growth parameters is due to the displacement of $Na^+$ by $Ca^{++}$and an increase in nutrient use efficiency of the crop.

Sugar beet mud is superior to gypsum because it contains 7% O.M. Generally, the treatments sequence from top to less at the three different growth periods under both soils was as follows:

1.5% compost > 1% compost > 1.5% sugar beet mud > 0.5% compost > 1% sugar beet mud > 1.5% gypsum > 0.5% sugar beet mud >1 % gypsum> 0.5% gypsum> control treatment.

**2- Nutrients Concentrations.**

Data illustrated in Tables (6 and 7) reflect the effect of different rates (0.5, 1 and 1.5%) of studied soil amendments (compost, gypsum and sugar beet mud ) on nitrogen, phosphorus, potassium, sodium, magnesium and calcium percentages in straw of barley plants at different growth periods (15, 30 and 45 days after sowing) under saline clay and nonsaline sandy soil conditions.

Data indicated that applying all soil amendments understudy to the soil before sowing at rate of 0.5, 1 and 1.5% pronouncedly affected the values of nitrogen, phosphorus, potassium, sodium, magnesium and calcium percentages in straw of barley plants grown on saline clay and nonsaline sandy soils at different growth periods (15, 30 and 45 days after sowing), where the values under saline clay soil were better than that under non saline sandy soil due to low absorbed nutrients on nonsaline sandy soil particles. Also, barley plants grown in the control treatment appeared extremely nutrient deficient. Similar results were obtained by El-Sherpiny, (2016).

Except the values of K (%) under both sugar beet mud and gypsum treatments, under each soil amendment; the values of nitrogen, phosphorus, potassium, sodium, magnesium and calcium percentages significantly increased with the increase of adding each rate of soil amendments understudy, where the highest values were realized due to the addition of studied soil amendments at rate of 1.5% followed by 1% and 0.5%, respectively.

On the contrary, as for K% under both sugar beet mud and agricultural gypsum which contain high calcium, the values of K (%) in straw of barley plants at different growth periods (15, 30 and 45 days after sowing) under saline clay and nonsaline sandy soils were significantly decreased as rate of application was increased, where the investigated rates sequence of both sugar beet mud and gypsum from top to less was 0.5% > 1% > 1.5%. This is due to the antagonism between calcium and potassium as mentioned by Rietra, (2017). This trend was found at the three growth periods.

**Table 6. Effect of compost, gypsum and sugar beet mud on N, P and K (%) in straw of barley plants grown on saline clay and nonsaline sandy at different growth periods (15, 30 and 45days after sowing).**

| Treatments | After 15 days | | After 30 days | | After 45 days | |
|---|---|---|---|---|---|---|
| | Saline clay soil | Nonsaline sandy soil | Saline clay soil | Nonsaline sandy soil | Saline clay soil | Nonsaline sandy soil |
| N% | | | | | | |
| Compost (0.5 %) | 1.90 | 1.76 | 2.20 | 2.14 | 2.76 | 2.60 |
| Compost (1 %) | 2.07 | 1.91 | 2.45 | 2.35 | 3.03 | 2.86 |
| Compost (1.5 %) | 2.18 | 1.40 | 2.56 | 2.45 | 3.14 | 2.98 |
| Gypsum (0.5 %) | 1.35 | 1.27 | 1.67 | 1.59 | 2.18 | 2.01 |
| Gypsum (1 %) | 1.48 | 1.36 | 1.76 | 1.70 | 2.31 | 2.09 |
| Gypsum (1.5 %) | 1.67 | 1.61 | 1.98 | 1.98 | 2.52 | 2.33 |
| Sugar beet mud (0.5 %) | 1.60 | 1.48 | 1.84 | 1.84 | 2.40 | 2.24 |
| Sugar beet mud (1 %) | 1.75 | 1.68 | 2.12 | 2.07 | 2.66 | 2.40 |
| Sugar beet mud (1.5 %) | 1.98 | 1.85 | 2.32 | 2.26 | 2.92 | 2.72 |
| Control | 1.24 | 1.22 | 1.55 | 1.50 | 2.02 | 1.90 |
| LSD $_{\text{at 5\%}}$ | 0.05 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 |
| P% | | | | | | |
| Compost (0.5 %) | 0.311 | 0.324 | 0.378 | 0.369 | 0.409 | 0.399 |
| Compost (1 %) | 0.339 | 0.350 | 0.411 | 0.401 | 0.438 | 0.418 |
| Compost (1.5 %) | 0.353 | 0.366 | 0.426 | 0.421 | 0.452 | 0.431 |
| Gypsum (0.5 %) | 0.255 | 0.259 | 0.294 | 0.295 | 0.350 | 0.337 |
| Gypsum (1 %) | 0.271 | 0.274 | 0.311 | 0.308 | 0.359 | 0.351 |
| Gypsum (1.5 %) | 0.290 | 0.302 | 0.344 | 0.335 | 0.386 | 0.371 |
| Sugar beet mud (0.5 %) | 0.278 | 0.285 | 0.323 | 0.323 | 0.370 | 0.362 |
| Sugar beet mud (1 %) | 0.302 | 0.311 | 0.362 | 0.351 | 0.400 | 0.383 |
| Sugar beet mud (1.5 %) | 0.328 | 0.339 | 0.398 | 0.390 | 0.426 | 0.406 |
| Control | 0.248 | 0.241 | 0.282 | 0.275 | 0.333 | 0.330 |
| LSD $_{\text{at 5\%}}$ | 0.006 | 0.009 | 0.005 | 0.007 | 0.004 | 0.005 |
| K% | | | | | | |
| Compost (0.5 %) | 2.59 | 2.42 | 2.84 | 2.92 | 3.45 | 3.28 |
| Compost (1 %) | 2.67 | 2.55 | 2.93 | 2.95 | 3.55 | 3.37 |
| Compost (1.5 %) | 2.79 | 2.68 | 3.05 | 3.02 | 3.70 | 3.54 |
| Gypsum (0.5 %) | 2.39 | 2.27 | 2.65 | 2.65 | 3.13 | 2.91 |
| Gypsum (1 %) | 2.18 | 2.03 | 2.33 | 2.38 | 2.82 | 2.64 |
| Gypsum (1.5 %) | 1.93 | 1.78 | 2.13 | 2.17 | 2.52 | 2.32 |
| Sugar beet mud (0.5 %) | 2.50 | 2.34 | 2.72 | 2.75 | 3.23 | 3.06 |
| Sugar beet mud (1 %) | 2.30 | 2.14 | 2.52 | 2.52 | 2.92 | 2.76 |
| Sugar beet mud (1.5 %) | 2.05 | 1.86 | 2.27 | 2.25 | 2.62 | 2.44 |
| Control | 1.84 | 1.61 | 1.99 | 1.93 | 2.33 | 2.19 |
| LSD $_{\text{at 5\%}}$ | 0.06 | 0.08 | 0.06 | 0.05 | 0.04 | 0.04 |

As for N, P, Na and Mg percentages, the treatments sequence from top to less at the three different growth periods under the both soils was as follows:

1.5% compost > 1% compost > 1.5% sugar beet mud > 0.5% compost > 1% sugar beet mud > 1.5% gypsum > 0.5% sugar beet mud >1 % gypsum> 0.5% gypsum> control treatment.

As for Ca percentage, the treatments sequence from top to less at the three different growth stages under the both studied soils was as follows:

1.5% gypsum > 1% gypsum > 1.5% sugar beet mud >0.5% gypsum > 1% sugar beet mud > 0.5% sugar beet mud > 1.5% compost >1% compost > 0.5% compost > control treatment.

At the same rate, the calcium percentage in barley plants grown on soil treated with gypsum or sugar beet mud was more than soil treated with compost due to the high content of calcium in both gypsum ($CaSO_4.2H_2O$) and sugar beet mud which contains 93% $CaCO_3$. On the other hand, the calcium percentage in barley plants grown on soil treated with gypsum was more than soil treated with sugar beet mud due to the solubility of calcium sulfate (2g $L^{-1}$) is more than calcium carbonate (0.013 g $L^{-1}$), thus the available $Ca^{++}$ in soil treated with gypsum was more than soil treated with sugar beet mud. This finding was reported by Straub, (1932).

As for K percentage, the treatments sequence from top to less at the three different growth periods under the both studied soils was different from the other measured nutrients (*i.e.*N, P and Mg). It was as follows:

1.5% compost > 1% compost > 0.5% compost > 0.5% sugar beet mud >0.5% gypsum>1% sugar beet mud >1 % gypsum>1.5% sugar beet mud > 1.5% gypsum > control treatment.

As mentioned previously, due to the antagonism between calcium and potassium, it was found that all rates of compost (0.5, 1, and 1.5 %) were better than these rates of other studied soil amendments. But the sugar beet mud gave higher K% compared to gypsum due to its content of 7% organic material.

The beneficial effects of these used substances on the physical, chemical and biological characteristics of soil such as water holding capacity, soil structure and it creates a good aeration in soil and decreased the pH value and consequently, nutrients in the soil became more available which in turn influence on the growth and increase of plants production under poor fertility soils such as saline clay and nonsaline sandy soils (Bello, 2012; Zaki, 2016 and Sanchary *et al*, 2019).

**Table 7. Effect of compost, gypsum and sugar beet mud on Ca, Na and Mg (%) in straw of barley plants grown on saline clay and nonsaline sandy at different growth periods (15, 30 and 45days after sowing).**

| Treatments | After 15 days | | After 30 days | | After 45 days | |
|---|---|---|---|---|---|---|
| | Saline clay soil | Nonsaline sandy soil | Saline clay soil | Nonsaline sandy soil | Saline clay soil | Nonsaline sandy soil |
| Ca% | | | | | | |
| Compost (0.5 %) | 0.24 | 0.22 | 0.33 | 0.22 | 0.47 | 0.35 |
| Compost (1 %) | 0.27 | 0.25 | 0.36 | 0.26 | 0.48 | 0.37 |
| Compost (1.5 %) | 0.31 | 0.25 | 0.39 | 0.30 | 0.51 | 0.41 |
| Gypsum (0.5 %) | 0.35 | 0.33 | 0.48 | 0.39 | 0.58 | 0.49 |
| Gypsum (1 %) | 0.39 | 0.37 | 0.52 | 0.44 | 0.63 | 0.57 |
| Gypsum (1.5 %) | 0.41 | 0.39 | 0.56 | 0.45 | 0.67 | 0.58 |
| Sugar beet mud (0.5 %) | 0.32 | 0.25 | 0.42 | 0.32 | 0.55 | 0.44 |
| Sugar beet mud (1 %) | 0.33 | 0.31 | 0.44 | 0.35 | 0.57 | 0.47 |
| Sugar beet mud (1.5 %) | 0.38 | 0.32 | 0.51 | 0.42 | 0.61 | 0.53 |
| Control | 0.23 | 0.18 | 0.30 | 0.19 | 0.44 | 0.32 |
| LSD $_{at\ 5\%}$ | 0.05 | 0.07 | 0.04 | 0.05 | 0.02 | 0.04 |
| Na% | | | | | | |
| Compost (0.5 %) | 0.18 | 0.12 | 0.22 | 0.12 | 0.33 | 0.22 |
| Compost (1 %) | 0.23 | 0.16 | 0.25 | 0.16 | 0.37 | 0.27 |
| Compost (1.5 %) | 0.25 | 0.17 | 0.28 | 0.18 | 0.39 | 0.30 |
| Gypsum (0.5 %) | 0.10 | 0.03 | 0.11 | 0.04 | 0.23 | 0.12 |
| Gypsum (1 %) | 0.10 | 0.04 | 0.15 | 0.03 | 0.25 | 0.15 |
| Gypsum (1.5 %) | 0.15 | 0.11 | 0.21 | 0.10 | 0.29 | 0.17 |
| Sugar beet mud (0.5 %) | 0.13 | 0.07 | 0.16 | 0.06 | 0.28 | 0.20 |
| Sugar beet mud (1 %) | 0.17 | 0.09 | 0.21 | 0.10 | 0.31 | 0.15 |
| Sugar beet mud (1.5 %) | 0.21 | 0.12 | 0.24 | 0.15 | 0.35 | 0.25 |
| Control | 0.07 | 0.02 | 0.12 | 0.01 | 0.23 | 0.09 |
| LSD $_{at\ 5\%}$ | 0.04 | 0.05 | 0.04 | 0.03 | 0.03 | 0.04 |
| Mg% | | | | | | |
| Compost (0.5 %) | 0.14 | 0.10 | 0.21 | 0.18 | 0.27 | 0.22 |
| Compost (1 %) | 0.18 | 0.15 | 0.26 | 0.21 | 0.32 | 0.27 |
| Compost (1.5 %) | 0.19 | 0.18 | 0.29 | 0.22 | 0.33 | 0.28 |
| Gypsum (0.5 %) | 0.04 | 0.02 | 0.10 | 0.06 | 0.16 | 0.13 |
| Gypsum (1 %) | 0.06 | 0.05 | 0.13 | 0.06 | 0.19 | 0.14 |
| Gypsum (1.5 %) | 0.13 | 0.08 | 0.16 | 0.11 | 0.22 | 0.19 |
| Sugar beet mud (0.5 %) | 0.08 | 0.07 | 0.12 | 0.10 | 0.20 | 0.17 |
| Sugar beet mud (1 %) | 0.12 | 0.09 | 0.16 | 0.13 | 0.25 | 0.21 |
| Sugar beet mud (1.5 %) | 0.16 | 0.13 | 0.26 | 0.17 | 0.29 | 0.24 |
| Control | 0.03 | 0.02 | 0.08 | 0.03 | 0.13 | 0.11 |
| LSD $_{at\ 5\%}$ | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 |

## CONCLUSION

1- Results obtained from this study increased our knowledge concerning the efficacy of some soil amendments on the enhancement of barley plants grown on degraded soils.
2- This study discovered that the soil application of sugar beet mud at different rates is useful for growing barley plants under saline clay and nonsaline sandy soils. That can be beneficial for soil reclamation such as saline clay and nonsaline sandy soils due to its high contents from calcium and organic matter. This study will help the researchers to uncover the sugar beet mud importance in soil reclamation that many researchers were not able to explore. Thus, a new way on the usage of sugar beet mud in agriculture proposes may be arrived at.
3- Generally, compost, agricultural gypsum and sugar beet mud are considered perfect soil conditioners and its applications to degraded soil positively influenced on barley plants growth.

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## استجابة الشعير النامي في أراضي مختلفة لبعض محسنات التربة.


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أجريت هذه الدراسة لتقييم تأثير الكومبوست والجبس الزراعي وطين السكر (ناتج ثانوي في عملية تصنيع السكر من البنجر) على نمو نباتات الشعير المزروعة في أصص تحتوي على تربة ملحية ورملية. لهذا الغرض، تم إضافة ثلاث معدلات مختلفة من الكومبوست والجبس الزراعي وطين السكر (0.5%، 1%، 1.5 ٪، أي ما يعادل 2.5، 5.0، 7.5 جرام /أصيص على التوالي) الي كلا نوعي التربة تحت الدراسة قبل أسبوعين من الزراعة والترطيب للسعة الحقلية، كان التصميم التجريبي المستخدم تصميمًا عشوائيًا تامًا مع تكرار المعاملات ثلاث مرات. تم تقييم مدلولات النمو (مثل الأوزان الطازجة والجافة (جرام/النبات) وعدد النباتات /الأصيص) وكذلك تركيز العناصر في النبات مثل النيتروجين والفسفور والبوتاسيوم والصوديوم والمغنسيوم والكالسيوم تم تقديرها. أشارت النتائج إلى أن القيم زادت بشكل ملحوظ مع زيادة معدل الاضافة لمحسنات التربة المدروسة، حيث أن أعلى القيم تم تحقيقها عند الإضافة بمعدل 1.5٪ يليها 1٪ ثم 0.5٪. هذا الاتجاه كان لجميع مدلولات النمو المدروسة وكذلك تركيز العناصر باستثناء البوتاسيوم الذي تأثر بالتضاد مع الكالسيوم. أيضا، لوحظ أن الشعير المزروع تحت معاملة الكونترول (بدون أي إضافة) عانى من نقص شديد في العناصر الغذائية. يؤثر الكومبوست والجبس الزراعي وطين السكر بشكل إيجابي على الشعير النامي بالتربة الملحية والرملية. أيضا وجد أن طين السكر للبنجر مفيدًا لنباتات القمح النامي بالأراضي المتدهورة بسبب محتواها العالي من الكالسيوم والمواد العضوية.