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Effects of some Soil Conditioners on Soil Physo-Chemical Properties and Onion Growth.

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ABATRACT

The field trials were conducted in the farm of El-Gemmeiza Agric. Res. Station, El-Gharbeia Governorate, during winter growing season of 2017/2018. This study aimed to improve physical and chemical properties as induced by the soil conditioners (sulphur(S), phosphogypsum(PG) and liquid calcium carboxylic acid (LCC)) on availability of essential nutrients and their positively effects on growth onion and this chemical composition. The experiment was designed in a complete randomized blocks design with three replicates. The treatments were (T1) control, (T2) sulphur (S) application at 1.50 ton ha^{-1} ,(T3)sulphur (S) application at 2.50 ton ha^{-1} ,(T4) phosphogypsum(PG) application at 5.00 ton ha^{-1} , (T5) phosphogypsum(PG) application at 10.00 ton ha^{-1} ,(T6) liquid calcium carboxylic acid (LCC) application at 5.00 liter ha^{-1} and (T7) liquid calcium carboxylic acid (LCC) application at 10.00 liter ha^{-1}. It was observed that application of S, PG and LCC at the high rate recorded maximum values of total water stable aggregates, hydraulic conductivity and cumulative infiltration. Regardless of application of S, PG and LCC up to 1.50 ton ha^{-1}, 10 ton ha^{-1} and 10 liter ha^{-1} level respectively led to decreased the soil properties (soil pH, exchangeable sodium and ESP) and increased the CEC, exchangeable cations , soil available NPK than other treatments. Soil treated with soil amendments showed apparent increases of macronutrients in both bulb and leaves onion, crude protein in bulb, chlorophyll a, chlorophyll b, chlorophyll a+b and carotenoid than control. The study recommends adding soil conditioners improve the physo- chemical properties and onion growth.

Keywords: conditioners, physical, chemical properties, onion

INTRODACTION

Onion (Allium cepa L.) are one of the most important vegetables in the world. Onion can be eaten fresh, boiled fried or roasted. They are used for spices or medical purposes. It has vitamin, calcium and iron, and it also lowers blood sugar. (FAO, 2013.). The onion is one of the vegetable crops grown in Egypt, not only for domestic consumption but for export, with an area of about 203 thousand fed produced around 2.947 million ton (Economic Affairs Sector, Ministry of Agriculture and Land Reclamation, 2015). In 2016, the global area under onion cultivation was about 5 million ha^{-1}, which produced 93 million ton, with an average calculated return of 18 ton ha^{-1} (FAOSTAT, 2016).

Sulphur is recognized as the fourth major elemental for plant nutrient after N, P and K in plants. It is composed enters in of amino acids (methionine and cysteine), peptides, chlorophyll, some enzymes and vitamins, oils and proteins, and a variety of products in allium, which are essential building blocks for proteins in the crops. Furthermore, it is essential for a good plant growth and onion evolution and has a strong effect on onion flavor and persistence through participation in sulphur volatile compounds (Forney *et al.*, 2010) and (Stewart, 2010). Sulphur has been important of nutrient value, diseases, flavors and pests, as that the severe S deficiency during the development of onion bulb have a detrimental effect on growth of onion (Hore *et al.*, 2014). sulphur as a macronutrient has different effects on soil physo-chemical characteristics, that effect on the growth and development of onion yield. Sulphure reduces soil pH, improves soil water relation and increases the nutrients available. Accordingly, the application of sulphur fertilizers has increase the number of green leaves, diameter, plant height, onion weight and quality of onion in various researches carried out by various researchers (Rizk *et al.*, 2012).

Phosphogypsum (PG) is a product of processing phosphate rock for producing phosphoric acid by acidity with sulfuric acid. PG are produced worldwide (nearly 170 million tons in 2006), most were stored. It consists mainly of gypsum, this means that, it could be a source of Ca and S agricultural soil, which is actually one of the main worldwide sinks of such material (Mesić *et al.*, 2016). The content of PG in sulphur and calcium contributes to improve plant uptake of these elemental. Phosphogypsum (PG) has shown relatively high impact in decreasing pH, ESP, EC and bulk density as compared with in agricultural gypsum (AG) reflecting more Ca^{2} released from the first region, probably because of its acidity(Abd El-Fattah, 2014). El-Rashidi *et al.*, (2010) found that the application of gypsum improve the availability of nutrients in soil. Gypsum plays an important role in the metabolism of plants and their soil supplies sulfur to crops in order to promote growth and yield through increased production of vitohormones, amino acids, glutathione and osmoproteons, which are vital explorers in plants' response to salinity stress. Also, causing low soil pH, enhancing solubility and availability of nutrients. Crusciol (2016) found that treated onion application of gypsum 100% gypsum Requirement (GR) improved bulk density, pH, and

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exchangeable Ca^{2+}. Sarwar *et al.* (2011) found that gypsum requirement (GR) at 8.75 ton ha^{-1} improved chemical properties (soil pH and soil available NPK) of soil. The purpose of this research is study the effect of different rates of sulphur(S), phosphogypsum (PG) and liquid calcium carboxylic acid (LLC) to obtain the best soil properties and growth of onion bulbs.

MATERIALS AND METHODS

The experiment was conducted at El-Gemmieza Agric., Res., Station of the ARC in El-Gharbiah Governorate (Middle Delta region). The experiment site coordinates are latitude 30◦ 43- latitude and 31◦ 47- longitude), during two successive winter growing seasons (2017/2018 and 2018/2019) to study the impact of some soil conditioners on soil properties and growth of onion. The design of experiment was carried out in a complete randomized blocks design with three replicates. The plots were allocated with seven soil amendments treatments as follows: (T1) - untreatment. (T2)- sulphur(S) application at 1.50 ton ha^{-1}.(T3)- sulphur (S) application at 2.50 ton ha^{-1}.(T4)- Phosphogypsum (PG) application at 5.00 ton ha^{-1}. (T5)- Phosphogypsum(PG) application at 10.00 ton ha^{-1}.(T6)- liquid calcium carboxylic acid (LCC)application at 5.00 liter ha^{-1}(T7)- liquid calcium carboxylic acid (LCC)application at 10.00 liter ha^{-1}. The soil conditioners were added during transplantation. Soil samples were taken from surface layer (0 - 30cm) of the experimental site to determine physical and chemical characteristics. Soil properties of the experimental soil are presented in Table (1). The chemical characteristics of soil amendments samples are shown in Table (2).

Seedlings of the onion (*Alluim cepa L.)* (Giza Red) were transplanted on October 22th, 2017 and November 1st, 2018 in the first and second seasons, respectively. The unit area in the experiment was 10.80 m^2 and it had three ridges 3.60 m each length and 3.00 m width. All the soil plots including the control treatment received 215 kg N ha^{-1} as ammonium nitrate (33.5% N), 72 kg P_2O_5 ha^{-1} as calcium superphosphate (15.50% P_2O_5) and 57 kg ha^{-1} K_2O as potassium sulphate (48% K_2O). The calcium superphosphate was added during soil preparation, while ammonium nitrate and potassium sulphate were added at two equal portions, after 30 and 60 days from transplanting. The plants were harvested after 50% of plant tops were fallen down (140-152) days from cultivation, bulb samples were taken for determining dry weights. Soil physical properties (i.e., total water stable aggregates, hydraulic conductivity, cumulative infiltration and pore size distribution) were measured and their relations to crop production for the two years and calculated as outlined by Klute (1986). Soil chemical parameters in soil and amendments, including pH, EC, soluble ions, organic matter, CEC, exchangeable cations, available N, P and K analyses in soil were evaluated according to Cottenie *et al.* (1982) and (A.O.A.C., 1995). Gypsum requirements (GR) determined according to schoonover, s methods A.O.A.C., (2012). Samples of onion were dried at 70°C in oven until a consistent weight was reached. Total nitrogen, phosphorus, potassium, calcium, magnesium and sulphur in leaves and bulb of onion were detected using the modified method and described by FAO (2008). Chlorophyll content was estimated as the method described by Gavrilenko and Zigalova (2003). Crude protein in onion sample was calculated by multiplying the total nitrogen by 6.25 (AOAC 2000). Statistical analysis: The statistical bundle (CoHort, 1986) was used for data analysis. These treatments were administered complete randomized blocks analysis of variances (ANOVA).The probability level for determine importance was 0.05.

Table 1. Physical and chemical properties of the investigated soil.

Chemical analysis

Season	Soil pH (1:2.5)	EC (dS m^{-1})	Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})				Available macronutrients (mg kg^{-1})			OM (%)	Exchangeable cations (cmol/kg)				CEC (cmol /kg)	ESP	GR Ton ha^{-1}
			Ca-2	Mg2+	Na+	K+	Cl-	CO3–	HCO3-	SO4-	N	P	K		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}			
2017	8.22	2.50	3.85	2.25	18.4	0.25	7.25	Nil	6.85	10.70	38.95	2.45	325	1.38	17.85	12.00	10.25	1.75	42.25	24.3	5.36
2018	8.15	3.08	3.15	2.65	24.4	0.29	8.65	Nil	7.86	13.98	40.12	1.65	378	1.52	19.15	12.85	12.45	2.05	46.65	26.7	7.15

Physical analysis

Season	bulk density g cm^{-1}	Total stable aggregates (%)	Hydraulic conductivity (cm h^{-1})	Cumulative Infiltration (mm h^{-1})	Particle size distribution				Texture
					c. sand	f.sand	silt	clay	
2017	1.18	62.85	0.65	8.75	10.15	14.65	27.22	47.98	clay
2018	1.23	56.78	0.42	6.95	8.95	15.09	25.85	50.11	clay

CEC=cation exchange capacity, ESP= exchangeable sodium percentages, GR= Gypsum requirements

Table 2. Chemical composition of soil amendments.

soil amendments	OM (%)	Total Ca (%)	Total S (%)	carboxylic acid (%)
sulphur	-----	------	98.5	------
Phosphogypsum	4.86	19.86	15.45	------
Calcium liquid	5.75	13.35	------	10.15

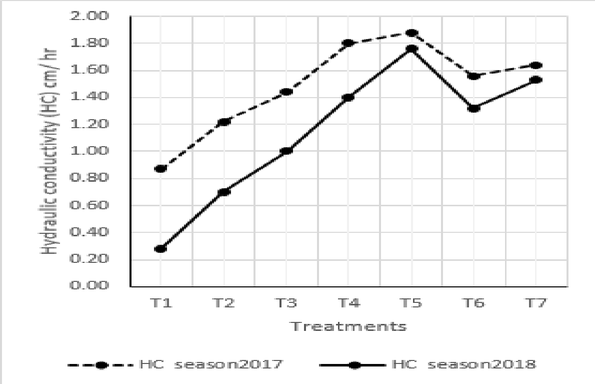
OM=organic matter

RESULTS AND DISCUSSION

Soil physical properties.

As shown in Fig. (1), the impact of amendments levels on soil physical properties were different statistically. It was suggested that increasing dose application of soil amendment materials into soil increased total water stable aggregates (WSA), hydraulic conductivity (HC) and cumulative infiltration rate (IR). Wherever, application soil amendment at rates T2, T3, T4, T5, T6 and T7 severally increased WSA values by 10.97, 16.97, 21.75, 29.08, 18.14 and 22.78% after the first season and increased by 9.17, 15.00, 21.21, 34.49, 17.13 and 27.54% after second one as compared with control treatment. It is worthy to mention that the increase in HC than control by 40.23. 65.52, 106.90, 116.09, 79.31 and 88.85% after the first season and increased by 175, 257.14, 400.00, 528.57, 371.43 and

446.43% after second one due to the effect of soil amendments addition of T2, T3, T4, T5, T6 and T7 respectively. In general, mean values (Fig, 1) revealed that IR responded positively to the tested treatments, since the relative increases IR which reached 30.69, 54.73, 51.25, 101.06, 25.48 and 51.54% after first season and increase by 31.44, 55.57,61.72, 98.49, 42.46 and 60.67% after second one with added T2, T3, T4, T5, T6 and T7, respectively, over the control treatments. The addition PG and LCC lead to enhance the proportion and stability of macro aggregates, because calcium acts as a binding factor, practices that increase calcium levels in the soil enhance the composition and stability of micro aggregates, which is essential for large aggregate arrangements. Also, because partially decompose of S, PG and LCC, which increased the soil aggregation. Thus, improved soil structure leads to an increase in soil total porosity, which improves water retention infiltration rate and soil aeration. These observations suggest that the presence of soil amendment were important for the removal of Na^+ from the exchange complex, which improved the physical properties for water movement. These treatments may also have led to an increase in aggregate stability, facilitating the rate of water infiltration and movement in the soil, as the gypsum provides Ca^{2+} to replace Na^+, which may reduce dispersion, thus improving the soil physical conditions (Gupta *et al.,* 2016).



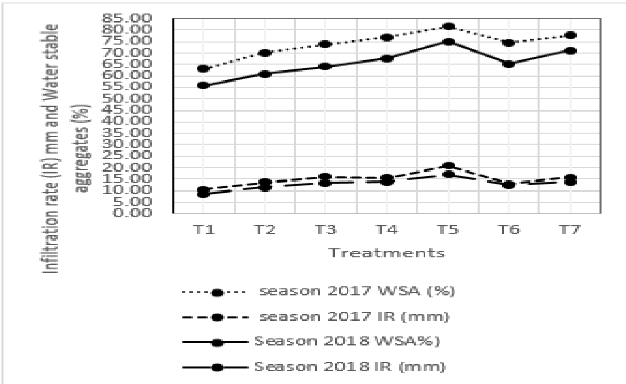


Fig .1. Effect of soil conditioners on hydraulic conductivity, total water stable aggregates cumulative infiltration rate after harvesting onion yield in the two seasons.

HC= Hydraulic conductivity, WSA= water stable aggregates, IR= infiltration rate

Sarwar *et al.,* (2011) showed that gypsum requirement (GR) at 8.75 ton ha^{-1} improved soil structure and soil aggregation in soil. Fisher (2011) reported that PG or gypsum improving soil structure. Congestion, or the aggregation or assembly of soil particles together, depends largely on electrostatic repulsive forces between negatively charged soil mineral particles by divalent cations, which facilitates the linking of soil particles and stimulates the stability of soil particles through flocculation. Mahmoud *et al.,* (2017)found that the soil aggregate, hydraulic conductivity, cumulative infiltration rate increased significantly as a result of the plots treated with PG at rate 10 Mg ha^{-1} when compared to control treatment in Vertic Torrifluvents. Gypsum prevents swelling and dispersal, increases total porosity, structural stability and hydraulic conductivity. Gypsum can improve the physical characteristics of soils Such soil conditioners enhance soil aggregation and can therefore (1) help prevent soil particle dispersal (2) reduce surface shell formation, (3) enhance seedlings' appearance (4) increase infiltration rates and movement through soil profile. (Liming and Dick, 2011).The supply of PG at rates 4.50 to 18.00 t ha^{-1} in alkaline clayey soils improve soil aggregation and other wise benefit soil structure. (Yu *et al*., 2015).

Soil chemical properties.

The impact of soil conditioners application on cation exchange capacity (CEC), exchangeable cations and exchangeable sodium percentage (ESP) are presented in Table (3). From these results, it could be concluded that increasing soil amendments rates had slightly increased significantly the soil CEC, exchangeable cations (Ca^{2+}, Mg^{2+} and K^+) and decreased significantly exchangeable sodium and ESP. On the other hand, these chemical parameters were not significantly affected by type onion. Application of soil amendments at high rate cause to increase CEC percent reached to 2.95, 5.37, 9.87,13.36, 4.64 and 9.23%, increase by 6.68,12.93, 22.74, 25.97, 15.40 and 22.58% for exchangeable Ca^{2+}, increase by 3.26, 6.43, 10.17, 12.39, 4.77and 9.37% for exchangeable Mg^{2+}, raise by 26.49, 47.03, 12.97, 30.27, 14.05 and 23.24% for exchangeable K^+ at the first season. While, in the second season, the values of CEC increase by 5.42, 9.84, 11.44, 15.34, 10.63 and 13.63%, and increase by 8.95,18.51, 31.66, 39.61, 32.27 and 36.27% for exchangeable Ca^{2+}, increase by 12.16, 18.04, 21.67, 27.06, 16.08 and 19.61% for exchangeable Mg^{2+}, raise by18.06, 40.28, 14.35, 25.46, 14.35 and 23.61% for exchangeable K^+ with added T2, T3, T4, T5, T6 and T7, respectively, as compared with control. The soil conditioners showed relatively large decline in exchangeable sodium and ESP following by increased soil amendments applications, the decrease of exchangeable sodium by 7.16, 13.14, 16.03, 22.65, 13.78 and 16.03%, decrease by 9.85, 17.59, 23.56, 31.77, 17.64 and 23.15% for ESP at the first season, the same trend obtained in the second season was cause to decrease exchangeable sodium where reached to 12.60, 21.81, 27.89, 34.49, 27.89 and 30.23%, and decrease by 17.10, 28.80, 35.33, 43.28, 34.90 and 38.58% % for ESP with added T2, T3, T4, T5, T6 and T7, respectively, as compared with control. The replacement of Na^+ by Ca^{2+} can reduce in exchangeable sodium in the soil exchange complex, where phsophogypsum being a rich source Ca^{2+}. The decline in soil pH as a result of gypsum application is a manifestation of a replacement of Na^+ by Ca^+ on the exchange complex, and composition of sulfate salts then low concentration of sodium in soil. Furthermore, the solubility of the gypsum must have improved due to increased Ca^{2+} and S activity coefficient as a result of increased ion strength of the solution and the formation of Na_2SO_4 ion (Prapagar *et al.*, 2012) In addition, significant amounts of CO_2 developed during leaching, some of which may become soluble in soil solution giving carbonic acids (Abdel-Fattah, 2012).

Table 3. Effect of soil conditioners on cation exchange capacity (CEC), exchangeable cations and exchangeable sodium percentage (ESP) after harvesting onion.

Treatments	First season (2017)						Second season (2018)					
	CEC	Exchangeable cations (cmol Kg^{-1})				ESP	CEC	Exchangeable cations (cmol Kg^{-1})				ESP
	(cmol kg^{-1})	Na	Ca	Mg	K		(cmol kg^{-1})	Na	Ca	Mg	K	
T1(control)	42.67c	9.36a	18.25d	12.59a	1.85d	21.94a	44.32f	11.51a	19.77f	10.20e	2.16d	25.97a
T2(S1)	43.93d	8.69 b	19.47c	13.00d	2.34bc	19.78b	46.72e	10.06b	21.54e	11.44d	2.55c	21.53b
T3(S2)	44.96c	8.13c	20.61b	13.40c	2.72a	18.08c	48.68d	9.00c	23.43d	12.04bc	3.03a	18.49c
T4(PG5)	46.88b	7.86d	22.40a	13.87b	2.09c	16.77d	49.39c	8.30d	26.03c	12.41b	2.47c	16.81d
T5(PG10)	48.37a	7.24a	22.99a	14.15a	2.41b	14.97e	51.12a	7.54e	27.60a	12.96a	2.71b	14.75f
T6(LCC5)	44.65c	8.07c	21.06b	13.19d	2.11c	18.07f	49.03cd	8.30d	26.15e	11.84c	2.47c	16.93d
T7(LCC10)	46.61b	7.86d	22.37a	13.77b	2.28bc	16.86d	50.36b	8.03d	26.94b	12.20bc	2.67b	15.95e
$LSD_{0.05}$	0.35	0.13	0.34	0.21	0.20	0.21	0.50	0.36	0.23	0.31	0.10	0.73

According to Vyshpolsky *et al.* (2010) using phosphogypsum by 3.30 and 8.00 ton ha^{-1} PG in heavy clay soil, the effects of excess Mg^{2+} in soil is negative in terms of soil structure and eventual plant growth. The low in soil pH as a results of gypsum addition may have been due to combination of more than one factor, mainly the substituted of Na^+ by Ca^{2+} and composition of neutral salts with $SO_4^=$ and reduced sodium concentration as a fraction of the cations. Similar effects were observed by Carvalho *et al.* (2013) who found that increases in soil contents of calcium and sulphur with the application phosphogypsum, and thus increase in base saturation, which is directly related to the displacement of hydroxyl (OH-) and the adsorption of sulphure, enabling the composition of metal bonds, and an increase in cation exchange capacity mainly related calcium (Raij, 2011).

Data in Table (4) revealed that, soil amendments application decreased significantly on the values of soil pH. The soil pH untreated soil (control) was 8.04 and 8.20 in first and second season, it was slightly lower in soil amended samples showing values ranging from 7.76 –7.87 with application S rate at 2.50 Mg ha^{-1}(T3), 7.83 –7.93 with application PG rate at 10 Mg ha^{-1}(T5) and, it ranged from 7.91 -7.94 with application rate of LCC at 10 Mg $liter^{-1}$(T7) in first and second, respectively. Therefore, it was clear that the type of onion did not effect on soil pH. Soils amended with T3, T5, and T7 showed significantly higher available N, P and K than the other treatments. Such increases were higher of when increasing rate of soil application amendments. These samples showed higher available of N by 37.42, 49.00 and 29.17%, available P by 209.43, 102.20 and 79.87% and available of K by 34.22, 19.12 and 12.36% with T3, T5, and T7 respectively than control treatment in the first season. It was observed that soil available N, P and K were increased with successive increase in the amendments levels. Where the increasing at T3, T5, and T7 resulted in progressive increase available N by 29.55, 34.04 and 20.82%, available P by 377.71, 206.37 and 140.13% and available K by 34.89, 15.24 and 10.74%, respectively over that untreated soil. The decline soil pH caused by added PG may be due to the release of phosphoric acid and sulfuric acid contained in sulphur and PG. The decrease in soil pH values led to enhancement of soil buffering capacity and increasing the partial pressure of CO_2 of the soil atmosphere due to the increase in the microbial activity and availability nutrients. The application of sulphur in an incubation experiment reduced pH values relative to the control treatment, but, the soil available P and K were found to have increased significantly (El-Kholy *et al.* 2013). Abd El-Naby *et al.* (2016) revealed that sulphure 1 ton fed^{-1} and Gypsum 2 ton fed^{-1} caused increased in the availability of (N, P and K) improved the plant tolerance to salt stress. Kim *et al.* (2021) suggest that PG supplies may be able to enhance soil fertility, which contributes to improving soil available nutrients. Mahmoud (2011) reported a relative decrease in soil pH from control which varied from 8.35 to 8.31 and 8.37 to 8.17 average over two seasons for gypsum and sulphur treatments, respectively. Gypsum application at the rate of 4 and 8 ton fed^{-1} decreased soil pH as compared to the control plot. However, the decline of soil pH, could be discussed by the following: Ca^{2+} ions interact with bicarbonate (HCO_3) to accelerate calcite ($CaCO_3$) and release protons (H^+) into soil solution which neutralize the (OH^-) hydroxide ions and reduce pH in soil. (Rasouli *et al.*, 2013).

Table 4. Effect of soil conditioners on soil pH, available N, P and K after harvesting onion.

Treatments	First season (2017)				Second season (2018)			
	pH (1:2.5)	Available nutrients mg Kg^{-1}			pH (1:2.5)	Available nutrients mg Kg^{-1}		
		N	P	K		N	P	K
T1(control)	8.04a	33.43f	3.18e	311.96f	8.20a	38.37e	1.57g	360.31c
T2(S1)	7.82d	42.13d	6.55b	381.41b	7.92c	46.03c	4.30c	408.11b
T3(S2)	7.76d	45.94b	9.84a	418.72a	7.87d	49.71b	7.50a	486.01a
T4(PG5)	7.87c	44.70bc	5.45c	346.79d	8.00b	46.10c	3.05e	400.33b
T5(PG10)	7.83d	49.81a	6.43b	371.62c	7.93c	51.43a	4.81b	415.22b
T6(LCC5)	7.95b	40.23e	4.27d	328.65e	8.03b	43.67d	2.18f	386.33b
T7(LCC10)	7.91c	43.18cd	5.72c	350.51d	7.94c	46.36c	3.77d	399.00b
LSD 0.05	0.035	1.61	0.40	8.60	0.028	1.40	0.42	21.61

Nayak *et al.* (2011) showed that increasing amounts of phsophogypsum application, pH was decreased in treatment with 20% PG. Turan *et al.* (2013) reported that addition of sulphur or gypsum to the alkaline soils causes decline in soil pH resulting in an increase in soil nutrients available. Gypsum is consisting of calcium sulfate dehydrate, with the chemical formula $CaSO_4.2H_2O$ which is a major source of Ca and S for the plant. With increased Ca, S, N, P and K absorption in roots. (Pradhan *et al.,* 2015).

Content of macronutrients

All nutrients content of onion bulb and leaves evaluated were significantly influenced by increasing soil amendments rates. Data in Tables (5 and 6) showed that N, P, K, Ca, Mg and S contents by in both bulb and leaves onion were significantly responded to the application of soil amendments. Where, increasing the rate of soil amendments led to the enhancement of nutrients content. The maximum content of bulb and leaves nutrients were recorded by S(T3 2.50 Mg ha^{-1}), PG (T5 10 Mg ha^{-1}) and LCC (T7 10 liter ha^{-1}).The N, P, K, Ca, Mg and S contents of bulb increased by 44.10, 95.83, 60.61, 59.52, 58.33 and 116.67% for S (2.50 Mg ha^{-1}), 34.93, 170.83, 65.66, 95.24, 83.33 and 83.33% for PG (10 Mg ha^{-1}) 19.65, 83.33, 46.46, 77.38, 54.17 and 66.67% for LCC (10 liter ha^{-1}). in response to 10 liter ha^{-1} application respectively over than control, the same amendments led to increase nutrients pervious of leaves by 46.45, 84.62, 83.33, 76.19, 61.54 and 116.67% for S (2.50 Mg ha^{-1}), increase by 30.81, 138.46, 50.00, 145.24, 92.31 and 83.33% for PG (10 Mg ha^{-1}) and increase by 20.86, 76.92, 34.92, 114.29, 61.54 and 66.67% for CLL (10 liter ha^{-1}) respectively over than control in the first season. It should be noted that the increase in nutrients contents is due mainly to the impact of added soil amendments. The applied treatments showed the highest increases for the content of N, P, K, Ca, Mg and S in both onion bulb after second season, where their increases reached to 46.45, 95.24, 59.48, 86.15, 90.91 and 221.05% for S (2.50 Mg ha^{-1}), increase by 30.81, 204.76, 44.83, 115.38, 118.18 and 178.95% for PG (10 Mg ha^{-1}) and increase by 20.85, 95.24, 36.21, 93.85, 40.91 and 47.37% % for LCC (10 liter ha^{-1}) respectively over the control treatments The relative the same previous nutrients of leaves were increase by 50.29, 91.67, 70.42, 97.44, 90.91 and 200.00 % for S(2.50 Mg ha^{-1}), increase by 40.94, 191.67, 44.37, 117.95, 127.27 and 163.64% for PG (10 Mg ha^{-1}) and increase by 29.83, 91.67, 25.35, 97.44, 63.64 and 90.91% for LCC (10 liter ha^{-1}) respectively over than the control treatments in the second season. The application of S, PG and CLL holding fertilizer positively affects with all parameters of onion due to its positive contribution to the availability of nutrients to onion crop. Other authors also reported that the use of S application significant increase N, P, K and S uptake by onion plant. Furthermore, application of S improves the uptake of other plant nutrients needed for growth and development of crop plants including onions. In this regard, Sankaran *et al.* (2005) showed that increase uptake of N, P, K and S by onion plant when sulphure was applied. Mazhar *et al.* (2011) reported that sulphur improves the use efficiency of the plant nutrients (N and P). Also, the application of gypsum has also shown a more pronounced impact on the nutrients percentage in plant members compared to sulfur applied. This effect seems to be depend on soil characteristics that limit the capacity to mobilize and local e nutrient content. Kim *et al. (*2021) found that the uptake of N, P, Ca, K, and S of onions increased by Phosphogypsum 50%, 100% and 150% .Also, higher content of nutrients (N, P, Ca and Mg) were observed in the leaves of plants exposed to 30 mg L-1 Prohexadione Ca, though there was no significant change in the leaves of plants exposed to 15 mg L-1 PProhexadionero-Ca.(Başak, 2021)

Table 5. Effect of soil conditioners on macronutrients content (%) in bulb and leave onion in the first season.

Treatments	nutrients content (%)in bulb onion season(2017)						nutrients (%)in leave season(2018)					
	N	P	K	Ca	Mg	S	N	P	K	Ca	Mg	S
T1(control)	2.29e	0.24e	0.99c	0.84d	0.24d	0.12c	2.11e	0.13d	1.26e	0.42f	0.13c	0.12c
T2(S1)	2.75c	0.38d	1.34b	1.18c	0.32c	0.22ab	2.67bc	0.20c	1.86b	0.63e	0.17bc	0.22ab
T3(S2)	3.30a	0.47c	1.59a	1.34b	0.38b	0.26a	3.09a	0.24bc	2.31a	0.74cd	0.21ab	0.26a
T4(PG5)	2.61cd	0.54a	1.36b	1.46b	0.37b	0.18bc	2.65bc	0.25b	1.73c	0.81c	0.19b	0.18bc
T5(PG10)	3.09b	0.65a	1.64a	1.64a	0.44a	0.22ab	2.76b	0.31a	1.89b	1.03a	0.25a	0.22ab
T6(LCC5)	2.53d	0.39d	1.33b	1.35b	0.32c	0.16bc	2.40d	0.2c	1.56d	0.71d	0.17bc	0.16bc
T7(LCC10)	2.74c	0.44c	1.45b	1.49b	0.37b	0.20ab	2.55e	0.23bc	1.70c	0.90b	0.21ab	0.20ab
LSD 0.05	0.13	0.051	0.10	0.11	0.037	0.058	0.11	0.28	0.096	0.074	0.036	0.058

Table 6. Effect of soil conditioners on macronutrients content (%) in bulb and leave onion in the second season.

Treatments	nutrients content (%)in bulb onion season(2018)						nutrients (%)in leave season(2018)					
	N	P	K	Ca	Mg	S	N	P	K	Ca	Mg	S
T1(control)	2.11e	0.21d	1.16f	0.65d	0.22d	0.19e	1.71e	0.12e	1.42f	0.39d	0.11d	0.11e
T2(S1)	2.67bc	0.31c	1.41d	0.86c	0.28cd	0.39c	2.17c	0.17d	1.94c	0.61c	0.16cd	0.22c
T3(S2)	3.09a	0.41b	1.85a	1.21b	0.42b	0.61a	2.57a	0.23c	2.42a	0.77b	0.21ab	0.33a
T4(PG5)	2.65bc	0.42b	1.35e	1.22b	0.33c	0.36c	2.07cd	0.28b	1.777d	0.74b	0.22ab	0.20cd
T5(PG10)	2.76b	0.64a	1.68b	1.40a	0.48a	0.53b	2.41b	0.35a	2.05b	0.85a	0.25a	0.29b
T6(LCC5)	2.40d	0.30c	1.32e	1.20b	0.26cd	0.23de	1.95d	0.19cd	1.63e	0.73b	0.15cd	0.17d
T7(LCC10)	2.55c	0.41b	1.58c	1.26b	0.31c	0.28d	2.22c	0.23c	1.78d	0.77b	0.18bc	0.21cd
LSD 0.05	0.11	0.053	0.04	0.081	0.057	0.054	0.14	0.038	0.091	0.047	0.044	0.034

Gypsum is consider a source of the essential plant nutrients. In general, calcium and sulphure can improve plant absorption nutrients. It can also decrease erosion nutrients loss of corrosion and reduce of soluble P in surface water runoff. This enhances deep cramping and the ability of plants to access adequate water and nutrient applied during droughts. Gypsum is the most commonly used conditioners for sodic soil reclamation and can also be included as a component in synthetic soils for nursery, landscape use and greenhouse (Liming and Dick, 2011). In general, the higher sulphur and gypsum application, apart from doses that increase in uptake of N, P, K and S of onion leaves, may affect the synthesis and translocation of stored materials Pradhan *et al.,* (2015),Yu *et al*., (2015) and Chandrakar *et al.,* (2018).

It is clear from Table (7) that the content of crude protein in bulb, chlorophyll a, chlorophyll b and chlorophyll a+b and carotenoid in leaves onion significant increase by the addition of different treatments compared to the control. These parameter were increased due to application of different treatments over the control. The corresponding highest crude protein values in onion bulbs were 26.38, 46.32, 25.55 ,30.86,13.72 and 20.85% in the first season, and were 26.92, 50.28, 20.75 ,40.84,13.92 and 29.44% in the second season, with T2, T3,T4,T5,T6 and T7 respectively over than control(T1), recorded under chlorophyll a in onion leaves while, the highest recorded values of were 111.54, 292.31, 80.77, 192.31 ,15.38 and 69.23% in the first season and increased by were 103.70, 292.59, 77.78, 185.19., 40.74 and 118.52% in the second season due to the treatments of T2, T3,T4,T5,T6 and T7 respectively over than control . The highest values of chlorophyll b in onion leaves were obtained by 100.00, 252.94, 47.06, 147.06, 29.41 and 82.35% in the first season, and 106.67, 233.33, 80.00, 220.00, 33.33 and 100.00% over control in the second season due to the same pervious treatments applied, receptivity. The highest values of carotenoid in onion leaves were obtained by 133.33, 258.33, 183.33, 400.00, 100.00 and 175.00% in the first season and increased by 145.45, 300.00, 209.09, 400.00, 72.73 and 136.36% in the second one due to the a much higher protein content was obtained under 22% of gypsum RDF substances that may be caused by deficiency, and a decrease in amino acid methionine and cysteine inhabit protein synthesis (Mazhar *et al.,* 2011)

Table 7. Effect of soil conditioners Crude protein in bulb, Chlorophyll a, Chlorophyll b, Chlorophyll a+b and carotenoid in leaves onion and protein in bulb onion.

Treatments	First season (2017)					Second season (2018)				
	Ch a (mg/g FW)	Ch b (mg/g FW)	Ch a+b (mg/g FW)	Carotenoid (mg/g FW)	Protein (%)	Ch a (mg/g FW)	Ch b (mg/g FW)	Ch a+b (mg/g FW)	Carotenoid (mg/g FW)	Protein (%)
T1(control)	0.26e	0.17e	0.44e	0.12f	13.19e	0.27f	0.15e	0.42f	0.11f	10.70e
T2(S1)	0.55c	0.34c	0.90c	0.28de	16.67bc	0.55c	0.31b	0.86c	0.27d	13.58c
T3(S2)	1.02a	0.60a	1.62a	0.43b	19.30a	1.06a	0.50a	1.56a	0.44b	16.08a
T4(PG5)	0.47d	0.25d	0.72d	0.34c	16.56bc	0.48d	0.27c	0.75d	0.34c	1292cd
T5(PG10)	0.76b	0.42b	1.18b	0.60a	17.26b	0.77b	0.48a	1.26b	0.55a	15.07b
T6(LCC5)	0.30e	0.22de	0.52e	0.24e	15.00d	0.38c	0.20d	0.58e	0.19e	12.19d
T7(LCC10)	0.44d	0.31c	0.74d	0.33g	15.94c	0.59c	0.30bc	0.89c	0.26d	13.85c
LSD 0.05	0.079	0.45	0.11	0.050	0.67	0.044	0.04	0.057	0.053	0.90

Ch a= chlorophyll a, ch b= chlorophyll b

Reassess of the response to sulphur and gypsum results through (Navaldey 2014) found that the highly enriched S fertilization increases protein and chlorophyll content which the important regulatory function of transferring Ca from the cytosol to chloroplast illumination. Calcium also travels along the potential electrochemical gradient from the cytosol into the stomach of the chloroplast. , which enhance leaf and Bulb protein content. Doklega (2017) found that sulphur gave significant increases in chlorophyll a, b and a+b (mg/g Fw), crude protein % in onion plant. In the current study, increases in chlorophyll a/b ratio were obtained by the increasing Pro-Ca doses. The chlorophyll a/b values were 1.98, 2.05, 2.18, 3.68, and 3.43 in 0, 15, 30, 45, and 60 mg L-1 Pro-Ca applied, respectively (Başak, 2021).

CONCLUSION

Sulphur, phsopsogypsum and liquid calcium carboxylic acid are three types of soil conditioner that can improve the physo-chemical characteristics of the soils. The effect of soil amendments on the physical characteristics of the soil revealed a better total water stable aggregates, hydraulic conductivity and cumulative infiltration when applying S, PG and calcium CLL. Concerning the chemical characteristics of the soil, soil amendments addition caused an important decrease in (soil pH, exchangeable sodium and ESP) and increased the CEC, exchangeable cations (Ca^{2+}, Mg^{2+} and K^{+}), available N,P,K, where, depending on the type and the level of applied amendments. Onion treated with soil amendments significantly produced higher of both yield, nutrients content, crude protein in bulb, chlorophyll a, chlorophyll b, chlorophyll a+b and carotenoid in leaves onion than those treated control. The best values of soil and onion properties were obtained with psopsogypsum at rate at 10.00 ton ha^{-1}than other treatments.

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تاثير بعض مصلحات التربة علي الخواص الطبيعية والكيميائية للتربة ونمو محصول البصل

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أجريت تجربة حقلية خلال موسمي 2017 ,2018 علي محصول البصل المنزرع في تربة ثقيلة القوام بمحطة البحوث الزراعية بالجميرة محافظة الغربية لدراسة تاثير مصلحات التربة المختلفة علي الخواص الطبيعية والكيميائية للتربة ونمو محصول البصل وتركيبة الكيميائي. وقد صممت التجربة في قطاعات تامة العشوائية في ثلاث مكررات وكانت المعاملات (T1) كنترول ,(T2) الكبريت بمعدل 1.50, (T3) الكبريت بمعدل 2.50 طن للهكتار , (T4) الفسفوجيبسيم بمعدل 5.0 , (T5) الفسفوجيبسيم بمعدل 10.0 طن للهكتار , (T6) الكالسيوم السائل المضاف الية احماض كربوكسلية 5.0 لتر للهكتار , (T7) 10.0 لتر للهكتار). أشارت النتائج الي ان اضافة محسنات التربة المختلفة الي زيادة معنوية لقيم الخواص الطبيعية للتربة وهي زيادة التجمعات الكلية الثابتة في الماء والتوصيل الهيدوليكي ومعدل الرشح مقارنة بمعاملة الكنترول مما يؤدي الي التهوية الجيدة للتربة. أدي إضافة محسنات التربة وخاصة مع المستويات المرتفعة وهي 2.5 طن كبريت و10 طن الفسفوجيبسيم و10 لتر كالسيوم سائل الي تحسين معنوي واضح في صفات التربة الكيميائية وهي رقم حموضة التربة و السعة التبادلية الكاتيونية والكاتيونات المتبادلة ونسبة الصوديوم المتبادل وكل من النيتروجين والفوسفور والبوتاسيوم. -أظهرت النتائج زيادة في تركيز والممتص من العناصر الغذائية (النيتروجين والفوسفور والبوتاسيوم والكالسيوم والماغنسيوم والكبريت من قبل البصل وزيادة المحتوي من الكلورفيل أ ,ب والكاروتين ,نسبة البروتين فى البصل نتيجة معاملة التربة بمحسنات التربة. توصي الدراسة باضافة محسنات التربة وهي الكبريت والفسفوجيبسيم والكالسيوم السائل مضاف الية أحماض كربوكسلية لتحسين الخواص الطبيعية والكيميائية للتربة الطينية الثقيلة القوام ورفع انتاجيتها من محصول البصل ومعدل امتصاص العناصر الغذائية. وكانت اكثر وضوحا مع اضافة الفسفوجيبسيم بمعدل 10 طن للهكتار.