EFFECT OF ADDED PHOSPHOGYPSUM AND GYPSUM ON SOME SOIL PROPERTIES AND YIELD COMPONENTS OF CORN PLANTS

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ABSTRACT

A pot experiment was conducted at Sakha Agriculture Research Station using two soils, alluvial and calcareous soil. Main objective was to explore the impact of added phosphogypsum (PG) on enhancing solubility of some elements and its relation to their levels in corn plant. Gypsum (G) was used as comparing material. Both PG and G were added at the rates; 3, 6 and 9 Mg/fed with or without organic material (OM, 1%).

Mean values of dry weight of corn plants (after 50 days) with PG were higher than G, at all rates of addition. Significant increase of corn dry weight was obtained due to PG application but not reached level of significant with G added with alluvial and calcareous soils. Combination of PG and OM improved corn dry weight in both soils and enhanced the PG efficiency.

Application of OM with PG or G increased the height of plants in both soils, the values of height increases were pronounced with alluvial soil compared with calcareous soil. The combination of OM with PG or G levels increased significantly the leaf area and leaves no. (except at the rate of 3Mg/fed of G in calcareous soil) in both soils and the all rates of addition. Application of PG materials had a beneficial effect on NPK levels of corn plants, such increase may be related, in part, to the acidic nature of PG that dissolve some soil components, release much minerals for plant use. Combination effect of OM and PG was clearly pronounced on NPK level of corn plants. The treatment 3Mg /fed + 1% OM was superior in enhancing level of soil mineral nutrients, in both soils. The combination of OM with G had no effect in alluvial soil compared with OM only. PG treatments with or without OM increased Fe, Zn and Cu content in corn plants comparing with G alone or with OM at the same rates of addition.

Data of chemical analysis of soil at the end of pot experiment showed very slight decrease in pH values of all treatments compared to the control in alluvial and calcareous soils. Electrical conductivity, (EC) as well as the available P, Zn, Fe and Cu recorded higher values as compared to the control.

Keywords: Alluvial soil, Calcareous soil, Corn, Gypsum, Phosphogypsum, Zea mays

INTRODUCTION

Phosphogypsum (PG) is a by-product of orthophosphoric acid fertilizer plants (at abu-zabal). It is inexpensive, strongly acidic materials (pH=2.5) and have high calcium, iron and manganese content, so it is postulated that PG might be used to decrease pH values in soil and provide Ca, P, Fe and Mn. PG is used as a soil amendment to improve water penetration and reduce the amount of runoff and erosion by 50 and 60 %, respectively (***Warrington et al.1989 and Bayrakli, 1990***)

Recent data indicate that phosphogypsum dissolves faster than mined gypsum, and hence it develops a higher electrolyte concentration during infiltration events. It would decrease soil pH, thereby, increasing the availability of trace metal nutrients and phosphate which are typically deficient in sodic soils because of high pH, also, the phosphate content of PG has value as a phosphate fertilizer, (***Oster, 1982 and Orlov et al., 1989***).

El-Fakhrani, (1997) study the effect of gypsum and poultry manure at the rates of (0, 1, 2, 4 and 8 ton/h) and (10 and 20 ton/h), respectively, on the growth, NPK content by broad bean (*Vicia faba*) grown in a salt-affected sandy loam soil (Saudi Arabia- Al-Qassim region). Data revealed that dry weight of both shoots and total plant and shoot NPK content were significantly increased with increasing gypsum rate up to 2 ton/ha at 20 tones/ha poultry manure in the order.

Gazia, (2001) reported that the gypsum application at the rate of 5 ton/fed. (field experiment clay soil, Sakha Agricultural Research Station Farm) had no significant effect on root yield, but slightly increased the shoot yield of sugar beet plants. On the other hand, gypsum showed negative effect on root N & P uptake and positive effect on shoot, while it had insignificant effect on K uptake for both roots and shoots.

Sonbol et al., (2001) showed that gypsum application to saline alkali soils (Akhtab village, Aga district, Dakahlia governorate) at the rates (0-0.5-1.0 of Gypsum requirement) in field experiments decreased grain and straw yield of rice plant in the first season 1998 from 55.24% to 49.38% under bad drainage conditions. While in the second season 1999 under a good drainage condition the grain and straw yields increased from 63.66% to 78.39% with the same ratios of applied.

The objectives of the present work are: 1) to explore the impact of applied PG compared to G on some nutrient elements of corn plants, 2) to illustrate the changes that would occur to some soil nutrients at the end of the experiment.

MATERIALS AND METHODS

A pot experiment was conducted at Sakha Agriculture Research Station using two different soils: alluvial soil from El-Karada, **(S1)** and Calcareous soil from Al-Gazaier, **(S2)**. Representative composite surface soil samples (0-30 cm) were collected, air-dried and passed through a 2 mm sieve. Thoroughly mixed samples were analyzed for their soil characteristics (Table 1) according to ***Page (1982)***. Available amount of Fe, Zn and Cu in the studied soils were extracted by DTPA according to ***Lindsay and Norvell, (1978)*** and measured using atomic absorption spectrophotometer Model Perkin Elimer, 3300.

Table (1): Some soil physical and chemical characteristics.

Soil characteristics	S1	S2	Soil characteristics	S1	S2
pH (1:5) soil : water suspension	7.98	8.50	**DTPA Extraction** **Zn mg/kg**	3.04	3.55
EC dSm^{-1} *	0.73	0.52	**Fe mg/kg**	12.11	5.35
Solubles cations*(mM) **Ca^{++}**	1.38	2.38	**Cu mg/kg**	2.32	0.52
Mg^{++}	1.08	0.34	**Particle size distribution** **Sand%**	18.92	48.72
Na^{+}	2.73	2.22	**Silt%**	34.48	28.11
K^{+}	0.15	0.18	**Clay%**	46.60	23.17
Soluble anions*,(mM) **$CO_3^{=}$**	0.00	0.00	**Texture class**	clayey	Loamy
HCO_3^{-}	1.20	2.4	**$CaCO_3$**	2.39	34.11
CL^{-}	1.14	0.86	**O.M. %**	2.1	0.69
$SO_4^{=}$	2.71	1.11	**F.C.** %**	43.1	20.5
Available P (mg/kg)	8.50	5.70	**SP%*****	67	57

S1= alluvial soil from El-Karada, S2= Calcareous soil from Al-Gazaier,
*** = (1:5) soil: water extract, **=Field capacity, ***= Saturation percentage,**
Gypsum Requirement of alluvial soil = 2.15 Mg/fed

Two and half kg/pot of soil samples were mixed carefully with 7.5, 15 and 22.5 g PG or G (these rates are equivalent to 3, 6 and 9 $Mgfed^{-1}$, respectively). Similar treatments were carried out with addition of 25 g clover straw (this rate is equivalent to 1% addition to the soils) as a source of organic material (OM). The pot experiment includes the following treatments:

No.	Treatment	No.	Treatment
1	S (soil control)	8	S (soil control) + 1 % OM
2	S+3 Mg PG fed^{-1}	9	S+3 Mg PG fed^{-1} + 1 % OM
3	S+6 Mg PG fed^{-1}	10	S+6 Mg PG fed^{-1} + 1 % OM
4	S+9Mg PG fed^{-1}	11	S+9Mg PG fed^{-1} + 1 % OM
5	S+3 Mg G fed^{-1}	12	S+3 Mg G fed^{-1} + 1 % OM
6	S+6 Mg G fed^{-1}	13	S+6 Mg G fed^{-1} + 1 % OM
7	S+9 Mg G fed^{-1}	14	S+9 Mg G fed^{-1} + 1 % OM

S=soil, OM=organic material, PG= Phosphogypsum, G= Gypsum

Some chemical characteristics of PG and G are given in the following:

Variables	PG	G
pH (1:5) soil: water suspension	2.97	6.90
EC dS/m(1:5) soil: water extract	5.09	2.92
Soluble cations and anions meq/L,(1:5) water extract		
Na^+	11.35	3.66
K^+	0.70	0.45
Ca^{++}	34.55	33.0
Mg^{++}	2.30	2.2
Soluble P (µg/ml)	16.20	1.12
Extractable mehlich mg/kg, *(Mehlich, 1984)*		
Soluble Fe	19.71	0.15
Soluble Zn	4.8	0.06

A complete randomized design with three replicates was used. Pots were seeded by using 4 seeds/pot of maize crop (***Zea mays L.***), variety, third hybrid 323, was used as test crop and then thinned to 2 plants after 15 days from sowing. All pots were irrigated at 60% of field capacity (FC) and each pot received the recommended doses of fertilizers. i.e. nitrogen (120 kg N/fed) as urea (46% N)which was added in two equal doses after thinning and before the third irrigation. Potassium (24 kg K_2O/fed) was added in one dose after thinning as potassium sulphate (48% K_2O). However phosphorus fertilizer was not added on the basis where PG contains phosphorus.

Dry weight, plant height and number of leaves were recorded. Leaf area was measured using leaf area meter model (LI-3100) after the vegetative stage (50 days from sowing). Collected plants were washed with tap and distilled water, oven dried at 60°C for 24 hours, weighted, ground in a stainless steel mill, mixed and stored in plastic bottles to be ready for digestion. Half gram was digested according to ***Chapman and Pratt, (1961)***. Total concentrations of N, P and K (%) after ***Page (1982)***. Fe, Zn, and Cu (mg kg^{-1}) were measured by atomic absorption spectrophotometers as mentioned above. Also, soil of each treatment after harvesting was air dried, crushed, and sieved to pass through 2 mm sieve to be ready for chemical analysis (pH, EC, available P, Zn, Fe, and Cu). The statistical analysis was done by using computer program.

RESULTS AND DISCUSSION

Yield and yield components:

Data of dry weight after 50 days in the two soils (calcareous and alluvial) are presented in Table (2). Mean values of corn dry weight with PG treatments were significantly higher than G treatments at the same rate of addition. All PG levels increased dry matter weight significantly compared with the control. Dry weight values were high in the alluvial soil as compared with the calcareous one. On the other hand, there were no significant differences within PG levels. *Attef (2002)* obtained similar results. Gypsum addition showed no significant increase in dry weight at all rates of application in the two soils. On the other hand, there was no significant difference between levels of G treatment and control in calcareous soil, except 9 Mg G treatment which showed significant increase. Data indicted that, 3 Mg of PG was clearly effective to increase the dry weight of corn plants and no needs PG above such level (according to the present data).

Table (2): Effect of added PG & G with or without organic material on yield component of corn plant growing in alluvial and calcareous soils.

Treatments	Alluvial soil				Calcareous soil			
	Dry weight, g/pot	Plant height, cm	Leaf area, cm^2	Leaves number	Dry weight, g/pot	Plant height, cm	Leaf area, cm^2	Leaves number
S(control)	12.92 b	71.33b	1230.2d	14.00 b	1.48 b	43.00 c	73.6 b	12.00d
S + 3Mg PG /fed	17.90 a	84.33 a	1748.5abc	16.00 a	8.9 a	72.0 a	756.76 a	14.00 bc
S + 6Mg PG /fed	18.25 a	82.00ab	1945.0 ab	16.67a	9.37 a	73.00 a	837.2 a	15.00ab
S + 9Mg PG /fed	18.43a	86.67 a	1982.0 a	17.33 a	9.84 a	76.00 a	965.4 a	15.67 a
S + 3Mg G /fed	13.40 b	73.67ab	1431.2 cd	16.00 a	1.72 b	45.67 bc	95.2 b	12.67 cd
S + 6M g G /fed	14.91 b	77.67ab	1569.0 c	16.00 a	3.26 b	55.33 b	247.8b	13.00c d
S + 9Mg G / fed	15.31 b	78.67ab	1633.6 bc	16.00 a	4.08 a	59.00 b	289.9 b	14.00 bc
S + 1% OM	14.31e	73.67 b	1502.5 e	16.00 c	2.84 b	52.00 d	180.4 e	13.33 d
S + 3 Mg PG / fed + 1% O M	18.91 bc	88.33 a	2102.2 bc	16.67bc	11.79 b	77.67ab	1185.5b	15.33 bc
S + 6 Mg PG/ fed + 1% O M	19.83ab	89.00 a	2155.4 ab	18.00 ab	13.60ab	81.67ab	1424.9a b	16.33ab
S + 9 Mg PG / fed + 1%O M	22.09a	91.33 a	2435.6a	18.67 a	15.32a	84.67a	1598.2a	17.33a
S + 3 Mg G / fed + 1% OM	16.13d	80.00ab	1707.4de	16.00 c	4.54d	5.00 d	339.5de	14.67 cd
S + 6 Mg G / fed + 1% OM	16.92cd	82.00ab	1801.9cd	16.67 b c	5.34d	64.00c	539.5cd	15.33 bc
S + 9 Mg G / fed + 1% OM	17.61cd	82.00ab	1856.5bcd	18.67a	8.29 c	71.67 bc	722.7c	16.33ab
L.S.D 0.05	2.44	11.34	310.57	1.42	2.44	11.34	310.57	1.42
L.S.D 0.01	3.24	15.09	413.39	1.89	3.24	15.09	413.39	1.89

S=soil, OM=organic material, PG= Phosphogypsum, G= Gypsum

Regarding to the effect of added OM alone at 1% level on corn dry weight, data showed slight increase with both soils. Mean dry weight with alluvial soil increased from 12.92 to 14.31 g /pot and with calcareous soil from 1.48 to 2.84 g/pot. Although, these increases at dry weights did not reach level of significant.

Addition of PG or G, at three rates 3, 6 and 9 Mg fed^{-1} combined with 1% OM improved dry weight in both soils. Mean corn dry weight, increased from 12.92 g/pot (control) to 18.91, 19.83 and 22.09 g/pot with 3, 6, and 9 Mg PG fed^{-1} combined with 1% OM in the alluvial soil, respectively. The corresponding values in calcareous soil are 1.48 g/pot (control) 11.79, 13.60 and 15.32 g/pot, respectively. The increase of dry weight was significant at all rates of PG plus OM in both soils. It seems that the superior treatment that gave the highest dry weight was (9 Mg fed^{-1} PG + 1% OM) in both soils. Regarding to the combination effect of added (OM + G), data showed significant increase in both soils but lower than that caused by PG + OM treatments at the same level of addition. Plant height is considered as an important yield component of corn. The results in Table (2) showed that plant height was significantly increased by PG applications in both soils. But G levels in alluvial soil and at the lower rate in calcareous soil did not reached level of significance. The results showed that the increase due to OM alone addition in both soils did not reached level of significance. The increase in plant height in alluvial soil was more pronounced than that in calcareous one at the same rates of both PG and G. There were no significant increase due to increasing the rate of PG or G additions compared to the lower rate (3 Mg fed^{-1}).

Higher values of plant height were obtained with treatments received (PG + OM), such trend was noticed in both soils. Plant height in early stage of growth reflects the nutrition status, therefore combination of both PG + OM or G + OM may maintain corn plants with sufficient levels of nutrients. Again the increase in plant height in both soils with or without OM was not significant due to PG increments over the lower rate. So, it may be concluded that addition of PG at 3 Mg fed^{-1} + 1% OM was the best rate for corn plants in both alluvial and calcareous soils.

Data in Table (2) showed a significant increase in leaf area and leaves no. of corn plants treated with PG or G as compared to control in the alluvial soil. Similar trend was only obtained with PG treatments of the calcareous soil. Comparing the values of plant leaf area and leaves no. in both soils as a result of PG or G addition, data indicated that both PG or G significantly increased plant leaf area in alluvial soil more than in calcareous soil at the same rates of addition. When OM was added alone to the soil, values of leaf plant area increased but not significant compared to control in both soils. While the combination of additions, PG+ OM or G + OM increased leaf area of corn plants significantly compared to control with both soils. In general we can conclude that PG at the rate of 3 Mg.fed^{-1} + 1% OM was the best treatment for alluvial and calcareous soils. High application rates of both PG and G seem to be uneconomic additions and may lead to soil pollution, we consider such result as a preliminary step that needs future work using the field experiment to reach the real application level.

N, P and K content of corn plants:

Data in Table (3) show a significant increase in N content of corn plants as compared to the control, in both alluvial and calcareous soils. This was a general trend with all PG+G treatments. Such increase of N content was clearly observed with the combination of PG and OM. Increments of PG application amended with OM had no significant differences on N content of corn plants. As obviously mentioned, 3 Mg PG/fed. is quite enough rate and no needs to add more PG. In case of G treatments, values of N content increased with alluvial soils but it was not at significant at 3 Mg G/fed. On the other hand, addition of gypsum increased N content significantly at all rates of additions with the calcareous soil. Combination of G +OM had a beneficial effect on N-content of plants. In general, higher values of N content were observed with alluvial soil treatments.

Table (3): Effect of added PG & G with or without organic material on NPK percentage of corn plant in alluvial and calcareous soils.

Treatments	Alluvial			Calcareous soil		
	N %	P %	K %	N %	P %	K %
S (control)	0.91 c	0.10 ef	3.93d	0.71 d	0.0 6 d	1.99 c
S + 3 Mg PG /fed	1.14 a	0.13 bc	3.70 d	1.02 b	0.09 bc	2.48 ab
S + 6 Mg PG /f ed	1.15 a	0.15 b	4.52 ab	1.0 6ab	0.11 b	2.57ab
S + 9 Mg PG /f ed	1.16 a	0.18 a	4.73 a	1.12 a	0.13 a	2.69 a
S + 3 Mg G /fed	0.96 c	0.08 f	4.23 c	0.86 c	0.07 cd	2.38 b
S + 6 Mg G /fed	1.06 b	0.11 de	4.39bc	0.89 c	0.07 cd	2.49 ab
S + 9 Mg G / fed	1.05 b	0.12 cd	4.55ab	0.90 c	0.08 cd	2.63 ab
S + 1% OM	0.96 d	0.12 cd	4.18 d	0.83 d	0.10 c	2.27 e
S + 3 Mg PG /fed + 1% O M	1.21 a	0.14 c	4.57 bc	1.16 a	0.11 bc	2.73 cd
S + 6 Mg PG /f ed + 1% OM	1.24 a	0.17 b	4.70 ab	1.18 a	0.13 b	3.12 b
S + 9 Mg PG /fed + 1%O M	1.25 a	0.20 a	4.96 a	1.23 a	0.17 a	3.44 a
S + 3 Mg G /fed + 1% OM	1.03 cd	0.12 d	4.39cd	0.91 c	0.10 c	2.53 d
S + 6 Mg G /fed + 1% OM	1.08 bc	0.12 cd	4.57bc	0.95 bc	0.11 c	2.83c
S + 9 Mg G /fed + 1% OM	1.12 b	0.12 cd	4.75 ab	0.99 b	0.11 bc	3.16 b
L.S.D. 0.05	0.07	0.02	0.25	0.07	0.02	0.25
L.S.D. 0.01	0.09	0.03	0.33	0.09	0.03	0.33

S=soil, OM=organic material, PG= Phosphogypsum, G= Gypsum

Addition of PG resulted in an increase of P percent compared to the control in both soils (Table 3). This trend was obtained with all PG + OM treatments, but the magnitude of increase were much dependent on PG levels than OM. The effect of G addition was less than that of PG. It increased P contents only at higher rates of application in alluvial soil, and very slight increase at all rates with calcareous soil. Combination of G + OM increased significantly P content with both soils at lower rate of G. Amended PG with OM had no effect on P content. This result means that PG has easily and readily P form that maintains considerable amounts of P to meet corn requirements. Similar results were observed by *Attef, (2002)* who found that PG treatments increase P content in ears leaf and strains of corn plants.

Data in Table (3) showed that both PG and G treatments increased K content in corn plants compared to control in both alluvial and calcareous soils. K content was also increased due to application of 1% OM in both soils. The same trend was observed in treatments received PG + OM or G + OM in both soils. Magnitude of K content was higher in alluvial soils than calcareous soil.

In general, application of PG to both soils had a beneficial effect on NPK levels of corn plants. Causes of N-corn increases may be related to nature of PG materials that has strong acidic character (pH= 2.94 at 1:2.5 soil to water ratio) due to the presence of H_3PO_4, since it is a by-product of H_3PO_4 manufacturing. Such pH may slow down and avoid NH_3 build up from nitrogen fertilizers resulting a pronounced reduce in ammonia volatilization (one source of N losses) and maintain a considerable concentration of N to meet corn requirements and increase N content as well. Combination effect of OM and PG rates was more effective on reducing NH_3-volatilization with mixed placement method *(Attef, 2002)*. Moreover as organic materials decay, it release mild acidic acids which dissolve soil minerals, freeing them for plant use, also OM itself had high nitrogen and potassium (*Edward, 1990*). Response and variation extent of N-corn content with the two soils may be related to their varied origin and soil characteristic as well. The beneficial effect of PG on P percent in the corn plants as compared to G materials may be attributed to the considerable amounts of P on the form of H_3PO_4 .PG contains 0.85% of P on the form of P_2O_5, therefore, 3Mg PG /fed. would equal to 25.5 Kg P_2O_5. These mean that PG has easily and readily P form that maintain a considerable amount of P to meet corn requirements and gave promising yield components.

Zn, Fe and Cu content of corn plants:

Data in Table (4) clearly show a significant increase in Zn, Fe and Cu contents according to increasing the level of PG additions in both soils. The highest values of Zn were observed in calcareous soil, while values of Fe were higher in alluvial soil than calcareous.

Addition of G alone increased Zn content significantly at all rates of addition with alluvial soil, while the increase of Fe and Cu was not significant at the same level. Increasing levels of G led to a moderate increase of the three elements content in plants. Similar trends were observed in calcareous soils. High values of Zn and Cu contents were observed in plants grown in calcareous soil than those grown in alluvial soil, the opposite were shown for Fe. Addition of 1% OM has a significant increase in Zn and Cu in both soils. Also, the combination of PG or G with organic material increased both Zn and Cu contents in plants significantly with all treatments and soils. Similar trends were observed for Fe in both soils. Actually, PG materials enriched with P and some trace elements proved to be inexpensive amendment that creat condition in soil system making nutrition status more available to plant growth.

Table (4): Effect of PG & G with or without organic material on Zn, Fe, Cu concentrations of corn plants growing in alluvial and calcareous soils.

Treatments	Alluvial			Calcareous soil		
	Zn	Fe	Cu	Zn	Fe	Cu
	(mg/kg)					
S (control)	11.33 d	79.33 b	8.00 c	17.67 c	39.67 b	10.67 e
S + 3 Mg PG /f ed	14.00 bc	332.67 a	14.67 a	18.00 c	146.0 ab	14.67bc
S + 6 Mg PG /f ed	15.33 b	342.67 a	15.33 a	18.67 bc	175.33ab	16.67 ab
S + 9 Mg PG /f ed	17.33 a	416.67 a	16.67 a	21.33 a	209.33 a	18.00 a
S + 3 Mg G /f ed	13.33 c	120.67 b	10.00 bc	18.00 c	81.00 ab	11.33 de
S + 6 Mg G /f ed	13.33 c	162.00 b	10.67 bc	18.67 bc	108.67 b	12.67cde
S + 9 Mg G / f ed	15.33 b	180.00 b	11.33 b	20.00 ab	120.00ab	14.00 cd
S + 1% OM	14.67 d	147.33 d	11.33 d	19.33 d	98.67 d	13.33 d
S + 3 Mg PG /f ed + 1% O M	16.67 bc	486.67 b	18.00 b	20.67 cd	251.33 bc	18.00 bc
S + 6 Mg PG /f ed + 1% O M	17.67 ab	738.67 a	20.00 ab	22.67 b	312.67 ab	19.33 ab
S + 9 Mg PG /f ed + 1%O M	19.33 a	832.0 0 a	22.00 a	25.33 a	409.33 a	21.33 a
S + 3 Mg G /f ed + 1% OM	14.67 d	210.00 cd	11.33 d	19.67 d	160.67 cd	14.00 d
S + 6 Mg G /f ed + 1% OM	15.33 cd	214.67cd	14.00 c	20.67c d	168.67 cd	16.00 cd
S + 9 Mg G /f ed + 1% OM	16.67 bc	303.33c	15.00 c	22.00 bc	180.67 bcd	17.33 bc
L.S.D. 0.05	1.77	129.91	20.60	1.77	129.91	2.60
L.S.D. 0.01	2.35	172.92	3.46	2.35	172.92	3.46

S = soil, OM=organic material

Soil chemical analysis after corn plant Removal:

Data of soil chemical composition at the end of pot experiment (50 days) are presented in Table (5). Very slight decrease were recorded in pH values of all treatments with PG and G as compared to the control of the alluvial soil. The corresponding changes with the calcareous soil revealed that pH values still affected with the residual acidic nature of PG, this is clearly observed when it mixed with OM at high rates (6 and 9 Mg PG / fed) in the two soils. Organic material seems to maintain pH reduction until the end of the pot experiment reflecting an enhancement on some soil chemical properties.

Electrical conductivity (EC) as well as the available Zn, Fe and Cu recorded higher values as compared to the control. For instance, DTPA extractable Zn was 1.55 mg/kg for the control, this value increased to 2.05, 2.23 and 2.92 mg/kg after application PG of 3, 6 and 9 Mg/fed in the alluvial soil. Corresponding values after mixing PG with 1% OM were 2.26, 2.46 and 3.49 mg/kg, respectively. This mean, that

PG residual effect has been detected due to PG as well as PG+OM application. Data of available P in the soil showed that G showed slight increase in available P. This increase ranged between 1.25 fold and 1.5 fold, according to the rate of additions.

Table (5): Some chemical properties and element content of studied soils after planting under using (PG) & (G) with or without organic material.

Treatments	pH*	EC** dS/m	A-P	DTPA extraction, Zn	Fe	Cu	pH*	EC** dS/m	A-P	DTPA extraction. Zn	Fe	Cu
			(mg/kg)						(mg/kg)			
alluvial soil							calcareous soil					
S(control)	8.11	0.57	8	1.55	12.11	2.32	8.15	0.60	5.2	3.04	5.35	0.5[illegible]
S + 3 Mg PG /f ed	7.97	0.88	18	2.05	12.55	2.46	7.97	0.91	8.5	3.31	6.02	0.[illegible]
S + 6 Mg PG /f ed	7.90	1.30	24	2.23	12.88	2.56	7.88	1.20	10.8	3.75	6.63	0.7[illegible]
S + 9 Mg PG /f ed	7.84	1.60	44	2.92	13.60	2.60	7.84	1.80	12.0	4.89	8.17	0.8[illegible]
S + 3 Mg G /f ed	8.06	0.80	10	1.80	12.24	2.42	8.03	0.82	5.2	3.27	5.55	0.[illegible]
S + 6 Mg G /f ed	7.94	1.20	10	2.02	12.83	2.44	7.94	1.15	5.3	3.60	6.22	0.6[illegible]
S + 9 Mg G / f ed	7.90	1.50	12	2.78	13.58	2.51	7.90	1.55	5.5	4.50	7.0	0.7[illegible]
S + 1% OM	8.04	0.68	16	1.60	12.18	2.38	8.07	0.65	5.6	3.18	5.60	0.5[illegible]
S + 3 Mg PG / fed + 1% O M	7.94	1.10	29	2.26	12.66	2.56	7.92	1.0	10.0	3.88	7.25	0.6[illegible]
S + 6 Mg PG / fed + 1% O M	7.82	1.4	36	2.46	13.49	2.60	7.83	1.50	11.0	4.66	8.62	0.[illegible]
S + 9 Mg PG /f ed + 1%O M	7.80	1.90	51	3.49	13.99	2.72	7.77	2.0	12.4	5.78	10.3	0.8[illegible]
S + 3 Mg G / fed + 1% OM	8.01	1.0	16	1.98	12.49	2.44	7.96	0.90	5.8	3.51	5.74	0.[illegible]
S + 6 Mg G / fed + 1% OM	7.90	1.45	17	2.26	13.18	2.48	7.91	1.03	6.4	3.89	6.53	0.7[illegible]
S + 9 Mg G / fed + 1% OM	7.87	1.7	21	2.85	13.63	2.54	7.85	1.63	6.4	5.12	8.81	0.7[illegible]

S=soil, OM=organic material, PG= Phosphogypsum, G= Gypsum ,A-P= Available P, * = (1:5 soil: water suspension, ** = (1:5) soil: water extract.

As PG levels increased, available P showed a detectable increase. Theses finding are expected due to PG containing from 0.7 to 1.0%P_2O_5 *(Attef, 2002)*. ***Rushchik and Parfenov, (1989)***, who found that PG application generally had a positive effect on available P. Also, available P content in the soil was increased over a five-year period. This transformation was conditioned by the formation of easily soluble mineral phosphates. Calcareous soil exhibited similar trend, but with different extent due to its available P which consider smaller then that of the alluvial soil.

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تأثير الفوسفوجبسم و الجبس علي الأرض ومكونات المحصول لنبات الذرة

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أجريت تجربة أصص بمحطة البحوث الزراعية بسخا باستخدام نوعين من الأراضي إحداهما رسوبية والأخرى جيرية لدراسة اثر إضافة الفوسفوجبسم علي تشجيع زائبية بعض العناصر وعلاقة ذلك بمحتوي نباتات الذرة منها ، كما استخدم الجبس العادي للمقارنة.وكانت إضافة الفوسفوجبسم أو الجبس بمعدلات ٣، ٦ و٩ طن للفدان مع أو بدون ١% مادة عضوية. وأظهرت النتائج أن:

١-متوسط الوزن الجافة لنبات الذرة (عمرها ٥٠ يوم) مع الفوسفوجبسم أعلي من الجبس عند كل معدلات الإضافة . وكانت الزيادة في وزن المادة الجافة معنوية مع إضافة الفوسفوجبسم في كلا الأرضيين الرسوبية و الجيرية بينما إضافة الجبس أدت لزيادة وزن المادة الجافة ولكنها لم تصل لمستوي المعنوية.خلط المادة العضوية مع الفوسفوجبسم أدى إلى زيادة في الوزن الجاف لنباتات الذرة في كلا الأرضيين كما أنة حسن كفاءة الفوسفوجبسم. وكذلك خلط المادة العضوية مع الفوسفوجبسم أو الجبس أدت لزيادة ارتفاع نباتات الذرة في كلا الأرضيين وكانت تلك الارتفاعات اكبر في الأرض الرسوبية بالمقارنة بالجيرية. وكذلك خلط المادة العضوية مع كل من الفوسفوجبسم أو الجبس أدت إلى زيادة معنوية في مساحة الأوراق وعددها (فيما عدا معدل ٣طن جبس للفدان بالأرض الجيرية) لنباتات الذرة في كلا الأرضيين عند كل معدلات الإضافة.

٢-إضافة الفوسفوجبسم لها تأثير إيجابي على مستوى NPK في نباتات الذرة وربما يرجع ذلك إلى حموضة الفوسفوجبسم الطبيعية التي تذيب بعض مكونات التربة وتحرر عناصرها للنبات . وكذا خلط الفوسفوجبسم والمادة العضوية رفع مستوى NPK بنباتات الذرة . وذلك لأن الفوسفوجبسم يحتوى على كميات محسوسة من الفوسفور ولذلك كانت استجابة الذرة لمعدلات إضافة الفوسفوجبسم . وكانت أفضل معاملة هي ٣ طن فوسفوجبسم/ للفدان + ١% مادة عضوية لكلا الأرضيين .وكانت لمعاملات التربة بالفوسفوجبسم المقدرة على إثراء وتهيئة الظروف الأرضية التي تجعل عناصر الزنك والنحاس والحديد والفوسفور أكثر يسراً للنبات وذلك عند مقارنتها بنفس المعدلات من معاملات الجبس . أوضحت النتائج انه ليس لمعاملات الجبس مع المادة العضوية بالأرض الرسوبية آي تأثير مفضل بالمقارنة بالمادة العضوية فقط. زاد محتوى نبات الذرة من الحديد والزنك والنحاس تحت معاملات الفوسفوجبسم مع أو بدون المادة العضوية و ذلك مقارن بالجبس فقط أو الجبس مع المادة العضوية عند نفس معدلات الإضافة .

٣-تشير نتائج تحليل الأرض بعد انتهاء التجربة إلى انخفاض طفيف في أل pH مع كل المعاملات لكلا الأرضيين أما التوصيل الكهربائي(EC) وكذلك الميسر من الزنك والنحاس والحديد سجلت قيم أعلى تحت المعاملات المختلفة مقارنة بمعاملة الكنترول .