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Interaction effect of organic and mineral amendments on soil properties, plant growth, and nutrients uptake by onion and corn plants

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ABSTRACT

Two field experiments were carried out in the Research Station Sids in Beni swef, Egypt, during winter season 2015/2016, and summer season 2016; to study the effect of amendments (sulfur at rate of 1ton/fed, Farmyard manure at rate of 4 ton/fed and filter mud at rate of 2 ton/fed and in combination) on soil properties, some characteristic growth and nutrients uptake by onion and corn plants.

The results showed that the highest values of grain yield of corn plant, dry weight of onion plant nitrogen, phosphorus and potassium uptake were recorded with combined effect of amendments (sulfur, farmyard manure and filter mud). The combined effect of amendments was found to be more effective in reducing EC and pH of the soil compared with application of sulfur or filter mud alone. Also, organic matters contain more of elements of nutrients by application of combined amendments which is due to solubility to nutrients uptake by plant. On the other hand, addition of sulfur to soil in combination with farmyard manure and filter mud caused a high increase of the available nitrogen, phosphorus and potassium due to increase of soil fertility compared with control treatment.

Generally, from these results it can be concluded that the application of amendments (sulfur, Farmyard manure and filter mud in combination) improved soil fertility as well as increase of plant growth and nutrients uptake by onion and corn plants.

Key words: Amendments, soil properties, plant growth, nutrients uptake.

INTRODUCTION

Organic manure reducing soil pH and increasing solubility of some plant nutrients. Also, soluble organic complexes of certain heavy metals could play an important role in getting such minerals more available to plant (Barness and Chen, 1991). Abou El-Defan *et al.* (2005) found that EC and ESP values significantly decreased with the application of farmyard manure mixed with gypsum in soil irrigated with drainage water. Meanwhile, El-Banna *et al*., (2004) found that applied of gypsum with farmyard manure improved soil properties and increased yield of wheat plant. Also, Negm *et al.* (2003) found that application of compost in combination with sulfur or phosphorus improved physical and chemical properties as well as increased both macro and micronutrients availability in the soil. Moustafa (2005) found that application of farmyard manure and gypsum reduced pH values in the alkali soil. These results could be attributed to the reduced amounts of soluble and exchangeable sodium and increased forms of both soluble and exchangeable calcium due to amendments applications.

Elemental sulfur as a soil amendment is generally used as a standard acidulant added to soil for pH reduction (Slaton *et al.,* 1999). Also, application of sulphur with mineral fertilizers, caused increase of some nutrients uptake by crops (Fismes *et al*., 2000). On the other hand, Skwierawska *et al*. (2008) reported that, the application of mineral fertilizers with

sulfur, caused available increase of some nutrients. Also, the applied of sulfur caused a significant increase in the concentration of available phosphorus in soil.

Choudhary *et al.,* (2004) found that the addition of amendments (organic matter with gypsum) decreased the ESP of the sodic saline soil. The decrease in soil ESP with increasing rates of amendments may be attributed to the increase of Ca in soil solution as a result of addition gypsum and organic amendments which promoted Na displacement and its removal by leaching process. Gharaibeh *et al.,* (2009) reported that, some amendments supply Ca directly to the soil to replace excess Na from the exchange site or out of the soil profile by leaching irrigation process with a good quality water.

Press mud is a by product of sugar cane industry which represents one of these important organic wastes that contains oxides of Si, Ca, P, Mg and K (Partha and Sivasubramanian, 2006). Negim *et al*. (2016) found that the application of Press mud as organic matter caused improvement in the physical and chemical soil properties such as bulk density, pH soil, EC soil and soluble cations.

Plant growth of tomato was significantly positively affected by the application of filter mud addition compared with control. Elsayed *et al.*(2008) reported that, the Press mud has improvement in the physical (structure, texture, aeration, water-holding capacity, and porosity), chemical (pH, EC, CEC) and biological properties. In this concern, McConnell *et al.* (1993) found that composted press mud contains essential plant nutrients such as nitrogen, phosphorus, and some micronutrients in higher concentrations than in agricultural soils. Arafat *et al.* (1997) reported that the use of filter mud as products of sugar residues source can play a role in decreasing the pollution effect of excessive mineral fertilizer in soil. However, Yassen *et al.* (2002) used sugar cane filter mud to minimize nitrogen fertilizers for sorghum growth and playing a role in decreasing the pollution effect of excessive mineral fertilizer in soil.

The main goals of this study is to investigate the effect of chemical and organic manure amendments on soil properties, plant growth and nutrients uptake by onion and corn plants.

MATERIALS AND METHODS

Two field experiments were carried out in the experiment Research Station Sids in Beni swef, Egypt, to study the effect of chemical (sulphur) and organic (filter mud, farmyard manure) amendments on soil properties, some characteristic growth, and nutrients uptake by onion (*Allium cepa*) and corn (*Zea mays*) plants during winter season 2015/2016, and summer season 2016. Onion and corn plants were grown in clay soil. Some physical and chemical characteristics of the studied soil before and after planting are given in Table (1), while those after planting are given in Tables (6 & 7). Some chemical characteristics of the filter mud and farmyard manure used are shown in Table (2a; b). Eight treatments were applied as follows:

1. Control (without any amendments).
2. Sulfur at a rate of 2.50 kg/plot (equal to 1 ton/fed).
3. Filter mud at a rate of 5.0 kg/plot (equal to 2 ton/fed).
4. Farmyard manure (FYM), at a rate of 10.0 kg /plot (equal to 4 ton/fed).
5. Sulfur (1 ton/fed) + Filter mud (2 ton/fed).
6. Sulfur (1 ton/fed) + Farmyard manure (4 ton/fed).
7. Filter mud (2 ton/fed) + Farmyard manure (4 ton/fed).
8. Sulfur (1 ton/fed) + F. manure (4 ton/fed)+ Filter mud (2 ton/fed).

The experiment using a randomized complete Plock design with three replications, the experimental unit area was 10.5 m^2 (3x3.5m), 12 rows in each plot and 20 cm apart. The Corn plant fertilization was taken place with the recommended dose of single superphosphate at a rate of 45 kg P_2O_5 /fed., before plant cultivation. Also, nitrogen fertilizer was added in the form of urea at a rate of 120 kg N/fed., potassium fertilizer was added in the form of

potassium sulphate at a rate of 24 kg K_2O/fed; other fertilizers was added according to the general recommendations by Ministry of Agriculture. At the end of harvest time of corn, 155 days from sowing, plant samples were taken and dried at 70 ^{0}C. Then, dry weight was calculated as well as some characteristic growth. The concentration of N, P and K in grain of corn and onion plants was recorded as well as content of nutrients. Also, some physical and chemical properties of the used soil, as well as content of soil fertility such as N, P and K in soil were determined.

Table (1): Some physical and chemical properties of the used soil.

Parameters	value
Some physical properties	
Sand%	15.00
Silt%	33.50
Clay%	51.50
Textural class	clay
Field capacity %	41.55
Permanent wilting point %	20.80
Available water%	20.75
Some chemical properties	
pH	8.31
EC (1:2.5) dS/m	0.80
OM %	1.52
Calcium carbonate %	1.70
Total nitrogen %	0.16
ESP	16.90

Table (2a): Some chemical properties of the used farmyard manure.

pH	EC dS/m	OC %	MO%	C/N ratio	Total macronutrients %				
					N	P	K	Ca	Mg
7.25	2.98	25.32	43.55	17.58:1	1.44	0.62	0.86	0.95	0.52

Table (2b): Some chemical properties of the used filter mud.

pH	EC dS/m	OC%	MO%	C/N ratio	Total macronutrients %				
					N	P	K	Ca	Mg
6.52	2.95	29.75	51.17	16.9:1	1.76	0.75	0.66	1.05	0.55

The soil sample was routinely analyzed according to Klute (1986) and Page *et al.* (1982) and the results are presented in Table (1). Plant analysis; total nitrogen was determined using Kjeldahl method, phosphorus was determined colorimetrically, potassium by flame photometer (Page *et al*., 1982). Statistical analysis: all obtained data were subjected to analysis of variance and treatment means were compared by L. S. D. test at 5% level of probability in the experimented season according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Dry matter yields:

Data presented in Table (3) show that the dry matter yield of grain were significantly affected by application of amendments treatments, The results revealed that all the treatments significantly increased the grain yields of corn plant and dry weight of onion plant compared with control treatment. In the summer season of 2016, applications of amendments to corn plant increased grain yields from 2769.20 to 3084.20 kg/fed; as well as winter season 2016/2017 onion plant increased from 2019.82 to 2416.87 kg/fed of dry weight. It is interesting to say that, the highest values of grain yield of corn plant were recorded by the combined effect of amendments (sulfur, Farmyard manure and filter mud). This could be due to the role of organic reducing soil pH and increasing solubility of some nutrients to plant. Also, soluble organic complexes of certain heavy metals could play an important role in getting such minerals more available to plant. Results are in a partial agreement with those obtained by Moustafa (2005) who found that application of farmyard manure and chemical amendments reduced pH values in the alkali soil. These results could be attributed to the reduced amounts of soluble and exchangeable sodium and increased forms of both soluble and exchangeable calcium due to amendments applications.

Table 3: Effect of chemical and organic improvement on some characteristic growth of corn and onion plants.

Characters / **Treatments**		Corn plant			Onion Plant			
	weight The Ear (kg/plot)	weight Ardab/fed	weight Grain (kg/plot)	weight Kg/fed	weight (kg/plot)	Dry weight (kg/fed)	weight Onion (ton/fed)	Diameter yield (mm)
control	12.30	19.56	9.13	2738.40	35.23	2000.47	14.09	58.39
sulfur	12.43	19.78	9.23	2769.20	35.85	2019.82	14.34	60.14
Filter mud	13.20	21.00	9.80	2940.00	37.54	2187.67	15.02	61.33
Farmyard manure	13.17	20.94	9.77	2931.60	38.00	2190.66	15.20	61.27
Sulfur+ Filter mud	13.43	21.37	9.97	2991.80	38.05	2221.14	15.22	62.00
Sulfur+ Farmyard manure	13.50	21.47	10.02	3005.80	39.03	2277.07	15.61	62.75
Filter mud + Farmyard manure	13.83	22.00	10.27	3080.00	40.02	2396.13	16.01	63.19
Sulfur+ F. manure+ Filter mud	13.85	22.03	10.28	3084.20	40.18	2416.87	16.07	63.75
LSD at 5%	0.09	0.07	0.08	3.71	0.32	3.46	0. 27	0.127

Some macronutrients concentrations and uptake by plant:

The effect of soil amendments on NPK content and uptake by onion and corn plant are presented in Tables (4 & 5). It was obvious that nitrogen, phosphorus and potassium uptake (kg/fed) was significantly increased by the applied amendments in onion and corn plant. The nutrients uptake in grain by corn plant increased and nitrogen uptake (kg/fed) was increased from 40.98 to 50.58. Also, phosphorus increased from 7.75 to 11.41 P-uptake (kg/fed), while potassium was increased from 15.78 to 21.28 K-uptake (kg/fed). On the other hand, the nutrients uptake of dry weight by onion plant increased; nitrogen was increased

from 44.23 to 55.83 N-uptake (kg/fed); while, phosphorus was increase from 12.52 to 16.68 P-uptake (kg/fed); potassium was increased from 14.95 to 21.03 K-uptake (kg/fed).

It was noticed that, the highest values recorded were obtained by applying the combination of amendments (Sulfur, Farmyard manure and filter mud). These results confirmed that, using combination of amendments was more effective in reducing the EC of the soil compared with application of sulfur or filter mud alone. Also, the combination of amendments contains organic matters that have more nutrients. Moreover, the solubility of nutrients uptake by plant increased. These results are in accordance with those reported by Barness and Chen (1991) who reported that organic manure reduces soil pH and increases solubility of some nutrients to plant. Also, soluble organic complexes of certain trace elements could play an important role in getting such minerals more available to plant.

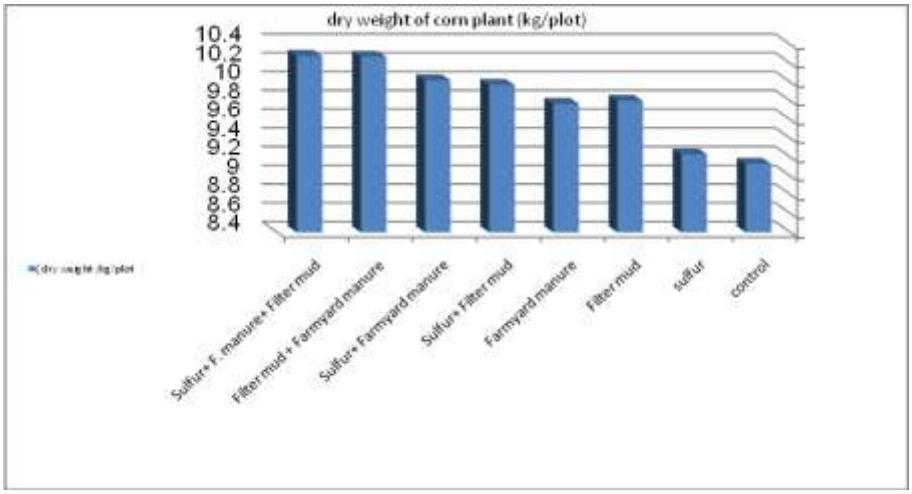

Fig.1: Effect of chemical and organic amendments on dry weight (kg/plot) of corn plant.

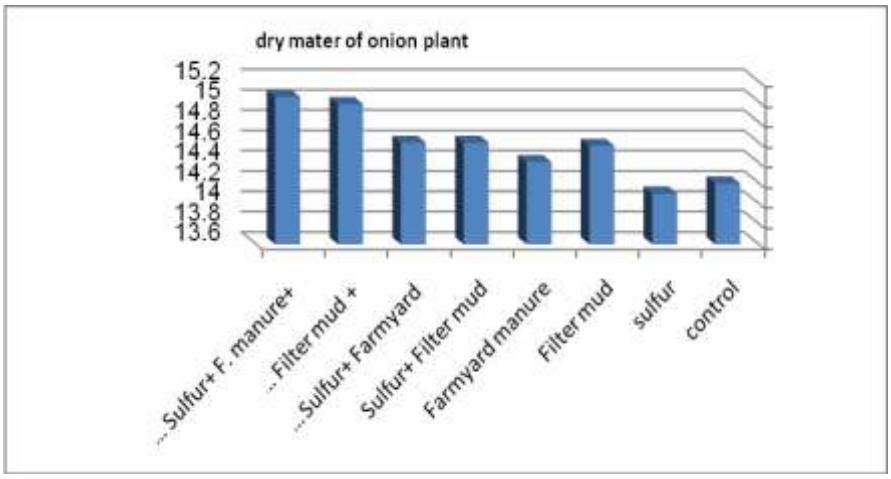

Fig. 2: Effect of chemical and organic amendments on dry matter yield of onion plant.

Table 4: Effect of chemical and organic improvement on some nutrients concentration (%) of corn and onion plants.

Characters / Treatments	Corn plant				Onion Plant		
	N %	P %	K %	Protein (%)	N %	P %	K %
control	1.45	0.28	0.58	8.28	2.20	0.60	0.73
sulfur	1.48	0.28	0.57	8.44	2.19	0.62	0.74
Filter mud	1.53	0.32	0.60	8.70	2.24	0.63	0.82
Farmyard manure	1.51	0.32	0.61	8.59	2.24	0.67	0.78
Sulfur+ Filter mud	1.56	0.34	0.62	8.89	2.31	0.68	0.85
Sulfur+ Farmyard manure	1.57	0.33	0.63	8.97	2.23	0.65	0.86
Filter mud + Farmyard manure	1.64	0.37	0.68	9.35	2.33	0.64	0.86
Sulfur+ F. manure+ Filter mud	1.64	0.37	0.69	9.35	2.31	0.69	0.87
LSD at 5%	0.02	n.s	0.015	0.014	0.017	n.s	0.017

Table 5: Effect of chemical and organic improvement on some nutrients uptake (kg/fed) of corn and onion plants.

Characters / Treatments	Nutrients uptake (kg/fed) by Corn plant			Nutrients uptake (kg/fed) by Onion Plant		
	N	P	K	N	P	K
control	39.71	7.67	15.88	44.01	12.00	14.60
sulfur	40.98	7.75	15.78	44.23	12.52	14.95
Filter mud	44.98	9.41	17.64	49.00	13.78	17.94
Farmyard manure	44.27	9.38	17.88	49.07	14.68	17.09
Sulfur+ Filter mud	46.67	10.17	18.55	51.31	15.10	18.88
Sulfur+ Farmyard manure	47.19	9.92	18.94	50.78	14.80	19.58
Filter mud + Farmyard manure	50.51	11.40	20.94	55.83	15.34	20.61
Sulfur+ F. manure+ Filter mud	50.58	11.41	21.28	55.83	16.68	21.03
LSD at 5%	0.75	0.62	0.36	0.87	0.017	0.019

Chemical and physical characteristics:

The effect of amendments on soil electrical conductivity is shown in Tables (6 & 7). At the end of experiments, the final electrical conductivity (EC) was found to be influenced by the applied amendments. The results revealed that all the treatments were slightly reduced the EC of the soil as compared with control treatment. It was noticed that, the combination of amendments (sulfur, Farmyard manure and filter mud) was more effective in reducing the EC of soil compared with the application of sulfur or organic alone; EC in soil was reduced from 0.68 dS/m to 0.50 dS/m. The decrease in EC of soil was resulted from the addition of organic matter and leaching of excessive ions by improving soil properties as reported by Prapagar *et al.* (2012). This reduction may be also due to the leaching of soluble salts and the effect of organic and inorganic acids which produced during the process of decomposition of amendments. The effect of soil amendments on soil pH, bulk density (g/cm^3) and organic matter (%) is presented in Tables (6 & 7). It was clear that at the end of experiments, soil reaction pH was influenced by the applied amendments. The results revealed that all the

treatments reduced significantly the pH of the soil as compared with control treatment. It was also noticed that, the effect of amendments combination (sulfur, Farmyard manure and filter mud) was more effective in reducing the soil pH compared with application of each of treatments alone. Soil pH was reduced from 8.26 to 8.08; while, bulk density was reduced from 1.34 to 1.17; in contrast organic matter was increased from 1.56 to 2.02 %. The reduced values of soil pH and bulk density were recorded with combined effect of sulfur, Farmyard manure and filter mud compared to the control treatment. This may be due to the addition of organic matter and leaching of excessive cation such as sodium which lead to improving soil properties. However, Sulfur and organic matter had about doubled; there were more water-soluble anion such as sulfur and organic acid in soil due to reduce soil pH as well as improved physical and chemicals properties. Similarly Elsayed *et al.* (2008) reported that the Press mud caused improvement in the physical, chemical and biological properties. On the other hand, Negm *et al.* (2003) found that application of compost in combination with sulfur or phosphorus improved physical and chemical properties.

Table 6: Effect of chemical and organic improvement on some physical and chemical properties of soil after harvesting of corn plant treatment.

Characteristics / Treatments	Physical and chemical properties of soil							
	N (ppm)	P (ppm)	K (ppm)	pH	EC	Bulk density	O.C %	O.M %
control	23.33	9.47	223.00	8.26	0.68	1.34	0.91	1.56
sulfur	24.00	10.60	239.67	8.19	0.67	1.31	0.93	1.60
Filter mud	32.00	12.27	264.00	8.18	0.59	1.26	1.05	1.82
Farmyard manure	33.33	12.60	251.00	8.16	0.60	1.26	1.07	1.84
Sulfur+ Filter mud	34.67	12.67	275.33	8.10	0.57	1.23	1.08	1.86
Sulfur+ Farmyard manure	34.67	13.53	256.00	8.12	0.56	1.23	1.10	1.90
Filter mud + Farmyard manure	37.33	13.80	288.00	8.09	0.53	1.36	1.18	2.03
Sulfur+ F. manure+ Filter mud	39.33	14.13	291.33	8.08	0.52	1.17	1.17	2.02
LSD at 5%	0.062	0.021	0.682	0.067	n.s	0.014	0.018	0.019

Table 7: Effect of chemical and organic improvement on some chemical properties of soil after harvesting of onion plant treatment.

Characters / Treatments	some chemical properties in soil							
	N (ppm)	P (ppm)	K (ppm)	pH	EC ds/m	TSS %	O.C %	O.M %
control	25.33	9.20	232.33	8.26	0.72	13.40	0.95	1.64
sulfur	25.67	10.20	240.00	8.19	0.68	13.45	0.96	1.65
Filter mud	33.33	12.13	266.67	8.19	0.62	13.89	1.03	1.77
Farmyard manure	35.33	12.27	267.67	8.22	0.63	13.86	1.02	1.76
Sulfur+ Filter mud	25.67	13.07	274.33	8.17	0.62	14.27	1.04	1.79
Sulfur+ Farmyard manure	37.67	13.27	272.33	8.17	0.61	14.19	1.04	1.79
Filter mud + Farmyard manure	43.33	14.13	288.33	8.15	0.56	14.70	1.10	1.90
Sulfur+ F. manure+ Filter mud	40.67	15.40	293.67	8.10	0.57	14.74	1.11	1.91
LSD at 5%	0.157	0.081	1.37	0.016	0.019	0.017	0.017	0.016

Fertility content in soil:

The effect of amendments on some nutrients (NPK) content (ppm) in the soil is presented in Tables (6 & 7). It was found that at the end of experiments, N, P and K in the soil were influenced by the applied amendments. The results revealed that all the treatments increased significantly the concentration of N, P and K in the soil as compared with control treatment. It was observed that, the combined effect of sulfur, Farmyard manure and filter mud were more effective of N, P and K in the soil compared with application of treatments. Nitrogen increased from 23.33 to 39.33 ppm, while phosphorus increased from 9.47 to 14.13 ppm; potassium increased from 223.00 to 291.33 ppm in the soil after harvesting time of corn plant. The same results were obtained after harvesting time of onion plant, but with slight different of some nutrition concentration. The maximum increase of N, P and K (ppm) in the soil were recorded with the combined effect of sulfur, Farmyard manure and filter mud compared to the control treatment. This may be indicated that the optimum mineral supply is independent of nutrition. However, Sulfur added to soil alone are in combination with farmyard manure and filter mud caused a very increase of available nitrogen, phosphorus and potassium compared with control treatment, as well as increase of soil. These results are in agreement with those obtained by Negm *et al.* (2003) who indicated that, application of compost in combination with sulfur or phosphorus improved soil properties as well as increasing both macro and micronutrients availability in the soil.

Conclusion:

Results obtained in the present work confirmed that the application of amendments (sulfur, Farmyard manure and filter mud in combination) improved soil fertility, as well as significantly improving plant growth and nutrients uptake by onion and corn plants. The highest values of nutrients up take have been observed with combined effect of amendments (sulfur, Farmyard manure and filter mud). This could be due to the reduction of soil pH, EC and increasing solubility of some nutrients to plant.

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تأثير التفاعل بين المحسنات العضويه والمعدنيه على صفات التربه ونمو النبات وامتصاص العناصر الغذائيه للنبات

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المستخلص

أجريت تجربتان من التجارب الحقليه بمحطة بحوث سدس، ببنى سويف، مصر خلال موسم الشتاء 2016/2015 وموسم الصيف 2016 فى تربه طينيه، لدراسة تأثير بعض محسنات التربه (الكبريت بمعدل 1طن/فدان والسماد البلدى بمعدل 4طن/فدان، وطين المرشحات بمعدل 2طن/فدان) والخليط بينهم على صفات التربه والمحتوي الخصوبى ونمو النبات وامتصاص العناصر الغذائيه لنبات البصل والذره الشاميه.

واشارت النتائج المتحصل عليها الى أن اضافة معدلات هذه المحسنات (الكبريت و السماد البلدى بمعدل ، وطين المرشحات) منفرده او مختلطه مع بعضها، ادت الى زيادة زياده معنويه فى وزن محصول حبوب الذره الشاميه والو زن الجاف لنبات البصل ، كما تجدر الاشاره ايضاً الى زياده امتصاص النيتروجين والفوسفور والبوتاسيوم فى نبات البصل وحبوب نبات الذره الشاميه. بالاضافه الى ماسبق فان اعلى القيم التى تم الحصول عليها كانت عند خلط الكبريت مع السماد البلدى وطين المرشحات ويرجع السبب فى ذلك الى التاثير الايجابى بين الكبريت والمركبات العضويه والذى يعمل على تقليل الاملاح و الاس الهيدروجينى للتربة ، بالاضافه انه يعمل على زيادة المحتوى الخصوبى للتربه وامتصاص وتيسر العناصر الغذائيه (النيتروجين والفوسفور والبوتاسيوم) بالمقارنه بالكنترول. بوجه عام ادى استخدام اضافة معدلات هذه المحسنات (الكبريت و السماد البلدى وطين المرشحات) منفرده او مختلطه مع بعضها للتربه الى زيادة معنويه فى النمو والمحتوى الخصوبى وامتصاص العناصر الغذائيه لنبات البصل والذره الشاميه.