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USING ORE MINERALS FOR FERTILIZING EGGPLANT IN RELATION TO ITS NUTRIENT, UPTAKE YIELD AND QUALITY

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ABSTRACT

A pot experiment was conducted at Agric. station of Faculty of Agric. Mansura University In 14 March; 2013 to study the effect of using some natural materials (phosphate rock and mineral sulfur ore) at two levels along with control treatment as fertilizers on eggplant growth, yield and some nutrients uptake.

Split-split complete block design was used with three replicates. The main treatments (3treatments) represent the studied natural materials and the sub-main treatments were arranged for theirs levels (two levels more than control) of the natural materials used. The sub-sub main treatments were oriented for bacterial treatments (with and without bacterial inoculation). The two levels of natural material used were 1.5 and 3 g pot^{-1} for each one and added to surface of soil and mixed with it before planting. Urea (46% N), superphosphate (15.5% P_2O_5) and potassium sulphate (50 % K_2O_5) fertilizers were applied at rates of 2.0; 1.5 and 0.5 g pot^{-1}, respectively (200 kg urea fed^{-1},100 kg supper phosphate fed^{-1} and potassium sulphate 50 kg fed^{-1}).

Data revealed that application of some natural materials as fertilizers (phosphate rock and mineral sulfer ore) to soil due to increase some growth parameters (length, diameter, fresh weight and dry weight of eggplant), increased NPK % in whole plant and fruit of eggplant, and increased some nutrient uptake both of eggplant at different periods and eggplant fruit at two collections.

INTRODUCTION

Solanum melongena L. (known as eggplant of America and aubergine in France and England) is one of the few cultivated solanaceous species originating from the Old World. It is known as brinjal in its home country, India, where it was domesticated long ago and where the greatest diversity is found.

In Egypt, eggplant is cultivated long ago because Egyptian people like to eat it in different farms. It's production is 1291 thousand tons year^{-1}. Nutritionally the value of eggplant per 100g fresh edible portion contains 93% moisture, energy 20 cal, CHO 4g, Protein 1.1g, fat 0.1mg, fibre 1g, Ca 7mg, phosphorus 25mg, iron 0.4mg, vitamin A 70IU, thiamine 0.09mg, ascorbic acid 15mg, riboflavin 0.2mg, nicotine amide 0.6mg and niacin 0.6mg (Norman, 1992).

Phosphorus is this nutrient plays an important role on energy transfer in cells, respiration, and photosynthesis, besides being a structural component of nucleic acids, as well as of several coenzymes, phosphoproteins, and phospholipids (Grant *et al*., 2001). Choudhary et al., (2005) found that the highest values for plant growth parameters and yield were recorded with *Azotobacter,* Phosphate Solubilizing Bacteria and

farmyard manure alongwith inorganic fertilizers. The combined use of organic manure, biofertilizers and inorganic fertilizers sustained the productivity. Saif-El-Deen, (2005) found that eggplant fruit weight loss and decay were negatively correlated with P-rates application. Also, increasing P-rate up to 60 kg P_2O_5 fed^{-1} significantly decreased the percentages of the above mentioned parameters during storage.

Sulfer is also an essential plant nutrient. It's function is somewhat like phosphorus in that it is involved in plant cell energetic. Sulfer also improves the yield and quality parameters of important vegetable crops. Sulfer is a constituent of secondary compounds viz., allin, cycloallin and thiopropanol which not only influence the taste, pungency and medicinal properties of vegetable crops but also induce resistance against pests and diseases (Tabatabai, 2001). Mahmoud (2000) found that the application of sulfur (100 kg $feddan^{-1}$) in combination with 0.2% P gave the best results for growth characters, total yield, dry matter (%) and mineral content (N, K and Fe) of eggplant. Phosphate content increased due to treatments of Phosphate application alone or in combination with sulfur. Haidar and Sidahmed, (2006) indicated that sulphur alone was increasing the yield of eggplant. The mixtures of chicken manure and sulphur at 8 and 12 Ton ha^{-1}infestation later in the season (75 and 90 days after transplanting) in eggplant, However, the mixtures of chicken manure and sulphur at all tested rates increased eggplant yield compared with the control. Therefore, the main objective of this research is to evaluate the response of eggplant to some natural materials as fertilizers and their effects on growth, yield and nutrient uptake. The objective of this work is studying the effect of using some natural materials as fertilizers on eggplant growth, yield and nutrient uptake.

MATERIALS AND METHODS

This work was carried out in a pot experiment during season (2013) at Agric. station of Faculty of Agric. Mansura University, Egypt to study the effect of using some natural materials (phosphate Rock and mineral sulfur ore) at two levels along with control treatment as fertilizers on eggplant growth, yield and some nutrient uptake. Each pot was filed with 10 kg soil of Agric. experiment. The length of pot is 30 cm and its diameter is 20 cm. Eggplant seedlings of variety, White ice, were cultivated on 14th of March 2013 and each pot was irrigated up to field capacity of soil (40% moisture content) and the amount of water needed was calculated by difference in weight of pot at every irrigation, between field capacity and moisture content before irrigation. Air dry soil samples after sieving were taken for analysis according to Jackson (1967) before planting (Table1) and after harvest to study some soil physical and chemical properties and also it was extracted for determine some available nutrients contents

Table 1: Some physical and chemical properties of experiment soil

Partial size distribution				Available Nutrient, mg/kg soil			Soluble cations (meq L^{-1})				Soluble Anions (meq L^{-1})			
Sand%	Silt%	Clay%	Texture	N	P	K	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO^{--}	Cl^{-}	SO_4^{--}	CO_3^{--}
15.90	44.47	39.63	clay soil	19	7	320	5.4	1.7	3.2	0.5	2.5	4.6	3.7	0.00

Some Physical and Chemical properties				
pH (1:2.5)	EC dSm^{-1}	Organic matter (%)	Total $CaCO_3$ (%)	Field capacity (%)
7.8	2.8	2.05	2.02	42.20

Split-split complete block design was used with three replicates. The main treatments (3treatments) represent studied some natural material and the sub-main treatments were arranged for their levels (two levels along with control) of the natural materials used. The sub-sub main treatments were oriented for bacterial treatment (with and without bacterial inoculation). The two levels of natural material used were 1.5 and 3.g pot^{-1} for each one and added to surface of soil and mixed with it before planting. Urea (46% N), superphosphate (15.5% P_2O_5) and potassium sulphate (50 % K_2O) fertilizers were applied at rates of 2.0; 1.5 and 0.5 g/pot respectively. (200 kg urea fed^{-1},100 kg supper phosphate fed^{-1} and potassium sulphate 50 kg fed^{-1}).Nitrogen fertilizer was applied in three doses, the first one was applied after 15 days from planting and the second one after one month and the third one after two months from planting, while phosphorus fertilizer was applied before planting and Potassium fertilizer was applied in two doses, the first one after 15 days from planting and the second one after one month from planting. The plant were thinned to one plant in each pot after one month from planting. Effect of using some natural materials as need to determine the following parameters:

1. length of eggplant fruit.
2. diameter of eggplant fruit.
3. fresh weight of eggplant fruit.
4. dry weight of eggplant fruit.
5. NPK % in eggplant at the end of cultivation.
6. NPK % in eggplant fruit at the fifth collections.
7. NPK uptake of eggplant at different periods
8. NPK uptake of eggplant fruit at two collections.

Chemical composition: Plant and fruit samples were taken at different periods; washed with distilled water; dried at $70C^0$ in oven until constant weight; grounded and kept for chemical analysis according to page, *et al.,* (1982). 0.2 g from each dried plant sample was digested by adding 2ml from sulphoric acid overnight and then 0.2ml mixture (1:1) of both perchloric and sulphoric acids was added to sample and put on sand path

until reach to white colour. The content of each flask for each sample was diluted by using distilled water and kept in bottle of 100ml to carry and different chemical analysis of studied nutrients Nitrogen was determined according to the method described by Black, (1982); using micro-kjeldhl method. Phosphorus was determined colourmetrically according to the procedure outlined by Ryan, *et al.,* (1996). Potassium was determined using Flame Photometer according to Black, (1965).

All data were statistically analyzed according to the technique of analysis variance (ANOVA) and the least significant difference (LSD) was used to compare the difference between the mean of treatment values as described by Gomez and Gomez (1984).All statistical analyses were performed using analysis of variance technique by mean of COSTATE computer software.

RESULTS AND DISCUSSION

1-Effect of using some natural materials as fertilizers on fruit length of eggplant.

Data in Table (2) show the effect of using some natural materials as fertilizers on fruit length of eggplant at the different collections. Results illustrated that the length was influenced significantly by using studied natural materials (phosphate rock and mineral sulfer ore and). The highest value of length of eggplant fruits was obtained from treatment of mineral S ore compared to control and P rock treatment for all collection except 2nd collections.

With regard to the effect of using two levels of some natural materials as fertilizer on dry weight of eggplant fruits, results in Table (2) showed that the highest value of length of eggplant fruit was recorded from the second level (3 g plant^{-1}) compared to control and the first level (1.5 g plant^{-1}) for all collection.

Concerning the effect of using some natural materials as fertilizers with bacterial treatment and without bacterial treatment on length of eggplant fruits. Also results in Table (2) revealed that the highest values of length of eggplant fruits were obtained from treatments with bacteria compared to other treatment without bacteria inoculation for all collections.

As for interaction effect among treatments of using some natural materials as fertilizers, two levels of them and inoculation with bacteria or without bacteria indicated, in that general, application of (natural materials+L2(level 2)+B1(with bactria) increased the length

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2- Effect of using some natural materials as fertilizers on diameter of eggplant fruit.

With respect to application of some natural materials as fertilizers (phosphate rock and mineral sulfer ore) affected diameter of eggplant fruit for different collections, the data are illustrated in Table (3). The highest value of diameter of eggplant fruits was obtained from treatment mineral S ore compared to control and P rock treatment for all collections except 2nd collection.

Concerning the effect of using two levels of some natural materials as fertilizers on diameter of eggplant fruits, results in Table (3) indicated that the highest value of diameter of eggplant fruit was obtained from the second level compared to the first level and control for all collections.

With respect to the effect of using some natural materials as fertilizers with bacterial inoculation and without bacterial treatment on fresh diameter of eggplant fruits, showed that treating eggplants with bacteria obtained the best results compared to untreated plants.

The effect of interaction among treatments of using some natural materials as fertilizers, two levels of them and inoculation with bacteria or without bacteria, results indicated that, application of (natural materials+L_2+B_1) commonly increased the diameter of eggplant fruit.

3-Effect of using some natural materials as fertilizers on fresh weight of eggplant fruit:

Data in Table (4) show the effect of using some natural materials as fertilizers on fresh weight of eggplant fruit at the different collections.

Results illustrated that the fresh weight was influenced significantly by using studied natural materials (phosphate rock and mineral sulfer ore). The highest value of fresh weight of eggplant fruits was obtained from treatment of mineral S ore compared to control and P rock treatments for all collection, except 4th collection, where the highest value is (7.98 g $plant^{-1}$) for the first collection.

Regarding the effect of using two levels except control of some natural materials as fertilizers on fresh weight of eggplant fruits, results in Table(4) illustrated that the best treatment was obtained from the second level of natural material used in this experiment where it recorded the highest value of fruit fresh weight compared to the first level and control.

Concerning the effect of some natural materials as fertilizers on eggplant inoculated with bacteria and uninoculated with bacterial treatment on fresh weight of eggplant fruits, results in Table (4) showed that treating eggplants with bacteria obtained the best results compared to untreated plants (control).

The effects of interactions among treatments of using some natural materials as fertilizers, two levels of them and with bacteria or without bacteria inoculate are showed in Table (4). Results indicated, generally, increasing the value of fresh weight of eggplant fruit with using natural materials containing nutrients obtained from these rocks (P and S) when applied at high level and inoculated with mixture of bactria.

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4-Effect of using some natural materials as fertilizers on dry weight of eggplant fruit:

Data in Table (5) show the effect of using some natural materials as fertilizers on dry weight of eggplant fruit at the different collections. Results illustrated that the dry weight was influenced significantly by using studied natural materials (phosphate rock and mineral sulfer ore). for 2nd and 5th collection where the highest value of dry weight of eggplant fruits was obtained from treatment of mineral S ore compared to control and P rock, but the highest value of dry weight of eggplant fruits obtained from treatment P rock compared to control and mineral S ore treatments for other collections.

Concerning the effect of using two levels (along with control) of some natural materials as fertilizer on dry weight of eggplant fruits, results in Table (5) indicated that the highest value of dry weight of eggplant fruit was obtained from the second level (3g/pot) compared to control and the first level (1.5 g/pot) for all collections.

Regarding the effect of some natural materials as fertilizers with bacterial inoculation and without bacterial treatment on dry weight of eggplant fruits, results in Table (5) showed that the highest value of dry weight of eggplant fruits were obtained from treatments with bacteria compared to other treatments uninoculated with bacteria for all collections.

The effects of interaction among treatments of using some natural materials as fertilizers, two levels of them and treating with bacteria or without bacteria are shown in Table (5). Results illustrated that, in general application of (natural materials+L_2+B_1) increased the dry weight of eggplant fruit.

5-Effect of using some natural materials as fertilizers on NPK % in whole eggplant at the end of cultivation:

Data presented in Table (6) point to application of some natural materials (phosphate rock and mineral sulphur ore) as fertilizers influenced on NPK % in whole eggplant at the end of cultivation. Application of PR to soil induced higher phosphate content % in whole eggplant. Adding of sulphur ore to soil mostly increased NPK % in whole eggplant.

Inoculation with bactria increased NPK % in whole eggplant because its role in fixing more nitrogen and increasing the solubility of phosphorus residual in soil, and for less extent improving soil available potassium, its absorption by eggplant and percentage of content.

Increasing the level of these natural materials used for fertilizing soil with phosphorus and sulphur instead of chemical fertilizers increased NPK % in whole eggplant. These finding are in harmony with those obtained by (Sheng and Huang, 2002 and Turan, *et al.,* 2007)

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Table 6: Effect of using some natural materials as fertilizers on(N;P and K) concentration of whole eggplant at the end of cultivation(21:August;2013)

treatment		Bactria treat.	N%	P%	K%
	Level				
Control	Zero	B0	2.14	0.13	3.13
		B1	2.16	0.14	3.85
PR	1	B0	2.25	0.16	3.68
		B1	2.31	0.16	3.82
	2	B0	2.83	0.25	4.71
		B1	3.12	0.26	4.79
SO	1	B0	2.14	0.13	3.57
		B1	2.14	0.14	3.92
	2	B0	2.19	0.15	4.39
		B1	2.96	0.18	4.45

6-Effect of using some natural materials as fertilizers on NPK % in eggplant fruit at the fifth collection:

In the present investigation, application effects of some natural materials as fertilizers (phosphate rock and mineral sulphur ore) on NPK % of eggplant fruit at the fifth collection, of the experiment are illustrated in Table (7). Adding PR to soil recorded the highest value of phosphate % in eggplant fruit. Adding sulphur ore to soil generally increased NPK % in eggplant fruit.

Treating with bactria increased NPK % in eggplant fruit because its role in fixing more nitrogen and increasing the solubility of phosphorus residual in soil.

Increasing the level of these natural materials used for supplying soil with phosphorus and sulphur instead of chemical fertilizers obtained higher value of NPK % of eggplant fruit.in comparison with control treatment. It can be ordered descending these materials used as follows: SO> PR> control in increment of soil available NPK. The cost of applied materials to soil is more cheaper than that chemical fertilizers used to supply soil with NPK. In the same time minimizing the quantity of these chemical fertilizers protect the soil and water from pollution and keep human health from its hazards.

Treating these rock nutrient –bearing rock materials with mixture of bactria increased the amount of released nutrient from these rocks to soil to be in available form where plant can absorb them and uptake to promote the growth and yield even at lower or high level.

Table 7: Effect of using some natural materials as a fertilizers on (N;P and k) concentration in eggplant fruit at the fifth collection (21:Augus;2013)

treatment	Level	Bactria treat.	N%	P%	K%
Control	Zero	B0	2.43	0.32	3.42
		B1	2.59	0.32	3.44
PR	1	B0	2.66	0.36	3.92
		B1	2.65	0.36	3.91
	2	B0	2.65	0.41	3.80
		B1	2.83	0.46	4.30
SO	1	B0	2.61	0.39	3.34
		B1	2.76	0.33	3.60
	2	B0	2.77	0.33	3.65
		B1	3.06	0.44	4.68

7- Effect of using some natural materials as fertilizers on NPK uptake of eggplant at different periods:

Data presented in Table (8) point to application of some natural materials (phosphate rock and mineral sulphur ore) as fertilizers influenced on NPK uptake in whole eggplant at the different periods of cultivation. For all different periods, application of PR to soil induced the higher phosphate uptake by whole eggplant. Adding of mineral sulphur ore to soil mostly increased NPK uptake by eggplant.

Inoculation with bactria increased NPK uptake in whole eggplant because its role in fixing more nitrogen and increasing the solubility of phosphorus residual in soil, and for less extent improving soil available potassium, its absorption by eggplant.

Increasing the application level of these natural materials used enriched with phosphorus and sulphur for soil instead of chemical fertilizers gained an increase in soil available NPK with increasing NPK uptake in whole eggplant. These findings are in harmony with those obtained by (Anith *et al.,* 2004 and Han *et al.,* 2006)

8-Effect of using some natural materials as fertilizers on some nutrients uptake of eggplant fruit at two collections:

Application of some natural materials as fertilizers (phosphate rock and mineral sulphur ore) increased NPK uptake in eggplant fruit at the first and fifth collection of the experiment as indicated in Table (9). For 1st and 5th collections adding PR to soil achieved the highest value of phosphate uptake in eggplant fruit. Application of mineral sulphur ore to soil generally increased NPK uptake in eggplant fruit.

Bacterial treatment caused less increase in potassium uptake of eggplant fruit but this effect was sharp for N and P uptake in eggplant fruit at two collections.

Increasing the application level of these natural materials used for fertilizing soil with phosphorus and sulphur instead of chemical fertilizers recorded higher NPK uptake value in eggplant fruit, because of increasing available NPK in soil which increased NPK uptake by eggplant fruit. These results are inagreement with those obtained by (Han and Lee, 2005)

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CONCLUSION

It can be concluded that using phosphate rock and mineral sulphur ore with bio fertilization is better than that chemical fertilizers because of its cheaper cost and minimizing pollution hazard for soil and water.

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استخدام المعادن الخام لتسميد الباذنجان وعلاقته بامتصاص العناصر الغذائيه والمحصول وجودته

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أجريت تجربة اصص فى محطة البحوث بكلية الزرعة – جامعة المنصورة فى 14 مارس 2013 لدراسة تأثير استخدم بعض العناصر الطبعية (صخر فوسفات و خام الكبريت المعدنى) بمستويات اعلى من كنترول على نمو المحصول و دراستة بعض العناصر فى الباذنجان.

استخدام القيمة الاحصائى فى قطاعات كاملة عشوائية منشقة مرتين رتب وذلك فى ثلاثة مكررات. تم وضع الخامة الصخرية الطبعية كمعاملات رئسية وضع مستويين اضافة اعلى من معاملة المقارنة كمعامل رئسية وامعاملات بالبكتريا كمعاملات تحت تحت رئسية.

كانت مستويات اضافة هى 1.5, 3حم\ وعاء تربة بالاضافة الى معامل مقارن كنترول والتى خلط مع التربة قبل الزرعة.

تم اضافة الاسمدة النتروجنية (يوريا 46%ن) واسماد الفوسفات (سوبر فوسفات 15.5% فو2أ5) والسماد البوتاسيوم (كبريتات البوتاسيوم 50 %بو2أ) بمعدل 2, 1.5,0.5حم\ وعاء تربة والتى تعادل 200كم يوريا\فدان؛ 100كم سوبرفوسفات \فدان و 50كم كبريتات بوتاسيوم\فدان على التوالى.

اضهرت النتائج ان اضافة هذه المواد الخام الصخرية كأسمدة (صخر فوسفات و خام الكبريت المعدنى) ادت الى زيادة معنوية فى النمو الخضرى والمحصول وكذلك النسبة المئوية لعناصرالنتروجين والفوسفور والبوتاسيوم وامتصاص هذه العناصر فى نبات الباذنجان وثماره فى الجمعات التى تم الحصول عليها فى التجربة

قام بتحكيم البحث

ا.د/ أيمن محمد الغمرى	**كلية الزراعة – جامعة المنصورة**
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Table8: Effect of natural materials used as fertilizers on some nutrients uptake(mg/ plant) of eggplant at three periods of growth.

Treatment	Level	Bactria treat.	one month from planting (15:April) mg/ plant			middle of plant growth (20: may) mg/ plant			end of cultivation (21:August) mg/ plant		
			N	P	K	N	P	K	N	P	K
Control	Zero	B0	121.00	5.75	112.20	282.85	15.47	498.30	996.25	62.09	1457.23
		B1	119.51	5.93	108.38	299.16	17.33	538.73	1026.65	67.35	1832.26
PR	1	B0	166.51	10.27	170.73	449.96	28.58	872.62	1072.90	74.17	1753.88
		B1	186.38	10.89	189.24	567.26	31.02	876.00	1169.55	78.83	1933.68
	2	B0	216.94	16.95	277.28	760.68	39.93	1076.44	1433.93	127.65	2388.09
		B1	238.43	19.77	292.66	866.24	44.28	1152.17	1992.31	164.97	3062.61
SO	1	B0	150.54	6.52	138.94	415.38	18.04	609.42	1030.48	60.44	1721.41
		B1	181.62	12.26	162.42	447.61	22.53	656.70	1234.61	83.38	2266.33
	2	B0	207.94	14.58	200.54	719.53	38.42	1106.51	1557.40	109.99	3129.52
		B1	239.21	16.95	318.08	772.68	42.40	1158.34	2012.16	125.40	3025.83

Table9: Effect of natural materials used as fertilizers on some nutrients uptake (mg/ plant) of eggplant at the different collection.

Treatment	Level	Bactria treat.	first collection (27 June, 2013) mg/ plant			fifth collection (21Augest, 2013) mg/ plant		
			N	P	K	N	P	K
Control	Zero	B0	305.30	41.15	425.27	279.98	36.57	395.01
		B1	327.63	45.33	514.10	313.51	39.14	415.76
PR	1	B0	384.62	99.63	744.56	298.98	39.91	440.74
		B1	410.17	104.83	760.10	323.93	44.22	477.54
	2	B0	389.19	131.17	759.17	374.85	57.97	537.32
		B1	557.32	168.66	1005.76	404.89	65.45	616.24
SO	1	B0	430.66	53.57	782.51	437.09	65.59	559.03
		B1	411.73	59.16	798.91	443.47	53.27	578.28
	2	B0	788.04	89.28	1185.24	494.80	59.20	651.07
		B1	783.31	110.21	1212.94	598.58	86.95	914.93