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Effect of the Natural and Chemical Phosphorus Fertilization as Individually And/or Mixed on the Productivity of Eggplant

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Abstract: Two field experiments were carried out during the two seasons of 2005 and 2006 at the National Research Centre Experimental Station at Nobaria (40 Kilometer Near Alexandria) to study the phosphorus fertilizer addition at the natural source (rock phosphate) or chemical source (calcium super-phosphate) as individually or as mixture at ratios of 1:1, 2:1 and 3:1 respectively. The obtained results indicated that the application of chemical phosphorus resulted in the vigor plant growth criteria, the higher total an early fruits tied as well as the higher N, P and K content if compared with the Natural phosphorus fertilizer. Moreover, the mixtures which contained more chemical phosphorus with less Natural one. The lowest values of plant growth, total and early yield, physical and chemical fruits quality were detected with that plants which fertilized by the natural phosphorus as rock phosphate.

Key words: Eggplant productivity, rock phosphate, phosphorous fertilization.

INTRODUCTION

Eggplant (*Solanum melogena* L.) is considered as one of the important vegetable crops in Egypt. As might to be expected with crops of such promising potentialities efforts to improve its production should be carried out. Natural like organic and/or fertilizer minerals may give part in decreasing these effects. However, phosphorus is very important nutritional element in metabolic processes i.e., plant growth, total and early fruits yield. In addition it is role as a main constituent of energy compounds, nucleic acids, phospholipids and co-enzymes. The available P levels for plants in Egyptian soil is usually low, since it rapidly converts to tricalcium phosphate, thus becomes in-accessible by plants. Under these conditions, the forms used to add considerable amount of mineral phosphorus fertilizers to face this problem, hence increasing that P amounts which will move to ground water, consequently caused an environmental pollution. Using mineral phosphorus like rock phosphate may be decrease the faced problem.

Many reported indicated that, phosphorus is play a great role to improve the plant growth of some solanaceae family (Eggplant, tomato, potatoes, pepper....etc.) and/or other plants such as[13,10,9,20,16,8,3,5]. whereas, they reported that, phosphorus fertilizer had a significant effect on plant growth and its yield. As well as the different forms of phosphorus affected the physical and chemical properties of vegetable fruits [14,225,22]. In spite of the great role of phosphorus to promote the growth and increase fruits yield and its physical and chemical properties, but most review reported that, the effect of phosphorus varied according to its source. Whereas, the application of chemical source like calcium super-phosphate results better plant growth, higher fruits yield compared to the addition natural phosphorus form Pardeep-Numar and[18,3,19]. Therefore, the portent work aimed to study the effect of the application of chemical phosphorus and/or rock phosphate as individually or as mixture within the two above forms by different ratios.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive seasons of 2005 and 2006 to study the response of eggplant to the application of phosphorus fertilizer, i.e. chemical and/or natural as individually or as mixtures by different ratios. These experiments conducted at the agricultural experimental station of Natural Research Centre at Nobaria (Behera Governorate). The physical and chemical characteristics of the experimental soil are presented in Table (1).

Each experiment included 5 treatments as follows:

1. Addition of all phosphorus requirements in natural form (rock phosphate 22 % P_2O_5).
2. Addition of all phosphorus requirements in chemical form (Calcium super-phosphate 16.5 % P_2O_5).
3. Addition rock phosphate + calcium super-phosphate at ratio 1:1.
4. Addition rock phosphate + calcium super-phosphate at ratio 2:1.

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5. Addition rock phosphate + calcium super-phosphate at ratio 3:1.

Design of the experiments is complete randomized block system in 3 replicates.

Each experimental plot consisted of four rows, each of 4 maters in length and 3.2 m in width i.e., the plot area was 12.8 m^2

Whereas the phosphorus fertilizer was added with rate of 60 P_2O_5 units/fed. At once time during preparing the soil for plantation. All experimental plots received equall nitrogen fertilizer at rate of as ammonium sulphate at rate of 90 N units/fed. And potassium sulphate at rate of 60 K_2O units/fed. The N and K fertilizers were added equally twice, i.e. 45 and 60 days after transplanting date. The eggplant seeding cv. Balady (white) were sown on one side of the ridge 30 cm apart during the second week of March in two experimental seasons. The normal cultural practices commonly used in growing and irrigation of eggplant was followed. Samples of eggplants at old of 75 days were collected from every experimental plot and the following plant growth characters were recorded: plant length (cm), number of shoots and leaves per plant, total fresh and dry weight (g) of eggplant and its different organs, i.e. shoots and leaves eggplant fruits were harvested weekly and were recorded sample were taken from the 4th picking and the following measured. The average fruits yield (total, and/or early), as tons/fed. And fruit dimension i.e., length and diameter (cm).

Also, in tissues of fruits the values of total soluble solids (TSS) were determined using hand refractometer. Nitrogen, phosphorus, potassium contents in fruits tissue were analyzed according to the method[24,17,6]. respectively. However, Fe, Cu and Zn contents were determined using flame ionization atomic absorption, spectrometer moded 1100 13 of perkin elemer and according to the method of[7]. The protein percentage in fruit was accountly by multiplying nitrogen content by 6.25.

All data values were subjected to the analysis of variance to[11].

RESULTS AND DISCUSSION

Plant Growth Characteristics: Eggplants which received chemical phosphorus fertilizer gained the vigor plant i.e., plant height, average numbers of leaves and stems, fresh and dry weight of whole plant and its organs if compared with that plants which supplied the natural phosphorus alone. These findings were had good during the two experimental seasons as shown in Table (1). Whereas, the heights plants which carried the largest number and weight of leaves and stems were detected with that plants grown under the application of calcium super-phosphate. In addition, mixing calcium super-phosphate as chemical fertilizer with rock phosphate as natural one at rate 1:1 gained the less vigor plant if compared with the application all phosphorus requirement as chemical.

Also, the obtained data indicated that, the mixture fertilizer contained more chemical and less natural phosphorus results higher values of plant growth parameter comparing with that plants which received more natural phosphorus with chemical.

It could be concluded that, the best benefit for fertilizing the eggplant by phosphorus which resulted the vigor plant growth is the chemical source as calcium super-phosphate, and the lesser one is rock phosphate alone. By other means, it summarized that chemical phosphorus fertilizer as individual and/or mixing with natural phosphorus resulted more vigor of plant growth.

The statistical analysis of the obtained data revealed also that the differences within different treatments were great enough to reach the 5% level for all plant growth measurements in both two experimental seasons. Many investigators studies the response of some vegetables to phosphorus fertilization and concluded that, the increment in plant growth parameter by P-application is in agreement with those reported by[13,10], on eggplants and by[14,15,3]. on pepper plants and by[8,23]. on tomato plants and by[20,5]. on potatoes. However, rock phosphate could enhanced the plant growth characters, but the results which obtained by[18,3,16,25]. on tomatoes revealed that, the chemical phosphorus form caused more enhancement in plant growth over the application phosphorus in the form of rock phosphate (natural P-form).

Total Fruits Yield and its Some Physical Properties: Table (2) show chearly that, the eggplants which fertilized by phosphorus as chemical source (Calcium super-phosphate) recorded the higher values of total fruits yield amounted by 13.18, 14.93 tons/fed.) and early fruits yield which amounted by 2.93, 3.04 tons/fed. respectively for 1st and 2nd seasons.

On the contrary, the lowest total eggplant fruits, i.e. 10.05, 11.26 tons/fed., and early fruits, i.e. 1.25, 1.35 tons/fed. For the same above respective were associated with that plants which received the natural phosphorus fertilizer as rock phosphate from other view, that results presented in Table (2) also indicated that, the mixtures which contained more chemical phosphorus with less natural phosphorus resulted the higher total and early fruits field than that contained less chemical with more natural phosphorus. The statistical analysis of the written data revealed that, the differences within different phosphorus treatments were enough to be significant at 5 % level.

Table 1: Effect of natural and chemical P-fertilizers application on vegetative growth of eggplant.

Treatments	Plant Length (cm)	Number of		Fresh weight (g)			Dry weight (g)		
		Leaves	Shoots	Leaves	Shoots	Total	Leaves	Shoots	Total
				First season (2005 / 2006)					
Rock phosphate	57.90	35.50	3.97	65.68	50.00	115.69	25.27	17.50	42.77
super phosphate	74.17	65.42	8.33	93.18	84.57	177.74	36.80	31.53	68.33
1 Super : 1 Rock	67.93	48.00	6.33	83.33	66.30	149.63	30.53	23.07	53.60
1 Super : 2 Rock	62.30	44.67	6.00	81.40	58.64	140.04	28.97	21.13	50.09
1 Super : 3 Rock	60.30	41.63	5.50	75.17	57.63	132.80	28.17	20.63	48.80
L . S. D.	6.56	8.38	1.88	13.12	10.43	16.64	4.73	4.48	7.75
				Second season (2006 / 2007)					
Rock phosphate	66.59	40.05	4.93	72.60	56.50	129.11	27.54	21.13	48.67
super phosphate	83.96	70.96	9.67	99.30	92.20	191.5	40.78	36.26	77.04
1 Super : 1 Rock	78.79	52.80	7.01	90.00	73.59	163.59	34.95	27.86	62.81
1 Super : 2 Rock	71.65	48.47	6.96	87.25	66.09	153.33	31.91	24.96	56.87
1 Super : 3 Rock	68.35	46.46	6.05	82.18	63.64	145.82	30.70	23.73	54.43
L . S. D.	8.46	8.68	1.90	13.04	8.71	13.99	4.59	4.31	7.31

It could be summarized that, chemical phosphorus fertilizer is better than natural one for eggplant where, it gained the higher total and early fruits yield. Generally, it could concluded that, the previous investigation which studied the effect of phosphorus fertilizers on fruits yield of many vegetables reported that, all phosphorus forms of phosphorus (single calcium super-phosphate, triple-calcium super-phosphate as a chemical source and or rock phosphate as a natural source, all of then individually and/or inoculated by bacteria) resulted in the higher yields if compared by the control treatment[4,26,1,8,23,25,22]. With other studies reported that, the chemical form of phosphorus gained a more fruits yield over than rock phosphorus[13,12,14,23]. reported that, the total yield had no great differences to be significantly within using the different phosphorus forms. Regarding the physical properties of eggplant fruit, i.e. length and diameter, the shown data in Table (2), indicated that, its response to the phosphorus fertilizer, followed the same order of change like that the previous mentioned trend of total and early fruits yield in both two seasons. By short words, it could be concluded that, the most proper and suitable phosphorus form if phosphorus for eggplant is that of calcium super-phosphate as chemical source.

The written results in this script are in good accordance with that reported by[20]. on potatoes and[3]. on pepper. In the same time[2,22]. on cowpea reported that, rock phosphate fertilizer caused on improve in pods yield quality.

Chemical Properties of Eggplant Yield: The contents of total soluble solids (TSS), total protein percentage, N, P, K, Fe, Cu and Zn in tissues of eggplant fruits as responded to the phosphorus fertilizer are shown in Table (3) for the two experimental seasons. Whereas, the highest values of TSS (5.41 and 5.63),protein (25.17 and 27.56 %), N (4.03 and 4.41 %), P (0.77 and 0.9 %) and K (3.3 and 3.76 %) in fruits tissues are defected with that plants which received phosphorus fertilizer as chemical form (calcium super-phosphate). But the lowest values of the above mentioned parameters are recorded with that plants which received phosphorus fertilizer as natural form (rock phosphate). Also, the obtained data revealed that, mixing chemical with natural gained less value of the before mentioned properties. It could be concluded that the best values of nutritional elements were associated with the addition, more chemical phosphorus in the mixture.

Concerning the variation within the different added phosphorus levels, the statistical analysis of the recorded data indicate that they were great to be statistically at the level of 5 %. These were true for the values of TSS, protein, N, P and K in both seasons of 2005 and 2006, but were not statistically for Cu (1^{st} season) and Zn (2^{nd} season).

It is obvious from the obtained data (Table 3) that, the highest Fe values in eggplant fruit tissues was defected with that plants which received rock phosphorus, in the two seasons. On the contrary, the lowest values were recorded with plant which applied chemical phosphorus form.

It could summarized that, the applying phosphorus fertilizer in the chemical form resulted the highest values of TSS, protein, N, P and K and the lowest values of F.

Table 2: Effect of natural and chemical P-fertilizers application on fruit yield and quality of eggplant.

Treatments	Fruit yield (ton / fed)		Fruit quality		
	Early	Total	Length(cm)	Diameter (cm)	Weight (g)
		First season (2005 / 2006)			
Rock phosphate	1.25	10.05	7.7	2.07	25.75
super phosphate	2.93	13.18	12.13	3.67	63.27
1 Super : 1 Rock	2.19	12.58	10.98	2.93	62.22
1 Super : 2 Rock	1.66	11.32	9.67	2.48	52.84
1 Super : 3 Rock	1.47	11.07	8.63	2.93	36.65
L . S. D.	0.29	0.78	1.48	0.68	12.65
		Second season (2006 / 2007)			
Rock phosphate	1.35	11.26	8.19	2.37	32.05
super phosphate	3.04	14.93	12.74	4.03	73.33
1 Super : 1 Rock	2.32	14.09	11.47	3.16	72.09
1 Super : 2 Rock	1.82	12.74	10.15	2.8	62.35
1 Super : 3 Rock	1.56	12.43	8.97	3.19	44.58
L . S. D.	0.34	0.87	1.57	0.63	14.88

Table 3: Effect of natural and chemical P-fertilizers application on minerals content of eggplant fruit.

Treatments	Minerals content of fruit							
	N (%)	P (%)	K (%)	Fe (ppm)	Cu (ppm)	Zn (ppm)	TSS (%)	Total protein (%)
				First season (2005 / 2006)				
Rock phosphate	2.67	0.52	2.13	7.07	0.2	0.19	3.93	16.69
super phosphate	4.03	0.77	3.3	5.83	0.18	0.16	5.41	25.17
1 Super : 1 Rock	3.5	0.67	3.05	6.42	0.19	0.17	4.9	21.88
1 Super : 2 Rock	3.27	0.6	2.62	6.71	0.2	0.17	4.43	20.44
1 Super : 3 Rock	3.09	0.53	2.47	7.02	0.2	0.18	4.43	19.29
L . S. D.	0.66	0.06	0.62	0.54	N.S.	0.01	0.66	4.13
				Second season (2006 / 2007)				
Rock phosphate	2.76	0.59	2.52	8.27	0.25	0.24	3.99	17.23
super phosphate	4.41	0.9	3.76	6.88	0.2	0.19	5.63	27.56
1 Super : 1 Rock	3.9	0.78	3.51	7.57	0.22	0.21	5.03	24.4
1 Super : 2 Rock	3.66	0.71	3.15	8.06	0.23	0.22	4.68	22.89
1 Super : 3 Rock	3.42	0.63	2.8	8.35	0.24	0.23	4.51	21.4
L . S. D.	0.92	0.06	0.77	0.74	0.02	N.S.	0.59	5.75

However, it is known that, presenting the nutritional elements in rooting zone by the availability form caused an increase in its absorption by plant, hence caused a rising in all elements in plant tissue, especially in storage organ, i.e. fruit, bulb, pod, …etc. The response of eggplant to the addition different forms of phosphorus was investigated by many workers, all of then reported that, phosphorus at any form resulted in an increase in the chemical nutritional values, i.e. protein, N, P, K, Mn, Zn, Cu, Fe[14,21,23,25].

Generally, it could be concluded that, either chemical or natural phosphorus form gained an increment in nutritional values for vegetables, but the application of the chemical source as calcium super-phosphate recorded more nutritional values in fruits tissue compared with the addition of rock phosphate as a natural form.

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