J. Agric. Sci. Mansoura Univ., 33 (12): 8709 - 8722, 2008

EFFECT OF GYPSUM, PHOSPHOREINE AND ROCK PHOSPHATE ON GROWTH AND YIELD OF SWEET PEPPER PLANTS.

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ABSTRACT

Two field experiments were performed during the successive seasons of 2006 and 2007 at Talkha district, Dakahlia Governorate, Egypt to determine the effect of gypsum, phosphoreine and rock phosphate rates on growth, chemical composition, yield and quality of sweet pepper plants cv. California wonder.

The main results could be summarized that:

- Application of 4 ton/feddan of gypsum as soil amendments and 1 kg of phosphorein as transplants inoculation with 60 or 90 kg P_2O_5 of rock phosphate induced a significant effect on root, shoot , total dry weights, N, P and K contents of pepper plant foliage as well as N and P total uptake.
- Additions of gypsum at 4 ton/ feddan and phosphorein at 1 kg/ feddan with 60 or 90 kg P_2O_5 of rock phosphate showed a significant effect on maximizing average fruit weight, number of fruits per plant, fruit yield per plant, total yield per feddan, fruit flesh thickness, fruit dry weight and fruit TSS.
- Adding 4 ton/feddan of gypsum and 1 kg/feddan of phosphorein with 60 kg P_2O_5 of rock phosphate increased sweet pepper fruit yield by 56.22 % above control.

In general, this study demonstrated that it is possible to produce highest growth, yield and quality of pepper plants by applying rock phosphate as a cheap phosphorus source; it will be necessary to add gypsum at 4 ton/feddan and 1 kg/ feddan of phosphorein with 60 kg / P_2O_5 of rock phosphate.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is one of the most important widely grown vegetable crops in the world being recognized as a reach source of minerals and vitamins; it is also one of the most important vegetable crops in Egypt for local utilization and export. Phosphorus plays an important role on plant metabolism functions and is one of the essential nutrients required for plant growth and development. It has functions of a structural nature in macromolecules such as nucleic acids and of energy transfer in metabolic pathways of biosynthesis and degradation (Marschner, 1995 and Jeschke *et al.*, 1996).

The major series problem of phosphorus fertilization in Egypt is that of unavailable form of phosphorus in the alkalinity soil, for that applying phosphorus fertilizers could be converted to unavailable form for plant absorption (El-Dahtory *et al.,*1989) and therefore, most growers apply too much P fertilizer for their crops, over-fertilization leads to unnecessarily high production costs and may lead to decrease yield and quality and pose a risk to the environment, so application of natural rock phosphate is an economically sound alternative to the more expensive superphosphate (Sale and Mokwunye,1993 and Chien *et al.,* 2003). Based on the unit cost of P, natural rock phosphates is usually the cheapest. Moreover, available information has suggested that phosphate rocks may also have potential agronomic value by provide some secondary nutrients, such as Ca and magnesium, and micronutrients, such as zinc and molybdenum, in spite of the fact that the phosphorus released from directly applied ground rock phosphate is often too low to provide sufficient phosphorus for crop uptake especially in the alkaline soil (Vassilev *et al.,* 2001). Rock phosphate was particularly effective in acid soils, at alkaline soil the obtained yield of rock phosphate treatments was about 20 to 40 % lower than superphosphate (Mengel and Kirkby, 1978). In general, experiments conducted in the past showed that rock phosphate was highly effective when applied to plants grown in acid soils (Khasawneh and Doll, 1978). On the other hand increased soil acidity can enhance rock phosphate dissolution and its availability to plants (Haynes, 1992 and Nakamaru *et al.,* 2000). Phosphorus solubilizing bacteria in general showed a positive effect on solubilizing inorganic phosphorus in the soils. As phosphorus solubilizing microorganisms render more phosphates into solution than is required for their growth and metabolism, the surplus could be absorbed by plants (Sundara *et al*. 2002).

Gypsum has several benefits including adding sulfur and calcium to the soil as an essential plant nutrients, Gypsum amendments may affect the recovery of applied P fertilizer as the addition of Ca and sulphate alters the P sorption and release capacities of soils through their effects on P adsorption and precipitation processes. Also, Gypsum amendments increase the efficiency of P fertilizer, contributing to enhanced productivity of freshly reclaimed saline and sodic marsh soils (Delgado *et al*., 2002).

This experiment highlights the potential use of rock phosphates as source of phosphorus in relation to gypsum and phosphorein as soil amendments on growth, yield and quality of pepper plants specially under Egyptian alkalinity soil and the continues increasing in price of superphosphate fertilizers.

MATERIALS AND METHODS

Two field experiments were conducted at Talkha district, Dakahlia Governorate, Egypt during the successive seasons of 2006 and 2007 to achieve the effect of gypsum, phosphoreine and rock phosphate rates on growth and yield of sweet pepper, CV. California wonder. Some physical and chemical properties of the experimental soil are in Table 1.

Table 1: Some physical and chemical properties of the experimental soil during 2006 season.

Sand %	Silt %	Clay %	Texture class	EC (dSm^{-1})	Organic matter %	pH	$CaCo_3$	Available nutrients (ppm)		
								N	P	K
19.15	30.70	48.45	clayey	0.92	1.91	7.8	2.92	29.24	13.41	304.2

A split-split plot design with three replicates was used. The experiment included 24 treatments, which were the combinations among three levels of gypsum, two phosphorein rates and four levels of rock phosphate. The main plots were assigned gypsum levels (0, 2 and 4 ton/fed).The sub plots were devoted to phosphorein rates (with and without). Meanwhile, the four rates of rock phosphate (0, 30, 60, 90 kg P_2O_5/ feddan) were randomly arranged in the sub-sub plots. Each experimental unit was 12.25 m^2 consisted of five ridges each of 3.5 m long and 70 cm wide.

On 1st March during the two seasons, pepper seedlings were transplanted in the open field into one side ridges at spacing 30 cm. phosphorus fertilizer in the form of rock phosphate (27 % P_2O_5) and gypsum (23% calcium and 18% sulfur) at previously mentioned rates were applied before planting at rowing preparation. Phosphorein contains "*Bacillus megatherium var. phosphaticum"* (pure local strain) as phosphate dissolving bacteria were obtained from biofertilizer production unit, Soil and Water Res. Inst., Agric., Res. Center, Giza, Egypt. Before transplanting pepper seedlings were treated with a suspension of 1 kg of phosphorein dissolved in 4 liter of tap water and mixed with Arabic Gum, as an adhesive substance. Pepper plants were received N and K fertilizers at the rates of 120 Kg N and 100 Kg K_2O/ *fed.* Fertilizers were applied in the form of ammonium nitrate (33.5 % N) and potassium sulfate (48 % K_2O).

Normal cultural practices for pepper were followed according to the instruction laid down by Egyptian Ministry of Agriculture.

A representative sample of 5 plants from each plot were taken at 105 days after transplanting and weight of root, shoot and total dry weight were recorded. Dry weight of root and shoot were used to determine nitrogen % according to the methods described by Bremner and Mulvaney (1982), phosphorus was estimated colorimetrically according to Olsen and Sommers (1982) and potassium was also determined flame photometrically as described by Jackson (1967), all obtained results were used to calculate the total uptake of nitrogen, phosphorus and potassium (mg/plant) for root and shoot dry weight.

All harvested fruits from each plot all over the season, were used to determine average fruit weight, number of fruits/ plant, yield/ plant and total yield/ feddan. A representative sample of 10 marketable fruits from each experimental plot were taken at the picking No. 8 for determination of fruit flesh thickness, fruit dry matter %,TSS % and Vit C mg/100 gm fresh fruit weight according to the methods of A.O.A.C. (1990).

The data were statistically analyzed as a combined for the two seasons using the procedure outlined by Snedecor and Cochran (1980). The treatment means were compared using least significant differences at 5% Level.

RESULTS AND DISCUSSION

1. Dry weight and plant chemical composition:

1.1. Effect of gypsum.

Data tabulated in Table 2 indicate that gypsum rates as soil amendment had a significant effect on dry weight and chemical components of pepper plants. It is clear from such data that addition of 4 ton/fed of gypsum resulted in the highest significant root, shoot, total plant dry weight, N, P, K % and N, P, K total uptake. These results are in harmony with those obtained by Tuna *et al*. (2007) who reported that supplemental calcium sulphate (gypsum) added significantly improved plant growth and increased concentrations of K in tomato leaves.

The pronounced promotional effect of gypsum on dry weight and chemical components of pepper plants may be due to the several benefits of gypsum including adding sulfur to the soil, provides calcium which is also a plant nutrient and needed to flocculate clays in acid and alkaline soils, calcium also, plays an essential role in processes that preserve the structural and functional integrity of plant membranes, stabilize cell wall structures, regulate ion transport and selectivity, and control ion-exchange behaviour as well as cell wall enzyme activities (Rengel, 1992 and Marschner, 1995). Moreover, gypsum had a role in improving soil structure, increasing aeration of the soil, improve moisture holding capacity, improve deep root systems, improve the uptake of water, improve uptake of nitrogen and phosphorus by root. Gypsum, also, decreased soil pH (Andrade *et al.*, 2002), electrical conductivity (Soni *et al.*, 1997). Such flocculation is needed to give favourable soil structure for root growth, air and water movement.

Table 2: Effect of gypsum rates on dry weight and chemical components of pepper plants, combined analysis of 2006 and 2007 seasons.

Gypsum	Dry weights /plant(gm)			foliage%			Total uptake (mg/plant)		
	Root	shoot	Total	N	P	K	N	P	K
Without	5.91	60.84	66.51	2.39	0.202	3.28	1595	136.5	2190
2 ton/fed.	6.70	69.48	76.18	2.55	0.220	3.45	1944	171.6	2643
4 ton/fed.	7.01	75.79	82.81	2.65	0.256	3.49	2201	217.3	2901
LSD 5%	0.21	3.26	3.48	0.25	0.02	0.24	185.4	31.4	234.1

1.2. Effect of phosphorein.

Data concerned with the effect of phosphorein on plant dry weight and chemical components of pepper plants are shown in Table 3. It is clear that inoculation of pepper transplants with 1 kg of phosphorein per feddan significantly increased root, shoot and total dry weight as well as P, K % in plant foliage and N, P, K total uptake compared with untreated plants. The unique exception was that of N % of plant foliage which was not significantly affected by phosphorein treatment. These results agree with those reported by Turan *et al*. (2007) who found that phosphorus solubilizing bacteria applications increased tomato plant shoot and root weights, also, increased P contents of plant by 12.1% above control.

Table 3: Effect of phosphoreine on dry weight and chemical components of pepper plants, combined analysis of 2006 and 2007 seasons.

Phosphoreine	Dry weights /plant(gm)			foliage%			Total uptake (mg/plant)		
	Root	shoots	Total	N	P	K	N	P	K
Without	6.02	66.55	72.41	2.51	0.217	3.39	1828	161.1	2472
With	7.04	70.95	77.99	2.56	0.233	3.42	2008	188.4	2685
F-test	*	*	*	N.S	*	*	*	*	*

The simulative effect of phosphorein on dry weight of plant might be attributed to the vital role of these bacteria in dissolving insoluble phosphates by more than one process, including the release of organic acids (Illmer *et al.*,1995) and the solubilization of calcium phosphates (Illmer and Scinner, 1995), reducing soil pH (Hewedy, 1999b and Turan *et al.*, 2007), producing phytohormones which could stimulate absorption of nutrients and consequently increasing dry weight (Bashan and Holguin,1997). Moreover, there are several reports on plant growth promotion by bacteria that have the ability to solubilize inorganic and organic P from soil after their inoculation of soil or plant seeds (Kucey *et al.*, 1989; Cakmakci *et al.*, 2001; Sundara *et al.*, 2002; Shen *et al*., 2004 and Turan *et al.,* 2006). Furthermore, the effect of phosphorein on nutrients uptake is generally due to the production of organic acids such as citric, glutamic, succinic, lactic, oxalic, malic, fumaric and tartaric acid which has been attributed to their chelating effect, as well as phosphorein render more available phosphates into solution than is required for their growth and metabolism, the surplus could be absorbed by plants (Sundara *et al.,* 2002).

1.3. Effect of rock phosphate rates.

Data in Table (4) show a significant effect of rock phosphate rates on pepper plant dry weight and chemical components. Such data revealed that increasing rock phosphate rates up to the highest used level (90 kg P_2O_5 / feddan) resulted in the highest significant of root, shoot and total dry weights, also P, K % contents in plant foliage and N, P and K total uptake. These results agree with those reported by Melton and Dafault (1991) who found that increasing phosphorus fertilization increased total dry weight of tomato and with the finding of Heuwinkel *et al*. (1992) who found that plant dry matter and root are much less affected by P deficiency. The favourable effects of rock phosphate on plant growth have been observed by Mandal (1975) on soybean and Mona and Nadia (2008) on okra.

Table 4: Effect of rock phosphate rates on dry weight and chemical components of pepper plants, combined analysis of 2006 and 2007 seasons.

Rock phosphate rates (kg P_2O_5/fed)	Dry weights /plant(gm)			foliage%			Total uptake (mg/plant)		
	Root	shoot	Total	N	P	K	N	P	K
0	4.99	60.96	65.95	2.54	0.171	3.32	1680	113.9	2198
30	5.63	63.78	69.41	2.51	0.203	3.35	1749	142.1	2330
60	7.61	72.87	80.15	2.53	0.248	3.43	2040	202.7	2757
90	7.93	77.21	85.14	2.55	0.281	3.54	2183	241.9	3028
LSD 5%	0.201	3.12	4.57	N.S	0.024	N.S	120.7	27.9	268.4

The simulative effect of phosphorus on dry weight of pepper plants may be due to that phosphorus is a part of molecular structure of nucleic acid (DNA and RNA), the energy transfer components and phosphoproteines (Mengle and Kirkby, 1978).Moreover, phosphorus plays a regulatory role in the formation and translocation of substances such as sugars and starch (Bennett, 1994). Good P uptake and translocation toward the leaves involve the transport of carbohydrates toward the root (Qiu and Israel, 1992). This is primarily because both P absorption by the root and the xylem loading process require carbohydrates as an energy source (Loughman, 1987).

1.4. Effect of interaction among phosphorein, gypsum and rock phosphate rates.

Data presented in Table 5 indicate that application of 4 ton/fed of gypsum and 1 kg of phosphorein with 60 or 90 kg $P_2O_5$of rock phosphate had a significant effect on root, shoot and total dry weights. It also clear that N, P and K contents % of pepper plant foliage and total uptake of N, P were also increased significantly. However, the interaction between gypsum at 4 ton, phosphorein at 1 kg and 90 kg $P_2O_5$of rock phosphate gave the highest values of K total uptake.

Table 5: Effect of the interaction among gypsum, phosphoreine and rock phosphate rates on dry weight and chemical components of pepper plants, combined analysis of 2006 and 2007 seasons.

G**	Phos*	P_2O_5 (kg/fed)	Dry weights /plant(gm)			Foliage%			Total uptake (mg/plant)		
			Root	shoot	Total	N	P	K	N	P	K
without gypsum	without Phos*	0	4.21	51.48	55.69	2.44	0.154	3.11	1358	85.7	1731
		30	4.97	54.32	59.29	2.37	0.184	3.21	1405	109.0	1903
		60	5.81	61.49	65.31	2.31	0.204	3.14	1508	133.2	2050
		90	6.45	65.48	71.93	2.47	0.246	3.34	1776	176.9	2402
	with Phos*	0	5.01	57.41	62.42	2.38	0.151	3.28	1485	94.2	2047
		30	6.47	61.43	67.90	2.35	0.199	3.32	1595	135.1	2254
		60	7.08	65.41	72.49	2.41	0.221	3.41	1747	160.2	2471
		90	7.34	69.71	77.05	2.45	0.257	3.46	1887	198.0	2665
2 ton/fed. gypsum	without Phos*	0	4.87	60.40	65.27	2.53	0.161	3.22	1651	105.0	2101
		30	5.19	64.37	69.56	2.51	0.198	3.48	1745	137.7	2420
		60	6.91	72.46	79.37	2.57	0.234	3.74	2039	185.7	2968
		90	7.28	76.44	83.72	2.50	0.277	3.68	2093	231.9	3080
	with Phos*	0	5.11	65.34	70.45	2.57	0.174	3.31	1810	122.5	2331
		30	5.97	62.71	68.68	2.59	0.191	3.25	1778	131.1	2232
		60	8.94	75.44	84.38	2.60	0.248	3.41	2193	209.2	2877
		90	9.34	78.68	88.02	2.55	0.284	3.57	2244	249.9	3142
4 ton/fed. gypsum	without Phos*	0	5.27	63.42	68.69	2.66	0.188	3.48	1827	129.1	2390
		30	5.39	69.74	75.13	2.64	0.209	3.51	1983	157.0	2637
		60	7.91	77.64	85.55	2.59	0.262	3.48	2215	224.1	2977
		90	8.01	81.47	89.48	2.62	0.289	3.37	2344	258.5	3015
	with Phos*	0	5.48	67.74	73.22	2.67	0.201	3.54	1954	147.1	2591
		30	5.79	70.12	75.91	2.62	0.241	3.34	1988	182.9	2535
		60	9.04	84.78	93.82	2.71	0.324	3.41	2542	303.9	3199
		90	9.21	91.48	100.6	2.74	0.334	3.84	2758	336.3	3866
LSD 5%			0.52	8.24	8.21	0.11	0.02	0.47	254.7	42.1	327.1

*** Phosphoreine **Gypsum**

These results coincided with those reported by Hewedy (1999a), Dawa *et al.* (2000) and Mahmoud and Amara (2000), they found that the interaction between phosphorein and NPK at 50 % or 75 % increased dry weight of tomato plant compared with 100 % NPK. Bardisi and Atia (2005) reported that using 60 kg P_2O_5/ feddan and inoculation with phosphorein gave the highest values of total dry weight, N, P and K total uptake by tomato plants. Many studies have demonstrated the dissolution of rock phosphate by phosphate solubilizing microorganisms (Barea *et al.,* 1983). Kumar and Sharma (2004) found that phosphate solubilizing bacteria increases rock phosphate availability and increased tomato plant height compared with rock phosphate alone. On the other hand Menary and Hughes, (1967) pointed out that when sulphate and phosphate were applied to the soil at the same time; the sulphate produced a significant increase in phosphorus uptake of tomato plants. They showed that sulphate allowed a better utilization of the added phosphate by reducing the rate of phosphate fixation.

2. Fruit yield and quality:

2.1. Effect of gypsum.

Considering the effect of gypsum additions on fruit yield and quality of pepper, data presented in Table 6 reveal that increasing gypsum additions to the highest used rate (4 ton/fed) significantly increased average fruit weight, number of fruits, fruit yield per plant and total yield per feddan as well as fruit dry weight. Meanwhile, fruit flesh thickness, TSS and vitamin C were not significantly affected by addition of gypsum comparing with control. Similar results were obtained by Delate and Arora (2003) who used gypsum as a soil amendment to enhance pepper production and postharvest quality; he found that there was a trend towards greater yield, number of fruits and average weight of pepper fruits with gypsum soil addition. Tuna *et al.* (2007) they found that addition of gypsum significantly improved tomato fruit yield. In addition, it has been shown that sulphur plays an important role in yield and quality of many crops (Pavlista, 2005 on potato and Heeb *et al.,* 2006 on tomato).

Table 6: Effect of gypsum on fruit yield and quality of sweet pepper, combined analysis of 2006 and 2007 seasons.

Gypsum	Fruit yield				Fruit quality			
	Average fruit weight (gm)	No. fruits /plant	Fruit yield (kg / plant)	Total yield (ton / fed.)	Flesh thick-ness (mm)	Fruit DW (%)	TSS %	Vit C mg/ 100gm FW
without	156.7	37.11	0.585	10.24	2.36	7.95	6.30	134.5
2 ton/fed.	164.6	38.26	0.632	10.86	2.45	8.16	6.40	142.7
4 ton/fed.	183.3	39.57	0.732	12.80	2.59	8.44	6.57	153.5
LSD 5%	15.14	1.11	0.037	0.247	N.S	0.219	N.S	N.S

2.2. Effect of phosphorein.

Data tabulated in Table 7 show the effect of phosphorein on fruit yield and quality of sweet pepper, it is clear that, number of fruits per plant, fruit flesh thickness, fruit TSS and Vitamin C were not significantly affected by the addition of phosphorein. On the other hand, the addition of phosphorein significantly increased average fruit weight, fruit yield per plant, total yield per fed and fruit dry weight compared with untreated pepper plants. These results agree with those reported by Subba Rao (1982), Wani and Lee (1992) and Verma (1993) on many crops include cabbage, tomato, potato, chickpea and soybean they found that the use of phosphate solubilizing Microorganisms can increase crop yields by up to 70 percent.

The above mentioned improving effect of phosphorein on pepper fruit yield and quality could be attributed to the activity of these bacteria in the absorption zone of plant root by improving soil fertility through releasing of certain other nutrients, *i.e.*, Fe, Zn and Mn (Bhonde *et al.*, 1997), and break down of organic and inorganic nutrients in the soil and changing these elements to available forms.

Table 7: Effect of phosphoreine on fruit yield and quality of sweet pepper, combined analysis of 2006 and 2007 seasons.

Phosphoreine	Fruit yield				Fruit quality			
	Average fruit weight (gm)	No. fruits /plant	Fruit yield (kg / plant)	Total yield (ton / fed.)	Flesh thickness (mm)	Fruit DW (%)	TSS %	Vit C (mg 100gm FW)
without	162.9	37.77	0.619	10.69	2.42	8.03	6.38	140.1
With	173.5	38.85	0.681	11.90	2.51	8.33	6.46	147.0
F-test	*	N.S.	*	*	N.S	*	N.S	N.S

2.3. Effect of rock phosphate rates.

Data presented in Table 8 show the effect of rock phosphate rates on fruit yield and quality of sweet pepper. It is clear that number of fruits per plant, fruit yield per plant, total yield per feddan and fruit flesh thickness were significantly affected by increasing rock phosphate rates up to the highest used level *i.e*. 90 kg P_2O_5. Meanwhile, average fruit weight, fruit dry weight and fruit TSS as well as vitamin C were significantly affected by addition of 60 or 90 kg P_2O_5 of rock phosphate. On the other hand there was no significant differences could be detected between the addition of 30 kg P_2O_5 of rock phosphate and control. Similar results were obtained by Di candilo *et al*. (1993) who found that increasing phosphorus fertilization increased yield and soluble solids percentage in tomato grown in high alkaline soil. Similar results were obtained by Hammond *et al*. (1980). Maloth and Prasad (1976) reported that cowpeas grown in alkali soil (pH 8.4) fertilized with 200 Kg P_2O_5/ha in from of rock phosphate gave the same yield as 100 Kg P_2O_5/ha in from of superphosphate. Moreover, Muleba and Coulibaly (1999) cowpea fertilization with natural rock phosphate Improved cowpea yield. Mona *et al.* (2008) reported that fertilization of okra with rock phosphate instead of P as chemical form resulted in the highest pods yield and increased pods nutritional values.

Table 8: Effect of rock phosphate rates on fruit yield and quality of sweet pepper, combined analysis of 2006 and 2007 seasons.

Rock phosphate rates (kg P_2O_5/fed)	Fruit yield				Fruit quality			
	Average fruit weight (gm)	No. Fruits /plant	Fruit yield (kg / plant)	Total yield (ton / fed.)	Flesh thickness (mm)	Fruit DW (%)	TSS %	Vit C (mg/ 100gm FW)
0	143.1	35.73	0.512	8.71	2.28	7.26	6.27	135.1
30	163.8	35.96	0.588	10.29	2.37	8.07	6.37	142.3
60	179.8	40.28	0.728	12.72	2.55	8.62	6.49	149.8
90	186.2	41.28	0.771	13.48	2.66	8.78	6.56	147.1
LSD 5%	15.12	0.95	0.037	0.343	0.054	0.184	0.197	8.24

2.4. Effect of the interaction among phosphorein, gypsum and rock phosphate rates.

Data in Table (9) show the effect of interaction among phosphorein, gypsum and rock phosphate rates on fruit yield and quality of sweet pepper. It is clear that the additions of gypsum at 4 ton/fed and phosphorein at 1 kg/fed with 60 or 90 kg P_2O_5 from rock phosphate had a significant effect on maximizing average fruit weight, number of fruits per plant, fruit yield per plant, total yield per feddan, fruit flesh thickness, fruit dry weight and fruit TSS. Meanwhile, vitamin C did not significantly affected by all used interaction treatments. The data showed also that the addition of gypsum at 4 ton/fed and phosphorein at 1 kg/fed with 60 kg P_2O_5 of rock phosphate increased sweet pepper fruit yield by 56.22 % above the control.

Table 9: Effect of interaction among gypsum, phosphoreine and rock phosphate rates on fruit yield and quality of sweet pepper, combined analysis of 2006 and 2007 seasons.

G**	Phos*	P_2O_5 (kg/ fed)	Fruit yield: Average fruit weight (gm)	Fruit yield: No. fruits / plant	Fruit yield: Fruit yield (kg / plant)	Fruit yield: Total yield (ton / fed.)	Fruit quality: Flesh thickness (mm)	Fruit quality: Fruit DW (%)	Fruit quality: TSS %	Fruit quality: Vit C (mg/ 100gm FW)
without gypsum	without Phos*	0	135.1	31.3	0.422	7.39	2.14	7.14	6.04	122.6
		30	155.2	36.2	0.561	9.83	2.29	7.98	6.24	128.9
		60	159.4	39.4	0.628	10.99	2.38	8.13	6.33	130.7
		90	164.4	40.5	0.665	11.65	2.51	8.47	6.41	134.1
	with Phos*	0	138.2	33.4	0.461	8.08	2.22	7.25	6.14	133.7
		30	159.2	35.8	0.569	9.95	2.32	8.07	6.31	139.4
		60	167.7	38.9	0.652	11.40	2.46	8.24	6.45	144.2
		90	174.6	41.4	0.722	12.64	2.59	8.38	6.53	142.6
2 ton/fed. gypsum	without Phos*	0	142.8	35.7	0.509	7.40	2.27	7.22	6.27	132.8
		30	157.4	37.0	0.582	10.18	2.29	8.04	6.34	137.4
		60	169.1	38.9	0.657	11.49	2.49	8.23	6.40	146.6
		90	171.5	39.4	0.675	11.81	2.61	8.31	6.44	138.0
	with Phos*	0	149.7	37.7	0.564	9.87	2.31	7.29	6.37	138.4
		30	163.4	36.4	0.594	10.41	2.40	8.11	6.39	144.7
		60	174.9	39.8	0.696	12.16	2.57	9.09	6.48	150.3
		90	188.4	41.2	0.776	13.57	2.69	9.01	6.51	153.8
4 ton/fed. gypsum	without Phos*	0	141.7	38.0	0.538	9.42	2.37	7.37	6.42	143.4
		30	169.4	35.7	0.604	10.58	2.42	8.01	6.49	150.4
		60	191.2	39.8	0.760	13.29	2.61	8.74	6.58	159.9
		90	198.4	41.4	0.821	14.35	2.74	8.82	6.64	157.1
	with Phos*	0	151.2	38.3	0.579	10.12	2.42	7.34	6.40	140.1
		30	178.2	34.7	0.618	10.82	2.54	8.21	6.47	153.2
		60	216.6	44.9	0.972	17.01	2.81	9.34	6.71	167.1
		90	220.4	43.8	0.965	16.88	2.84	9.71	6.87	157.2
LSD 5%			18.24	2.37	0.042	0.421	0.078	0.417	0.314	N.S

*** Phosphoreine Gypsum****

The results are in harmony with those of Hewedy (1999a) who found that number of fruits, average fruit weight, total yield, TSS, vitamin C and fruit dry weight significantly increased by inoculation of tomato transplants with phosphorein at 500 gm/*fed* + 75 % NPK comparing with 100% NPK alone. Mahmoud and Amara (2000) showed that addition of *Bacillus megatherium* + 50 % NPK increased tomato fruit yield, TSS and Vit.C in of tomato fruits. Similar results were reported by Abd El-Rahman *et al.* (2001) on tomato. Moreover, Kumar and Sharma (2004) found that using rock phosphate and phosphate solubilizing bacteria increased number of tomato fruits, yield per hectare, total soluble solids and ascorbic acid compared with rock phosphate alone. On the other hand, Menary and Hughes (1967) pointed out that when sulphate and phosphate were applied to the soil at the same time; the sulphate produced a significant increase in number of fruit per plant. Also, Xiangyun *et al.* (1996) pointed out that application of phosphorus and gypsum improves vegetables fruit quality.

In conclusion, this study demonstrated that it is possible to produce highest growth, yield and quality of pepper plants by applying rock phosphate at rate of 60 kg / P_2O_5 as a cheap phosphorus source; it will be necessary to add gypsum at 4 ton/feddan and treating pepper seedlings before transplanting with phosphorein at rate of 1 kg/ feddan.

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تأثير الجبس و الفوسفورين وصخر الفوسفات علي نمو و محصول نباتات الفلفل الحلو

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أجريت تجربتان حقليتان خلال الموسمين ٢٠٠٦ و ٢٠٠٧ بناحية طلخا- محافظه الدقهلية - مصر و ذلك لدراسة تأثير الجبس و الفوسفورين و صخر الفوسفات علي نمو و التركيب الكيماوي و محصول و صفات الجودة لنباتات الفلفل الحلو صنف كاليفورنيا وندر.

وكانت أهم النتائج ما يلي :

- أدي إضافة أربعه أطنان من الجبس الزرساعي و كيلو جرام من الفوسفورين (معامله قبل الشتل) للشتلات مع التسميد بصخر الفوسفات بمستوي ٦٠ أو ٩٠ كجم فو٢أ٥/فدان إلي الحصول علي أعلي زيادة معنوية للمادة الجافة للجذور و المجموع الخضري و كذلك الوزن الجاف الكلي للنبات بالإضافة إلي زيادة نسبه النيتروجين و الفوسفور و البوتاسيوم في المجموع الخضري و كذلك زيادة كميه النيتروجين و الفوسفور الممتصة بالمجموع الخضري لنباتات الفلفل.
- أدي إضافة أربعه أطنان من الجبس الزراعي و كيلو جرام من الفوسفورين مع التسميد بصخر الفوسفات بمستوي ٦٠ أو ٩٠ كجم فو٢أ٥/فدان إلي الحصول علي أفضل زيادة معنوية لكلا من متوسط وزن الثمرة و عدد الثمار للنبات و محصول الثمار للنبات و كذلك المحصول الكلي للفدان بالإضافة إلي سمك لحم الثمرة و وزن المادة الجافة للثمرة و محتوي الثمرة من المواد الصلبة الذائبة الكلية.
- أدي إضافة أربعه أطنان من الجبس الزراعي و كيلو جرام من الفوسفورين مع التسميد بصخر الفوسفات بمستوي ٦٠ كجم فو٢أ٥/فدان إلي زيادة محصول الثمار الكلي بنسبه ٥٦,٢٢ % بالمقارنة بمعامله المقارنة.

و عليه توصي الدراسة بتسميد نباتات الفلفل صنف كاليفورنيا وندر بصخر الفوسفات كمصدر رخيص لعنصر الفوسفور و ذلك بإضافة أربعه أطنان من الجبس الزراعي و كيلو جرام من الفوسفورين مع التسميد بصخر الفوسفات بمستوي ٦٠ كجم فو٢أ٥/فدان و ذلك للحصول علي أفضل نمو خضري و محصول و جوده لنباتات الفلفل.