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A COMPARATIVE STUDY FOR IMPACT OF LOW PHOSPHORUS FERTILIZATION IN DIFFERENT COMBINATIONS WITH SULPHUR, GYPSUM AND PHOSPHOREIN ON TOMATO GROWTH, MINERAL STATUS AND PRODUCTIVITY.

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ABSTRACT

Two field experiments were conducted at Kalabshow district, Dakahlia Governorate during two successive summer seasons of 2007 and 2008 to study the effect of phosphorus fertilizers,*i.e.*, super phosphate and rock phosphate in different combination with gypsum, sulphur and phosphorein on growth ,mineral composition and productivity of tomato cv. Super marmand . The experiment included fourteen treatments arranged in randomized complete block design. The treatments contained two sources of phosphorus (P) fertilizers [super phosphate (SP) and rock phosphate (RP) at 100% from recommended dose (RD),i.e,75KgP_2O_5] and different combination of SP or RP at low rate (65%),i.e,52.5 KgP_2O_5 of RD) with gypsum (G),sulphur (S)and phosphorein(Phn).

The main results were as follows:

1- Addition of super phosphate(SP) at 65 % of the recommended phosphorus rate(RD) with gypsum(G) and phosphorein(Phn) as soil amendment had a significant effect on number of leaves per plant, plant height , roots& shoots and total dry weights per plant as well as relative dry weight (%)during the two seasons.
2- Application of rock phosphate (RP) at 65 % of the recommended phosphorus rate RD) resulted in significant decrease of foliage concentration of N and P as well as the N, P ,K total uptake from N,P,K in both seasons.
3- The highest significant N and P concentration and N, P and K uptake were resulted from application of super phosphate (SP) at 65 %from RD in the presence of gypsum (G) and phosphorein (Phn) at both seasons.
4- Addition of the recommended phosphorus rate as super phosphate(SP) or applying (SP) at 65% from RD with gypsum and phosphorein showed the most superior effect regarding average fruit weight, number of fruits and fruit yield of tomato plant as well as total yield per feddan.
5- Application of super phosphate (SP) at 65 %with gypsum (G) and phosphorein (Phn) resulted in 6.45 % increment in the total yield comparing to the control treatment (average of the two seasons) .
6- Applying super phosphate (SP) at 65% from RD with gypsum (G) and phosphorein (Phn) showed the superior significant values for most fruit quality, *i.e.*, T.S.S %, Vit C and total carbohydrates content of tomato fruits.

In general, this study demonstrated that it is possible to produce highest growth, yield and quality of tomato plants by applying super phosphate at 65 % of the recommended phosphorus rate with 2.5 ton/feddan of gypsum and 1 kg/feddan of phosphorein. Moreover, the phosphatic fertilization can be reduced by 35 % of the recommended rate beside reduction of chemical pollution.

INTRODUCTION

Tomato is one of the most important vegetable crops in worldwide. Fertilization efficiency availability and the uptake of N, P and K elements and others macronutrients known to be high attributed with the soil conditions. Phosphorus is one of the major element for both growth and productivity,its shortage within plant tissue resulted in reduction in foliage and roots expansion (Fredeen *et al*., 1989),loss in photosynthetic efficiency (Lauer *et al*., 1989),reduction in nutrients uptake, decrease in bioassimilates transportation and the whole energy and metabolitic machinery (Marschner,1995), drastic depression in yield mass and quality (Lopez *et al.*, 1998). Phosphorus deficiency is widespread and phosphorus fertilizers are almost universally required to maintain crops production because when it is added (P_2O_5) to the alkaline soil only small part of phosphorus is utilized by plants and the rest is converted into insoluble fixed form (Rodriguez and Fraga, 1999).

To maximize phosphorus fertilizers efficiency and improve growth, mineral composition and productivity of tomato, it was suggested to apply calcium super phosphate or rock phosphate alone or in different combinations with sulfur products (mineral sulpher and / or gypsum) and phosphorus solubilizing bacteria(*Bacillus megatherium* var.phosphaticum) under the commercial name of phosphorein (Radwan,1983;Tuna *et al*.,2007andTuran *et al*., 2007).It was reported that mineral sulpher when incorporated into soil considerably increase solubility of phosphorus under alkaline soil condition (Rivera and Irgazarry, 1984) on pepper due to its acid reaction in soil and producing sulphoric acid (H_2SO_4) and consequently increased viability of phosphorus and other elements, *i.e.*, Cu, B, Fe, Zn and Mn (Topcuoglu and Yalcin, 1997) on tomato, Rahman and Hoque, 1994 on eggplant); improving growth and chlorophyll content (Topcuoglu and Yalcin,1997) on tomato, enhancing fruit yield and quality (Topcuoglu and Yalcin, 1997) on tomato.

On the other hand, incorporation of gypsum ($CaSO_4.2H_2O$) mixed with the soil tend to improve physical and chemical properties, reducing the value of pH, increased availability of N, P, K, Fe, Mn and Zn (Awad *et al*., 2002). In addition Tuna *et al*.,(2007) work on tomato plants they reported that applying different sulpher products in SO_4 form in combination with different phosphorus fertilizers decreased the rate of phosphate fixation, increased its solubility, enhanced uptake and use efficiency, improved growth and fruit productivity.

Many biological and microbial procedures suggested that it can be maximizing the efficiency and benefits of the applied phosphorus fertilizers by inoculation of soil or plant roots mainly with that known as phosphorus solubilizing bacteria.

Rock phosphate was particularly effective in acid soils, at alkaline soil the obtained yield under the case of using rock phosphate treatments was less by 20 to 40 % than using super phosphate (Mengel and Kirkby, 1978). Rock phosphate found to be more solubility, availability and uptake of phosphorus due to the applied phosphorus solubilizing bacteria (Radwan,

1983), it reduced the soil PH (Hewedy, 1999), improved growth foliage N, P and K content, fruit yield and quality of tomato (Hewedy, 1999; Bardisi and Atia, 2005) on tomato. Turan *et al*., (2007) use different P_2O_5 fertilizers, *i.e.* normal and triple supper phosphate, rock phosphate they found that phosphorus solubilizing bacteria decreased soil pH, increased availability and uptake of phosphorus from all phosphorus fertilizers, improved growth and dry mass of tomato plants. Moreover, Kamal (2008) demonstrated that application of gypsum at rate of four ton/feddan of 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 growth, yield and quality of pepper plants.

The effect of phosphorus solubilizing bacteria in solublization of phosphorus fertilizers is generally due to the production of organic acids (Sundara *et al*., 2002) on sugar cane and Turan *et al*., 2007 on tomato). Moreover, the microbial based mechanisms to improve the agronomic effectiveness of rock phosphate and phosphate fertilizers are well proved and reported by Arcanda and Schneider (2006) who reported that biological excretion of H^+ ions and organic acids (citric, gluconic and oxalic) by phosphorus solubilizing bacteria decreased soil pH, releasing Ca from rock phosphate and super phosphate.

The main purpose of this research is to study the effect of two sources of phosphorus fertilizers rates and their combinations with sulphur, gypsum and biofertilizer phosphorien on growth, mineral composition, and yield and fruit quality of tomato.

MATERIALS AND METHODS

Tow field experiments were conducted during the two successive summer seasons of 2007 and 2008 at Kalabshow area, Dakahlia governorate, Egypt.

On 1st March during the two seasons, tomato cv. super marmand seedlings were transplanted in the open field into one side ridge. Each experimental unit was 25 m^2 consisted of five ridges each of 5 m long and 1 m wide with 0.5 m planting space. Some physical and chemical properties of the experimental soil are presented in Table 1.

Table 1 .Some physical and chemical properties of the experimental of the soil during 2007 and 2008 seasons.

Parameters / Seasons	Texture%			OM %	EC (dSm^{-1})	PH	N ppm	P ppm	K ppm
	Sand	Silt	Clay						
1st season	52.10	24.15	21.80	1.05	1.82	7.9	15.30	4.17	98
2ndseasons	51.40	23.63	21.71	1.01	1.78	7.8	16.65	5.28	114

A complete randomized block design with three replicates was adopted. The experiment included 14 treatments as follows:

1- Super phosphate (15.5 % P_2O_5); 100% of recommended P rate (RD) (75 kg P_2O_5/ fed.) as a control treatment.

2 - Super phosphate 65 % of RD, i.e, 52.5 kg P_2O_5/ fed.
3- Super phosphate 65%of RD + phosphorein (Phn) 1kg /feddan.
4- Super phosphate 65% of RD + Sulphur (99.9% S) at rate of250 kg/ fed.
5- Super phosphate 65% of RD + gypsum (18.6% S) 2.5 ton/ fed.
6- Super phosphate 65% of RD + Sulphur 250 kg/ fed.
+ Phosphorein at 1 kg / fed.
7- Super phosphate 65% of RD + Gypsum at 2.5 ton / fed + Phosphorein at 1 kg / fed.
8- Rock phosphate 22 % P_2O_5; 100% of recommended P rate ,i.e,(RD) 75 kg P_2O_5/ fed.
9 - Rock phosphate 65 % of recommended P rate (52.5 kg P_2O_5/ feddan)
10- Rock phosphate 65% of RD + phosphorein (Phn.) at 1 kg / fed..
11- Rock phosphate 65% of RD + Sulphur (99.9% S) at rate 250kg /feddan.
12- Rock phosphate at rate of 65% + gypsum at rate (23% Ca and 18% S) 2.5 ton/ fed.
13- Rock phosphate at rate of 65% of RD + Sulphur (99.9% S) at rate 250kg /feddan.
+ Phosphorein at 1 kg / fed.
14- Rock phosphate 65% of RD + Gypsum at rate (23% Ca and 18% S) 2.5 ton/ fed. + Phosphorein at 1 kg / fed.

Super phosphate, rock phosphate, sulphur and gypsum 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. At transplanting tomato seedlings were treated with a suspension of 1 kg of phosphorein which dissolved in 4 liter of tap water and mixed with Arabic gum, as an adhesive substance. N , K fertilizer and the other practices were applied as recommended of Ministry of Agriculture.

The following data were recorded.

First: vegetative growth parameters

At 70days after transplanting five plants from each plot were randomly taken with their roots for determination growth parameters in terms plant height (cm), number of leaves, root, shoot and total dry weights(g). Also, dry weight (%) was calculated as percent of dry weight of each treatment relative to the control (100% of recommended phosphorus rate as super phosphate).

Second:chemical composition

Mineral composition was determined in terms of total uptake and concentration (%) of N, P and K in plant samples which taken from each plot at the same times of vegetative growth samples. Total nitrogen was determined according to the methods described by Bremner and Mulvaney (1982), phosphorus was estimated colormetrically according to Olsen and Sommers (1982) and potassium was also determined using flame photometrically method as described by Jackson (1973).Then their uptake calculated considering their concentration (%) and plant dry weight.

Third:fruit yield and its components

Fruit yield and its components were determined from the cumulative fruit harvesting (number and weight) of each plot, then number of fruits per plant, average fruit weight(g), fruit yield per plant and total yield (ton/fed.). Also, relative yield (%) was calculated as percent of total yield of each treatment relative to the control (100% of recommended P rate as super phosphate).

Fourth: fruit quality

Arepresentative sample of 5 fruits from each experimental plot at the marketable ripe stage were taken from the 4th harvest for determination of total soluble solids (TSS), vitamin C and titratable acidity according to the methods of A.O.A.C. (1990).

Total carbohydrates were estimated in fresh fruit weight according to method of Mitchal *et al*., (1956).

The obtained data were subjected to statistical analysis according to Gomez and Gomez (1984). The treatment means were compared using New Least Significant Difference at 5% level of probability as mentioned by Waller and Duncan (1969).

RESULTS AND DISCUSSION

First: Vegetative growth parameters

Data presented in Table 2 show the effect of different sources of phosphorus fertilizers, *i.e.*, super phosphate and rock phosphate that applied at 100% and 65 % of the recommended phosphorus rate and their combinations with mineral sulpher, gypsum and phosphorein on tomato growth parameters, *i.e.,* number of leaves, plant height, roots, shoots and total dry weight as well as the relative dry weight of tomato plant, during 2007 and 2008 seasons. It is evident clear from such data that the individual treatments and combinations of super phosphate fertilizer considerably enhanced all growth parameters of tomato plants than those of rock phosphate fertilizer in both seasons.

Application of either supper phosphate and / or rock phosphate alone at low phosphorus rate at (65% of the recommendation) resulted in considerable reduction in all growth parameters *i.e.* plant height, number of leaves/ plant, shoot and root dry weight of tomato. It is clear that the addition of super phosphate at 65% of the recommended rate with gypsum and phosphorein as soil amendment had a significant effect on number of leaves per plant, plant height, roots, shoots and total dry weights per plant as well as relative dry weight (%) in both seasons.

These results were in line with those obtained by Fredeen *et al*., (1989) on *Glycine max* plants; Topcuoglu and Yalcin ,(1997) on tomato; Awad *et al*., (2002) on potato, Tuna *et al*., (2007) on tomato and Kamal ,(2008) on pepper plants.

The growth enhancement due to application of phosphorus fertilizer with gypsum or mineral sulpher may be not only due to their reducible effect of the soil pH, render phosphorus and other elements to be in more soluble and available form for plant (Rivera and Lrgazarey, 1984) on pepper

,Topcuoglu and Yalcin, 1997 ; Turan *et al* ., 2007) on tomato but also due to supplementation of sulpher and calcium into tomato plants and in turn their structural and regulatory functions and involvements within plant tissues, *i.e.,* sulpher as methionine, cystein and protein components, also component of gluathion (antioxidant) and sulpholipids and enzymes functions (Dekok *et al*., 2002). As well as the role of calcium in membrane stability and selectivity, carbohydrates and protein biosynthesis, cell division and signal transduction response all in relation with growth and dry matter accumulation and partitioning (Marchener, 1995). On the other hand, presence of phosphorein with the low applied rate of phosphorus fertilizers which resulted in growth encouragements also could be attributed to its enhancing effect on phosphorus uptake and the concentration, N and K in plant tissue (Table 3), this is due to its biological solublization effect, releasing phosphorus from of the applied super phosphate and rock phosphate and the soil via the biological release of H^+ ions, organic acids chelating and in turn better growth response even with low phosphorus supply (Sundara *et al*., 2002 on sugar cane; Arcanda and Schneider, 2006 and Turan *et al*., 2007 on tomato).

Second : chemical composition

Data in Table 3 showed the impact of the applied phosphorus fertilization treatments on both concentration and total uptake of N, P and K of tomato plants. Such data reveled that, application of super phosphate at low phosphorus rate compared with the recommended rate only resulted in significant reduction in both concentrations and total uptake of N,P and K in the two seasons, whereas, application of rock phosphate alone at 100 % of the recommended phosphorus rate resulted in significant reduction concentration of N and P as well as significant resulted for N,P, and K total uptake in two seasons .

Also, it was observed that different combinations of super phosphate fertilizer tended to be more effective than rock phosphate combinations with improving mineral status of tomato plants particularly in minerals foliage concentration and total uptake. The same data showed also that application of gypsum or sulphur amendments and inoculation the seedling roots with phosphorein at different combinations with low rate of super phosphate was greatly improved and recovered mineral status of tomato plants, in this respect the highest significant N and P concentration and N, P and K uptake resulted from application of super phosphate at low rate phosphorus with gypsum and phosphorein, it was not only restored mineral status of tomato plants but also more superior on the mineral status of the plants that received the recommended phosphorus fertilizer (super phosphate at 100 % of recommended phosphorus rate). On the other hand, the applied phosphorus fertilizer in the form of super phosphate or rock phosphate at rates 100 and / or 65 % of the recommended rate of phosphorus and their combinations with sulphur, gypsum and phosphorein did not show significant effect on potassium concentration in tomato plant foliage in both seasons.

These results and interpretation were confirmed by those obtained by Topcuoglu and Yalcin,(1997) on tomato, Awad *et al*.,(2002) on potato; Sundara *et al.*,(2002) on sugar cane; Arcanda and Schneider,(2006) and Tuna *et al*.,(2007) on tomato and Kamal,(2008) on pepper plants.

T2-3

Under present works condition the effect of all treatments on N, P and K concentration in tomato plant tissue and total uptake of tomato plants could be attributed based on the known role of gypsum due to lowering the soil pH via the direct acidifying effect of SO_4 and indirectly due to Ca uptake that corresponded with realizing of H^+ ions, also, SO_4 known to be reduce the capacity of soil to fixing PO_4 ions (Awad *et al*., 2002) on potato;(Tuna *et al*.,2007) on tomato. Furthermore, mineral sulpher is biologically oxidized in soil with time into SO_4 and inturn reducing the soil pH, improving phosphorus fertilizers dissociation, soil and plant phosphorus status, also, uptake and concentration of N and K (Topcuoglu and Yalcin, 1997) on tomato; (Rahman and Hoque, 1994) on eggplant.

Third: fruit Yield and its components

Data presented in Table 4 illustrate the effect of the applied phosphorus fertilizer super phosphate and rock phosphate at rates of 100 and 65 % of the recommended rate phosphorus and their combinations with sulpher, gypsum and phosphorein on average fruit weight, number of fruits, fruit yield of tomato plant as well as total yield per feddan and relative yield (%), during 2007 and 2008 seasons. Such data indicated that, using the recommended phosphorus rate as super phosphate or applying supper phosphate at the low phosphorus rate (65%) of the recommendation with gypsum and phosphorein showed the most superior effect regarding average fruit weight, number of fruits, fruit yield of tomato plant as well as total yield per feddan, this was also true for rock phosphate combinations compared only with rock phosphate alone at 100 % of phosphorus during both seasons. Based on relative yield values, it was found that the most superior treatment was super phosphate at low rate with gypsum and phosphorein which the total yield increases by 6.45 % (average of the two seasons) followed by supper phosphate at 100 % of the recommended phosphorus rate.

The obtained results and the suggested interpretation were confirmed by finding obtained by Fredeen *et al.* (1989) on *Glycine max* plants; Marchener,(1995) ; Topcuoglu and Yalcin,(1997) ; Awad *et al.*, (2002) ;Tuna *et al.*,(2007); and Turan *et al.,* (2007) on tomato on super phosphate and rock phosphate; working on mineral sulpher; Hewedy (1999); Bardisi and Atia,(2005) and Turan *et al.*,(2007) working on phosphorus solubilizing bacteria.

The above mentioned cited interpretation and explanation due the application of low phosphorus rate, gypsum and phosphorein may be due to thier enhancing impact on root and foliage growth of tomato plants (Table 2), that associated with the potentiality of nutrient uptake (Table 3) and bioassimilation process of the whole metabolic machinery, those known to be reflected in similar beneficial way on fruit yield responses of tomato plants.

Fourth: Fruit quality

Data concerned in table 5 show the effect of applied phosphorus fertilizer in the form of super phosphate and rock phosphate at rates 100 % and 65 % of the recommended phosphorus rate and their combinations with sulphur at the rate of Sulphur (99.9% S) at rate of250 kg/ fed. gypsum at the rate(18.6% S) 2.5 ton/ fed. and phosphorein on tomato fruit quality.

T4-5

It was evident from such data that reducing rate of applied supper phosphate and / or rock phosphate to 65% of the recommended phosphorus rate resulted in significant reduction in all studied tomato fruit quality characters including TSS %,vit.C and total carbohydrate contents except those of fruits titratable acidity which showed no significant differences during the two seasons. The same data indicated that applications of 100% of the recommended phosphorus rate as supper phosphate or applying supper phosphate at low phosphorus rate at (65%) with gypsum and phosphorein showed the most significant values for most of fruit quality,*i.e.,* TSS %,vit C and total carbohydrates content of tomato fruits in two seasons.

Similar results were obtained by Topcuoglu and Yalcin, (1997) on tomato; Awad *et al.*,(2002) on potato; Bardisi and Atia,(2005) on tomato and Tuna *et al.*,(2007) on tomato.

Under this work condition, these results could be explained based on the previously observed beneficial effects of the same treatments in similar way on their plants growth and dry matter accumulation, contents of N, P and K in plant tissues (Tables 2 and 3). Also, fruits mass were greatly associated with dry matter and bioassimilates formation within foliage parts and their subsequent partitioning into reproductive sinks (Marchener, 1995).

Conclusion:

This investigation could suggest that application of superphosphate at 65 % of recommended rate / feddan and gypsum (18.6% S) 2.5 ton/ fed. with combination of inoculation tomato seedlings with the biofertilizers phosphrien indispensable for optimum tomato productivity and maximum yield .Moreover , the addition biofertilizers would decrease chemical pollution of environmental and the production costs.

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دراسة مقارنه لتأثير التسميد الفسفوري المنخفض في توليفات مختلفة مع الكبريت والجبس و الفوسفورين على النمو و الحالة المعدنية والإنتاجية للطماطم.

السعيد محمود السعيد

قسم بحوث الخضر – معهد بحوث البساتين – مركز البحوث الزراعية – مصر.

نفذت تجربتان حقليتان بمنطقه قلابشو، محافظة الدقهلية، خلال الموسمين الصيفين ٢٠٠٧ و ٢٠٠٨ لدراسة تأثير بعض الأسمدة الفوسفاتية (السوبرفوسفات و صخر الفوسفات) مضافه منفردة بالمستوى الموصي به (٧٥ كجم فو٢أه/ فدان) أو بمستوى منخفض ٦٥ % من الموصى به (٥٢,٥ فو٢أه/ فدان) و توليفات مختلفة للمستوى المنخفض مع الكبريت بمعدل ٢٥٠ كجم للفدان والجبس الزراعي بمعدل٢,٥طن للفدان و الفوسفورين بمعدل ١كجم للفدان و ذلك على النمو و التركيب المعدني و محصول و جودة الثمار لنباتات الطماطم صنف سوبر مارمند و ذلك بهدف تقليل المعدلات المستخدمة من الأسمدة الفوسفاتية الكيماوية و دراسة استخدام بدائل طبيعيه مثل صخر الفوسفات و الجبس الزراعي و الكبريت لتقليل التلوث و التكلفة.

و قد استخدمت ١٤ معامله في تصميم القطاعات العشوائية الكاملة وكانت أهم النتائج ما يلي:-

١-أدي إضافة سماد السوبر فوسفات بمعدل ٦٥% من المستوى الموصى به من الفوسفور مع الجبس الزراعي بمعدل ٢,٥ طن / فدان و الفوسفورين بمعدل كجم/ فدان إلي الحصول علي أعلي نمو خضري متمثلا في قياسات عدد الأوراق و إرتفاع النبات و الوزن الجاف للجذور و الأوراق و الوزن الجاف الكلى للنبات.

٢-أدي التسميد بصخر الفوسفات بمعدل ٦٥ % من الموصى به من الفوسفور إلي نقص في تركيز النيتروجين و الفوسفور بالأوراق و كذلك الامتصاص الكلى للنيتروجين و الفوسفور و البوتاسيوم.

٣-أدي إضافة السوبر فوسفات بمستوي٦٥ % من الموصى به مع الجبس و الفوسفورين إلي الحصول علي أعلي قيم لتركيز النيتروجين و الفوسفور بالأوراق و كذلك الامتصاص الكلى لهما بالإضافة لعنصر البوتاسيوم.

٤-أدي إضافة كلا من سماد السوبر فوسفات بالمستوي الموصى به من الفوسفور أو المستوي المنخفض ٦٥% مضافا إليه الجبس و الفوسفورين إلي الحصول علي أفضل نتائج فيما يخص محصول الثمار ومكوناته متمثله في وزن الثمرة و عدد الثمار و محصول النبات و كذلك المحصول الكلي للفدان.

٥-أدي إضافة السوبر فوسفات بمستوي٦٥ % من الموصى به مع الجبس و الفوسفورين إلي زيادة المحصول الكلي بنسبة ٦,٥ % بالمقارنة مع سماد السوبر فوسفات بالمستوي الموصى به.

٦-أدي إضافة الجبس و الفوسفورين مع السوبر فوسفات بمستوي٦٥ % من الموصى به إلي حدوث زيادات معنوية سفي المواد الصلبة الذائبة الكلية و فيتامين ج و الكربوهيدرات الكلية لثمار الطماطم.

و عليه توصي الدراسة بتسميد نباتات الطماطم صنف سوبر مارمند بإضافة سماد السوبر فوسفات بمستوي٦٥ % من الموصى به(٥٢,٥ كجم بو٢ ٥ه / فدان) مع إضافة ٢,٥ طن من الجبس الزراعي و كيلو جرام من الفوسفورين و ذلك للحصول علي أفضل نمو و تركيب معدني و محصول و جودة للثمار مع تقليل استخدام الاسمده الفوسفاتيه بمعدل ٣٥ % والتلوث البيئى.

Table 2: Effect of super phosphate, rock phosphate, sulphur, gypsum and phosphorein on vegetative growth of tomato during 2007 and 2008 seasons.

Characters / Treatments	Season 2007						Season 2008					
	No. leaves / plant	Plant height (cm)	Dry weight /plant (g)			Relative D .W. % I	No. leaves / plant	Plant height (cm)	Dry weight /plant (g)			Relative D .W. %
			Roots	shoots	Total				Roots	shoots	Total	
SP 100% of RD (control)	111.3	87.5	9.04	79.89	88.93	100	105.0	79.6	8.24	76.21	84.45	100
SP 65% of RD	93.1	78.6	6.41	64.21	70.62	79.4	86.1	72.4	5.94	61.28	67.22	79.5
SP 65% + Phn	96.7	84.2	7.02	70.10	77.12	86.7	91.4	75.7	6.45	66.12	72.57	85.9
SP 65% + S	100.3	83.9	7.34	75.21	82.55	92.8	95.7	77.2	7.45	77.08	84.53	100.1
SP 65% + S + Phn	108.5	82.6	8.04	81.28	89.32	100.4	102.4	74.2	7.94	79.24	87.18	103.2
SP 65% + G	115.5	85.6	8.03	80.27	88.3	99.2	107.1	78.8	7.91	81.07	88.98	105.3
SP 65% + G + Phn	123.1	90.7	9.34	88.45	97.79	109.9	113.2	83.4	9.27	91.24	100.51	119.0
RP 100% of RD	94.9	81.9	7.24	71.23	78.47	88.2	89.7	73.6	6.81	68.14	74.95	88.7
RP 65% of RD	85.8	74.1	4.76	50.82	55.58	62.4	79.3	69.2	4.98	45.81	50.79	60.1
RP 65% + Phn	88.7	76.6	6.07	58.24	64.31	72.3	83.9	72.4	6.11	55.14	61.25	72.5
RP 65% + S	86.3	78.0	6.28	61.37	67.65	76.1	81.6	71.9	6.25	58.19	64.44	76.3
RP 65% + S + Phn	95.5	80.3	6.91	67.12	74.03	83.2	91.2	74.9	6.71	61.57	68.28	80.8
RP 65% + G	93.5	82.0	7.55	69.07	76.62	86.2	88.4	76.4	7.41	65.48	72.89	86.3
RP 65% + G+ Phn	98.0	84.9	7.87	76.17	84.04	94.9	93.5	79.0	7.91	70.18	78.09	92.5
New L.S.D.(0.05)	7.21	5.01	0.87	6.61	8.04		8.13	4.76	0.95	8.87	11.04	

SP = Super phosphate RD = Recommended P rate Phn = Phosphorein S = Sulphur G = Gypsum RP = Rock phosphate

Table 3: Effect of super phosphate, rock phosphate, sulphur, gypsum and phosphorein on chemical composition of tomato during 2007and 2008 seasons.

Characters / Treatments	Season 2007						Season 2008					
	N (%)	P (%)	K (%)	Total uptake (mg/ plant)			N (%)	P (%)	K (%)	Total uptake (mg/plant)		
				N	P	K				N	P	K
SP 100% of RD (control)	3.22	0.37	4.11	2854	334.3	3663	3.04	0.34	3.95	2575	295.3	3340
SP 65% of RD	3.02	0.29	4.15	2125	207.6	2937	2.85	0.27	3.99	1922	183.7	2684
SP 65% + Phn	2.98	0.31	4.28	2305	240.6	3308	2.84	0.29	4.11	2061	210.5	2988
SP 65% + S	3.03	0.32	4.25	2509	265.8	3516	2.88	0.29	4.08	2441	253.1	3456
SP 65% + S + Phn	3.20	0.35	4.16	2867	304.1	3724	3.04	0.31	4.02	2658	276.4	3489
SP 65% + G	3.31	0.34	4.17	2922	305.5	3690	3.14	0.32	4.01	2797	286.3	3570
SP 65% + G + Phn	3.42	0.38	4.21	3334	371.6	4126	3.23	0.35	4.05	3256	355.2	4071
RP 100% of RD	2.96	0.28	4.06	2330	222.8	3193	2.82	0.26	3.91	2114	197.9	2928
RP 65% of RD	2.88	0.24	4.24	1606	138.3	2362	2.74	0.23	4.07	1394	117.6	2072
RP 65% + Phn	2.93	0.29	4.15	1871	189.0	2675	2.76	0.27	3.99	1693	167.4	2446
RP 65% + S	2.89	0.28	4.21	1961	202.9	2854	2.75	0.27	4.05	1775	179.7	2610
RP 65% + S + Phn	2.91	0.31	4.19	2154	230.2	3109	2.76	0.28	4.03	1887	197.4	2753
RP 65% + G	3.03	0.31	4.10	2306	241.3	3149	2.85	0.29	3.94	2084	213.5	2875
RP 65% + G+ Phn	3.11	0.33	4.23	2613	280.6	3563	2.95	0.31	4.06	2307	242.5	3178
New L.S.D.(0.05)	0.17	0.031	N.S.	324.1	25.6	398.4	0.18	0.033	N.S.	411.6	41.6	422.5

SP = Super phosphate RD = Recommended P rate Phn = Phosphorein S = Sulphur G = Gypsum RP = Rock phosphate

Table 4: Effect of super phosphate, rock phosphate, sulphur, gypsum and phosphorein on yield and its components of tomato during 2007 and 2008 seasons.

Characters / Treatments	Season 2007					Season 2008				
	Average fruit weight (g)	No. of fruits /plant	Yield/ plant (g)	Total yield (ton /*fed*)	Relative yield (%)	Average fruit weight (g)	No. of fruits /plant	Yield/ plant (g)	Total yield (ton /fed)	Relative yield (%)
SP 100% of RD (control)	75.68	29.90	2262	20.59	100	74.80	30.79	2303	20.96	100.0
SP 65% of RD	65.71	24.42	1604	14.76	71.6	62.50	24.49	1531	14.39	68.6
SP 65% + Phn	69.21	27.63	1912	17.40	84.5	65.28	26.20	1710	15.90	75.8
SP 65% + S	71.31	26.86	1915	18.58	90.2	67.59	28.07	1897	17.83	85.0
SP 65% + S + Phn	73.45	28.10	2063	19.40	94.2	69.25	28.75	1991	18.12	86.4
SP 65% + G	75.44	27.51	2075	19.09	92.7	70.84	27.18	1925	18.10	86.3
SP 65% + G + Phn	79.88	31.11	2485	22.61	109	77.82	31.09	2420	21.78	103.9
RP 100% of RD	64.28	22.67	1457	13.26	64.4	62.48	25.33	1582	14.24	67.9
RP 65% of RD	59.64	22.25	1326	12.47	60.5	57.00	23.82	1358	12.36	58.9
RP 65% + Phn	62.14	23.88	1484	14.24	69.1	61.18	24.11	1475	13.86	66.1
RP 65% + S	63.48	24.35	1545	14.68	71.2	62.74	24.89	1561	14.52	69.2
RP 65% + S + Phn	63.40	24.68	1565	14.71	71.4	61.81	23.93	1479	13.90	66.3
RP 65% + G	68.11	23.07	1571	14.14	68.6	64.51	24.06	1552	14.28	68.1
RP 65% + G + Phn	71.00	24.07	1709	15.89	77.1	68.25	24.71	1687	15.35	73.2
New L.S.D.(0.05)	6.21	3.24	228.9	2.15		5.87	2.15	301.9	2.41	

SP = Super phosphate RD = Recommended P rate Phn = Phosphorein S = Sulphur G = Gypsum RP = Rock phosphate

Table 5: Effect of super phosphate, rock phosphate, sulphur, gypsum and phosphorein on fruits quality of tomato during 2007 and 2008 seasons.

Characters / Treatments	Season 2007				Season 2008			
	TSS %	Vit C mg/100gm FW	Titratable acidity (mg/100 ml juice)	Total carbohydrates	TSS %	Vit C mg/ 100gm FW	Titratable acidity (mg/100 ml juice)	Total carbohydra-tes
SP 100% of RD (control)	5.64	62.4	0.70	87.24	5.51	58.4	0.89	78.66
SP 65% of RD	5.24	55.4	0.67	79.22	5.01	51.1	0.77	72.88
SP 65% + Phn	5.31	52.4	0.72	82.04	5.19	50.4	0.81	72.71
SP 65% + S	5.29	51.9	0.72	84.17	5.24	54.1	0.83	75.59
SP 65% + S + Phn	5.81	53.4	0.71	86.21	5.47	53.6	0.86	74.55
SP 65% + G	5.74	54.1	0.70	85.09	5.34	55.1	0.88	74.60
SP 65% + G + Phn	6.04	59.3	0.73	92.03	5.64	64.2	0.91	82.06
RP 100% of RD	5.24	53.4	0.62	82.36	5.04	50.4	0.68	75.53
RP 65% of RD	5.11	48.5	0.64	78.86	5.13	48.0	0.65	77.39
RP 65% + Phn	5.37	52.7	0.70	80.14	5.27	50.4	0.74	75.72
RP 65% + S	5.16	51.7	0.71	84.49	5.28	51.4	0.71	74.05
RP 65% + S + Phn	5.39	49.4	0.70	83.64	5.34	52.5	0.85	75.95
RP 65% + G	5.41	52.7	0.72	81.49	5.26	50.7	0.72	72.97
RP 65% + G+ Phn	5.50	51.4	0.71	80.41	5.14	54.8	0.84	74.65
New L.S.D.(0.05)	0.341	6.11	N.S.	5.57	0.187	7.94	N.S.	3.87

SP = Super phosphate RD = Recommended P rate Phn = Phosphorein S = Sulphur G = Gypsum RP = Rock phosphate