Australian Journal of Basic and Applied Sciences, 2(3): 447-457, 2008
ISSN 1991-8178

# Response of Lettuce Followed by Sorghum to Application of Different Types of Phosphorus, Compost and Sulfur

[1]Hanan S. Siam, [1]M.R. Abd El-moez and [2]S.M. El-ashry

[1]Department of Plant Nutrition, National Research Centre, Cairo, Egypt.
[2]Department of Soils & Water Use, National Research Centre, Cairo, Egypt.

**Abstract:** A green house experiment was conducted at the National Research Centre, Cairo, Egypt. The experiment was designed to study the effect of different types of phosphorus, sulfur and application rate of compost on productivity of lettuce followed by sorghum plants. Data revealed that phosphate fertilizers positively affected the fresh and dry weight of lettuce and sorghum plants grown in calcareous soil. The response was depending on the type of P-Fertilizer, application rate of organic matter and Sulfur. The results indicated that the highest values for dry weight of roots and leaves and N, P and K uptake by lettuce plant were obtained when O.M was applied at higher rate with different sources of P especially superphosphate, while the lowest values of plant growth and nutrients uptake were found with rock phosphate alone. Furthermore, data representing the growth and uptake of N, P and k by the three cuts of sorghum plant as affected by different application types of P, rate of O.M and Sulfur fertilizer showed that positive responses in comparison with sources of P alone. These results indicated that the highest values for dry weight in all cuts of sorghum plant and N, P and K uptake were obtained when rock phosphate was applied at higher rates with O.M application. Meanwhile, the lowest values of plant growth, N, P and k uptake of the three cuts were found with superphosphate (SSP). Data representing the fresh and dry weight, N, P and K uptake of sorghum plants increased gradually at the first and second cuts which decreased in the third cut.

**Key words:** Superphosphate, residual effect, rock phosphate, triple phosphate, compost, sulfur, lettuce, sorghum, yield, nutrients uptake

## INTRODUCTION

Lettuce (*lactuca stiva* L.) is one of the most important leafy vegetables of high nutritional value (vitamin A, $B_1$, $B_2$ and C), as well as calcium and iron. Phosphorus, like nitrogen, is extremely important as a structural part of many compounds, notable nucleic acids, phospholipids, coenzymes NAD and NADP, ATP and other high energy compounds. It plays a fundamental role in a very large number of enzyme reactions that depend on phosphor-relation. It is also a constituent of the cell nucleus and is essential for cell division and the development of meristematic tissues, moreover, phosphorus is a ubiquitous and essential element in the energy transfer processes; It is needed in the formation of fat, in transformation of starch to sugar, in fruiting and flowering and in fact is very phase of the plant vital process. Single super phosphate has been most widely used as P fertilizer for agricultural purposes in Egypt. It contains around 15.5% $P_2O_5$, 11-9% sulphur and 20.4% calcium. Lana *et al.* (2004) stated that P is an important element for lettuce development that significantly responded to different P sources.

In the newly reclaimed land areas, where calcareous soils have very low levels of natural available phosphorus, therefore, P-fertilizer applications are essential for the establishment and maintenance of most crops and host cultural plants, Gouda *et al.* (1990) stated that increasing P levels Triple super phosphate per feddan in study soil causes a highly significant increase in groundnut pod yield and yield components. The response of plants to the concentration of phosphate in the root environment has important implications in both soil chemistry and plant physiology. Phosphorus fertilizer can be classified in three main groups or water soluble phosphate fertilizers such as single super phosphate (SSP) with phosphorus content 16% as phosphorus pentoxide ($P_2O_5$). Triple super phosphate with 48% $P_2O_5$ (TSP) and rock phosphate with 38% ($P_2O_5$) treated with $H_2SO_4$. Supplying vegetable crops with organic and inorganic fertilizers was proved to be very essential for the production of higher yield and for improving its quality (Mengal and Kerkby 1987, Edmoned *et al.*,

**Corresponding Author:** Hanan S. Siam, Department of Plant Nutrition, National Research Centre, Cairo, Egypt.

1981 and Borin *et al*., 1987). Sarkadi (1995) stated that the efficiencies of FYM and super phosphate were in increasing P content in plant. Mehala and Shaktawat (2004) reported that the effect of sources of P such as (SSP, RP and rates of FYM (FYM; 0 and 10 Ton/ ha) on the yield and nutrients uptake by maize plant, grain yield, N and P uptake increased with increasing rates of P and FYM. Among the sources used, SSP gave the highest values of the parameters measured. Further more Miche *et al*. (2003) stated that effects of green manures on biomass and P utilization of a succeeding grain sorghum, and also Vanlauwe *et al*. (2000) reported that adding plant residues to soil can increase soil test P. Mohammad *et al*. (2004) reported that results showed that application of SSP increased the fresh and dry weight by lettuce over control treatments as affected by sewage sludge application to calcareous soils. Sulfur as an element essential for plant growth ranks in importance with N and P in the formation of plant protein (Sarkar *et al*., (1994). Among other nutrients, sulfur (S) is essential constituent of S containing amino acids promoted the bio synthesis of protein and being associated with N- metabolism, improved growth, yield and its qualities status corps, as well availability of soil nutrients as influenced by S- application have been reported. Parasuraman (2005) reported that nutrients (N, P and K) uptake and dry matter production affected by residual soil fertility.

Organic fertilization with cotton compost is a practice for providing plants with their nutritional requirements without having as undesirable impact on the environment. In the newly reclaimed land areas, where calcareous soils prevail, it would help not only improving physical characters of the soil, but also sustain and increases soil fertility such agricultural practices are of special interest specially in virgin unpolluted like deserts, it would preserve the environment as cleans as possible and ensure edible products with no hazards or bad residual effect on human health. With regard to the effect of O.M compost on plant growth and yield. Also, application of N, P, and K fertilizers and manure is an important strategy to maintain or increase soil organic C and N, improve soil fertility, maintain nutrients balance, and minimize damage to the environment, while also improve crop yield (Sheng Mao yang *et al*., 2007).

## MATERIALS AND METHODS

Green house experiment was carried out in the National Research Centre and designed as complete randomized block with three replicates. Each pot containing 10 kg of air-dried soil, chemical properties of the soil surface layer (0-30 cm) and analysis of compost are shown in Tables 1 and 2. The soil texture was sandy loam contain 9.1% clay, 18.92% silt and 71.98% sand and $CaCo_3$ content was 22.3%. Three different types of phosphate fertilizers were used namely, single super phosphate (SSP), triple super phosphate (TSP) and rock phosphate (RP) at the rate of 250 kg/Fed. were applied either alone or in combination with cotton compost or sulfur fertilizer during soil preparation before sowing the lettuce plant. The control treatment received ammonium nitrate, superphosphate and potassium sulfate at the rates of 33.5, 23 and 24kg N, $P_2O_5$ and $K_2O$ per/fed. respectively. Sulfur was applied at the rate of 300 kg S/fed. and cotton compost was applied at the rates of (20 or 30 ton/fed). Two successive experiments were conducted during the winter and summer seasons in the green house. Lettuce seedlings of 40 days old were selected and transplanted. After harvesting, samples from the tested treatments were taken for recording fresh weight (g/pot). Separated parts of both crops were washed with distilled water before drying then oven-dried at 70 °C and dry weight was recorded. The dry samples were ground and prepared for analysis. Nitrogen, P and K were determined according to the methods described by Cottenie *et al*. (1982) and Black (1982).

**Table 1:** Some chemical properties of the cotton compost.

| Cotton compost | pH | C/N | N % | P % | K % | Fe ppm | Mn ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|
| | 7.17 | 20.2 | | | | | | |
| | | | 1.62 | 0.89 | 1.85 | 106 | 178.6 | 161 |

**Table 2:** Some chemical properties of the experimental soil.

| soil depth (cm) | soil pH (1:2.5) | E.C (dS/m) | C.E.C.meq/100g soil | Available macronutrients (ppm) | | | O.M (%) | $CaCO_3$ (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | N | P | K | | |
| 0-30 | 8.1 | 1.4 | 8 | 32.2 | 2.1 | 75.22 | 0.6 | 22.3 |

| soluble cation (meq/L) | | | | soluble anion (meq/L) | | | |
|---|---|---|---|---|---|---|---|
| $Ca^{++}$ | $Mg^{++}$ | $Na^{++}$ | $K^{++}$ | $CO_3^-$ | $HCO_3^-$ | $Cl^-$ | $SO_4^-$ |
| 7.5 | 1.5 | 4.2 | 0.44 | 0.38 | 0.76 | 4.8 | 7.7 |

The same previous procedures were used with sorghum (*Sorghum Sudanese* L.) after lettuce. Seeds (0.5 g/pot) were sowing and three cuts were taken after 45, 90 and 135 days from sowing on 1 cm above the soil surface and the fresh or the dry weight of plant samples from all replicates were recorded. After each cut plant samples collected and prepared for analysis.

Data were subjected to statistical and analysis of variance according to Snedecor and Cocharn (1980). Treatment means were compared using the lest significant difference (L.S.D) at 0.05% level.

## RESULTS AND DISCUSSION

***Lettuce Plant:***

***Fresh and Dry Weight:***

The effect of Phosphorus source on the fresh and dry weight of lettuce plants are presented in Table (3) and Figs. (1) and (2). Data show that the addition of single super phosphate (SSP) had significantly increased the fresh weight of leaves and roots of lettuce plants which amounted to 12%, 21.5 % and 31, 3%, 62.8% as compared to triple or rock phosphate respectively, this may attribute to the important role of P form super phosphate involved rapidly and absorbed by soil constituents within days of its application to the soil,(Mehala *et al.,* 2004) these results confirmed by Mengel and Kirkby (1987). Who stated that the important role of P on the roots growth and proliferation of plants which increases nutrients uptake and also to role in plant metabolism, which increased nutrients absorption leading to an increase in dry weights.

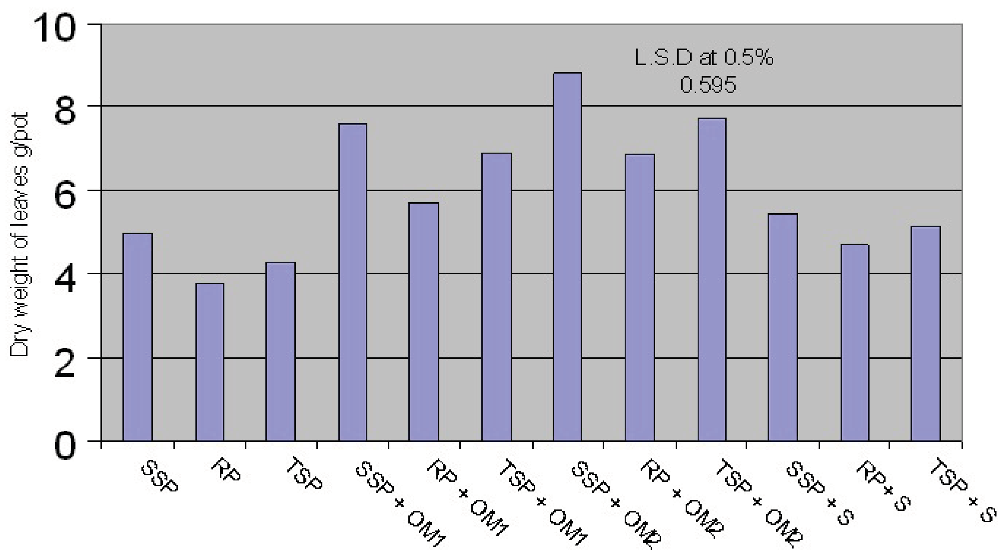


**Fig. 1:** Dry weight of leaves (g/pot lettuce plants) as affected by application of different types of phosphorus, organic compost and sulphur.

Among P sources used, SSP gave the highest values of the measured parameters. This form of sorbed P is more readily to soil solution and hence to plant than from RP which will be partly present as P sorbed onto soil constituents and partly residual (Abdel-Hamid *et al*., 2003). Furthermore, data also show that the addition of triple super phosphate increased significantly fresh weight of leaves and roots amounted to (8%, 24%) compared with rock phosphate respectively. Hedley *et al*. (1994) confirm these results and could be explained by the beneficial effect of the DAP and (TSP) used and increases the solubility of DAP and TSP by the action of acid generated through nitrification of the ammonium ions. In this concern the rock phosphate may be to slowly release and residual value accumulate in the soil.

The contribution of these residues to P status is most detected by alkaline soil P tests and also RP dissolution is influenced by climatic and other factors, as well as soil properties.

Generally, the values of fresh and dry weight of lettuce plants as well as the root and leaves recorded in Table (3) and Figs. (1) and (2). The highest values were noticed when lettuce plants received SSP while the lowest values were recorded when rock phosphate fertilizers were used.

Data show that, addition of O.M at a rate of 20 or 30 ton/fed. with the different types of phosphorus significantly increased fresh and dry weight of root and leaves for lettuce plants compared with control

**Table 3:** Leaves and roots fresh weight (g/pot) of lettuce plants as affected by application of different types of phosphorus, organic compost and sulphur.

| Treatments | Fresh weight of leaves (g/pot) | Fresh weight of roots (g/pot) |
|---|---|---|
| SSP | 79 | 4.07 |
| RP | 65 | 2.50 |
| TSP | 70 | 3.10 |
| SSP + Compost1 | 170 | 8.98 |
| RP + OM1 | 121 | 5.03 |
| TSP + OM1 | 157 | 6.82 |
| SSP + OM2 | 201 | 9.60 |
| RP + OM2 | 143 | 6.50 |
| TSP + OM2 | 185 | 7.48 |
| SSP + S | 111 | 5.50 |
| RP+ S | 81 | 3.50 |
| TSP + S | 99 | 4.80 |
| L.S. D at 0.05% | 9.87 | 1.24 |

SSP: Single superphosphate, O.M1 = 20 Ton/fed.
RP : Rock phosphate, O.M2 = 30 Ton/fed.
TSP: Triple superphosphate, S = 300 kg S

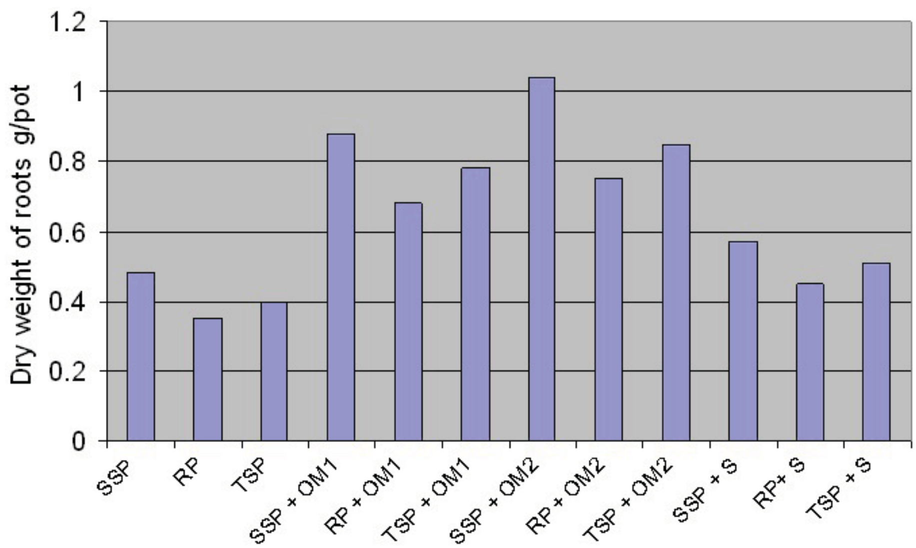


**Fig. 2:** Dry weight of roots (g/pot lettuce plants) as affected by application of different types of phosphorus, organic compost and sulphur.

treatments. Furthermore, Data show that the fresh and dry weight of lettuce plants significantly increased with increasing rate of organic matter. These results attributed to the favorable effect on the nutrients availability may be due to one or more of the followings: a) improving effect of O.M on physical and chemical soil properties and its content of the availability nutrients (Mengel and Kirkby, 1987) and/or also may be O.M is the component of mineral soils that makes it creditable for successful growth of most plants. It improves the water holding capacity, cation exchange capacity and stabilizes the structure of soil (Abou Seeda *et al*., 1997). Simultaneously, soil biological processes and increased the transfer elements between the solid phase and soil solution and by the higher microbial activity. They also reported that organic soil management improved the soil structure by increasing soil activity. This action improves the growing conditions for plants and may be due to organic additives that produce organic acids during the course of decomposition which increased the availability of phosphorus in soil and compost P was more efficient than super phosphate fertilizers alone because compost P hold lower initial availability and became plant available slowly. Time release of soluble P as mineralize would result in continuing supply of soluble P. Whereas P added the start of the growing seasons would likely absorbed to the soil particles with time Tester *et al*. (1982) also suggested that phosphorus compost was released more slowly than super phosphate and microbial activity was thought to be important mechanism in this slow P release and these studies suggest composting may be increases P solubility by generation of organic acids or humic substrates that compete with P adsorption sites, resulting in higher concentrations of P in soils amended with composts P.

It was noticed also that the addition of form P as triple phosphate fertilizer with O.M at 20 ton/fed. increased significantly root and leaves on the fresh weight plants at (35.6% and 29.7%) respectively than which received rock phosphate fertilizer these results are in confirmation with those obtained by (Lana *et al*., 2004) and this may be due to the superiority of TSP than rock phosphate that TSP adjusting soil acidity and enhanced the accumulated level of P in leaves. When triple superphosphate added increased production of root dry mass because TSP enhanced the utilization of N, P and K uptake through improving nutrients supply. On the other hand, rock phosphate has two different characteristics of regions of dissolution.

In the same Table, addition of high rate of organic matter (30 ton/fed.) with different sources of P increased significantly fresh and dry weight by plant than the other treatment and resulted in the highest mineralization rate due to great microbial activity. Also, it may be due to the beneficial effect of high rate of compost applied to plant than that for mineral fertilizers through previous mechanism leading to a reduction in soil pH values and consequently increasing macro- and micro-nutrients. In this concern, addition of 30 ton O.M with superphosphate increased significantly fresh weights of roots and leaves of lettuce amount to (28.3% and 48% for roots and 9 and 40.6% for leaves) compared to triple or rock phosphate treatments respectively. These increases may be due to increased supply of slowly released inorganic nutrients. Since the total P in the soil depend on soil organic matter. The break down of the OM ensures a steady release of P at a time when the established crop can use it prevention of phosphate fixation by iron and aluminum oxides.

Furthermore, rock phosphate dissolved slowly released to soil solution and partly as residual RP (Khasawneh and Doll, 1978).

Generally, it could be concluded that decomposition of O.M not only increased the microbial population but also enriched the soil by releasing available plant nutrients due to their activities and compost increase soil phosphate activity due to the stimulation of the microbial activity to the soil.

Data show application that 300 kg S with any type of P increased all parts lettuce plants significantly in comparison with the control treatment. Application of 300 kg S with the superphosphate increased fresh weight of leaves and roots by amounted to (40.5 and 35.1%) respectively compared to control treatment followed by triple superphosphate+300 kg S 41.4 and 55% and rock phosphate+300 kg S amounted to (24.6 and 40%) respectively compared to control treatment. These results attributed to sulphur with super phosphate might have increased efficiency of nutrients utilization, besides acting as the source of adequate amount of sulphate S for optimum plant growth and noticed S reduction soil pH, so increased nutrients availability and improved efficiency of macronutrients uptake by lettuce plants. The obtained results are in agreement with the findings of Puri (1984).

***Nutrient Content and its Uptake:***

Data of macro nutrients content and uptake are given in Table (4), the results show a similar trend to those of the dry and fresh weight of roots and leaves of lettuce plants in all the studied treatments.

In this study, data in Table (4) show that N, P and K concentrations and their uptake (mg/pot) of lettuce plants grown in calcareous soil resulted from super phosphate treatment was higher than all the other types of phosphorus fertilizers. This may be due to the effect of the phosphate fertilizers on plant growth and its absorption of nutrients. The superiority effect of SSP may be attributed to its rapid solubility or which was more than that triple or rock phosphate fertilizers. However values of uptake of all the tested nutrients were still much higher than that of the other treatments.

**Table 4:** Macronutrients (N, P and K) concentration(%) and uptake (mg/pot) by leaves lettuce plants affected by different types of phousphorus, organic compost and sulphur.

| Treatments | N | P | K | N uptake | P uptake | K uptake |
|---|---|---|---|---|---|---|
| | | leaves | | | leaves | |
| | % | % | % | mg/pot | mg/pot | mg/pot |
| SSP | 1.76 | 0.23 | 1.3 | 88.00 | 22.00 | 150 |
| RP | 1.40 | 0.17 | 0.85 | 53.20 | 14.06 | 95 |
| TRP | 1.61 | 0.19 | 1.00 | 69.23 | 17.63 | 120 |
| SSP + $OM_1$ | 2.85 | 0.35 | 2.4 | 216.60 | 51.68 | 327 |
| RP + $OM_1$ | 2.22 | 0.27 | 1.8 | 126.50 | 31.35 | 217 |
| TSP + $OM_1$ | 2.54 | 0.31 | 2.1 | 176.70 | 42.09 | 276 |
| SSP + $OM_2$ | 3.30 | 0.40 | 3.1 | 290.40 | 80.96 | 458 |
| RP + $OM_2$ | 2.78 | 0.32 | 2.2 | 190.40 | 52.06 | 2.88 |
| TSP + $OM_2$ | 3.05 | 0.36 | 2.8 | 263.40 | 64.33 | 372 |
| SSP + S | 1.90 | 0.24 | 1.6 | 103.60 | 28.34 | 185 |
| RP+ S | 1.50 | 0.20 | 1.00 | 70.50 | 19.27 | 132 |
| TSP + S | 1.75 | 0.22 | 1.4 | 90.10 | 25.24 | 160 |
| L.S.D at 0.05% | 0.066 | 0.023 | 0.26 | 15.32 | 3.45 | 11.32 |

SSP: Single super phosphate, O.M1 = 20 Ton/fed.
RP : Rock phosphate, O.M2 = 30 Ton/fed.
TSP: Triple super phosphate, S= 300 kg S

**Table 5:** Macronutrients (N, P and K) concentration % and uptake (mg/pot) by roots lettuce plants as affected by application different sources of phousphorus, organic compost and sulphur.

| Treatments | N | P | K | N uptake | P uptake | K uptake |
|---|---|---|---|---|---|---|
| | | roots | | | roots | |
| | % | % | % | mg/pot | mg/pot | mg/pot |
| SSP | 0.84 | 0.23 | 1.30 | 4.03 | 1.10 | 6.24 |
| RP | 0.56 | 0.17 | 1.85 | 1.96 | 0.59 | 2.98 |
| TSP | 0.72 | 0.19 | 1.00 | 2.88 | 0.76 | 4.00 |
| SSP + $OM_1$ | 1.40 | 0.35 | 2.40 | 12.32 | 3.08 | 21.12 |
| RP + $OM_1$ | 0.98 | 0.27 | 1.80 | 6.66 | 1.84 | 12.24 |
| TSP + $OM_1$ | 1.20 | 0.31 | 2.10 | 9.24 | 2.39 | 14.28 |
| SSP + $OM_2$ | 1.80 | 0.40 | 3.10 | 18.72 | 5.60 | 32.24 |
| RP + $OM_2$ | 1.35 | 0.32 | 2.20 | 10.13 | 2.40 | 16.50 |
| TSP + $OM_2$ | 1.58 | 0.36 | 2.80 | 13.43 | 3.06 | 23.80 |
| SSP + S | 0.91 | 0.24 | 1.60 | 5.19 | 1.37 | 9.12 |
| RP+ S | 0.78 | 0.20 | 1.00 | 3.51 | 0.90 | 4.50 |
| TSP + S | 0.85 | 0.22 | 1.40 | 4.34 | 1.12 | 7.14 |
| L.S. D at 0.05% | 0.069 | 0.024 | 0.130 | 1.043 | 0.515 | 2.301 |

SSP: Single super phosphate, O.M1= 20 Ton/fed.
RP : Rock phosphate, O.M2= 30 Ton/fed.
TSP: Triple super phosphate, S= 300 kg

The favorable effect of phosphorus fertilization on nutrients uptake by plants may due to the direct effect of this essential element in increasing photosynthesis activity and subsequently chemical content such as N, P and K (El-Ashmoony, 1991). Also, this increase of N, P and K in leaves could be attributed to the increase of the absorption efficiency of the roots by P. These results coincided with those of Arich (1993) and Dawa *et al*. (2003) on pea. The variation efficiency of P utilization by plants supplied as different P fertilizers. The addition of TSP enhanced the utilized of N, P and K uptake through formation of phosphorus sources.

On the other hand, rock phosphate application depends on its rate of dissolution at the site of use and RP residues should be restricted to site, where the RP is known to dissolve at a reasonable rate. It is taken from sites with known high and low. It can not supply adequate amounts of P to meet the external P requirements for maximum growth.

Data in the same Table show that the highest values of concentrations and uptake (mg/pot) of N, P and K by lettuce plants was noticed that added of O.M. The addition of O.M increased the uptake of N, P and K by lettuce plants due to the beneficial effect of O.M for improving the nutritional status particularly macronutrients. The uptake of N, P and K increased with increasing rate of O.M. This may be due to the favorable effect of the OM on the nutrients availability and this may be to one or more of the followings: a) release of nutrients through decomposition of O.M, b) effect of organic compost on lowering nutrients fixation through several mechanisms such as relatively available for plants, c) production of humates which cause exchange for absorbed anions such as phosphates which should available and d) prevention of phosphate fixation by iron and Aluminum oxides (Bationo and akwunye, 1991). Furthermore, the highest values in this study recorded when addition of high rate of organic compost at 30 ton O.M/fed. in increasing N, P and K uptake by lettuce plants compared by any other treatments. This may be due that addition of compost decreased soil pH and increased soil P. Data show that the addition of organic matter either with 20 or 30 ton/fed. with phosphate fertilizers increase of significantly of N, P and K concentrations and uptake compared with the controls without addition treatments. The superiority effect of SSP may be attributed to its solubility, which was more than that of triple or rock phosphate.

Moreover application of O.M with super phosphate recorded the highest values of N, P and K uptake (mg/pot) by lettuce plant in roots and leaves when application of 20 ton /fed. O.M amounted to (1.4, 0.35 and 2.4% in roots and 2.85, 0.35 and 2.4% in leaves, respectively). While the lowest values at when application of 20 ton OM with rock phosphate in the roots and leaves by latuce plant (0.98, 0.27 and 1.8% in roots and 2.22, 0.27 and 1.8% in leaves respectively). This trend resulted from role of O.M and its humic acids production in promoting the uptake of N, P and K (Nour el-Dein, 1996).

Compost P was more efficient than sources of phosphorus alone because compost P had lower initial availability and became plant available slowly, time release of soluble as composts mineralize would result in a continuing supply of soluble P. Whereas fertilizer P added the start of the growing seasons would likely be adsorbed to soil particles with time (Tester *et al.,* 1982).

Generally, the highest values in this study recorded when addition of high rate of organic compost at 30 ton O.M/fed. in increasing N, P and K uptake by lettuce plants compared by any other treatments.

This increasing may be due to the promoting effects of compost on soil biochemical activities and changing in partial water availability. Increasing availability of macro and micronutrients stimulation of microbial activity, augmentation of critical enzymes activities or production of plant growth promoting materials (Tayler *et al.*, 1993). In the same Table: data show that application of 300 kg to different sources of P fertilizer increased significantly N,P and K concentration and uptake by lettuce plant and the same trend was found. This may be due to increasing the availability of nutrients and utilization of plants of macro and micro-nutrients. Moreover, decreased of pH soil resulting application of S, so decrease their susceptibility to adsorption fixation or precipitation reaction in the soil.

***Residual Effect (RE) of Applied Different Fertilizers:***
***Sorghum Plant:***

Sorghum (*sorghum bicolor* L.) is one of the important cereal crops in upper Egypt in summer season. Therefore, many studies were conducted to increase its yield and improved its quality; therefore, prepare fertilization and good management as well as releasing new high varieties. The present investigation was carried out to study the phosphorus release pattern. The addition of organic materials either in form of manures or crop residues had beneficial effects on soil's chemical and physical properties. The amounts of nutrients in crops and crop residue are often several orders of magnitude higher than the quantity of the some nutrients applied as fertilizer.

Fresh and dry weight of sorghum (gm/pot) grown after lettuce as influenced by the above mentioned treatments are shown in Table (6) and Fig. (3).

**Table 6:** Fresh weight (g/pot) of sorghum plants as effected by application different types of phosphorus, organic compost and sulphur fertilizer.

| Treatments | Fresh weight g/Pot | | | |
|---|---|---|---|---|
| | Cut I | Cut II | Cut III | Mean |
| RP | 25.00 | 32.81 | 21.00 | 26.27 |
| SSP | 20.00 | 22.30 | 16.00 | 19.43 |
| TSP | 23.00 | 27.20 | 18.50 | 22.90 |
| RP+ $OM_1$ | 38.00 | 52.60 | 35.00 | 41.87 |
| SPP + $OM_1$ | 29.00 | 38.75 | 25.00 | 30.92 |
| TSP + $OM_1$ | 33.00 | 45.85 | 29.00 | 35.95 |
| RP+ $OM_2$ | 45.00 | 58.80 | 40.00 | 47.93 |
| SPP + $OM_2$ | 38.00 | 43.78 | 36.00 | 39.26 |
| TSP + $OM_2$ | 41.00 | 51.90 | 39.00 | 43.97 |
| RP+ S | 27.90 | 36.75 | 23.75 | 29.47 |
| SPP + S | 23.50 | 27.75 | 18.35 | 23.20 |
| TSP + S | 25.70 | 32.15 | 21.25 | 26.37 |
| L.S. D at 0.05% | 2.16 | 3.20 | 2.051 | |

SSP: Single super phosphate, O.M1 = 20 Ton/fed.
RP : Rock phosphate, O.M2= 30 Ton/fed.
TSP: Triple super phosphate, S= 300 kg S

The positive balance was more pronounced with rock phosphate than SSP and TSP fertilizers. This suggests that residues of rock phosphate were more effective than TSP and SSP on the sorghum plants values the mean for the three cuts were 26.27, 22.9 and 19.43 gm/pot for RP, TSP and SSP respectively. Furthermore, the residual effectiveness of rock phosphate depends mainly on crop type. For example, clover, silver grass, barley, sorghum, and corn gave their maximum growth. (Abd El-Hamid *et al.*, 2003).

This may be due to that Triple phosphate was more efficient than SSP because triple phosphate had lower availability and became plant available slowly. Furthermore, time release of soluble P as triple phosphate mineralize would result in a continuing supply slowly of soluble. Perhaps all TSP is exposed to soil adsorption after application. While, fertilizer P as super phosphate added at the start of the growing season would likely be absorbed to soil particles with time and it dissolved rapidly.

The addition of organic compost at a rate (20 and 30 ton/fed.) increased by significant by the fresh and dry weight of sorghum plants. The mean values of the three cuts were 41.87, 35.95 and 30.92 gm/pot at 20 ton/fed. and 47.93, 43.97 and 39.26 gm/pot at 30 ton/fed. compared to 26.27, 22.9 and 19.43 gm/pot in controls of RP, TSP and SSP respectively.

The addition of organic compost at a rate (20 and 30 ton/fed.) with rock phosphate increased significantly of fresh and dry weights than the other sources of P with O.M.

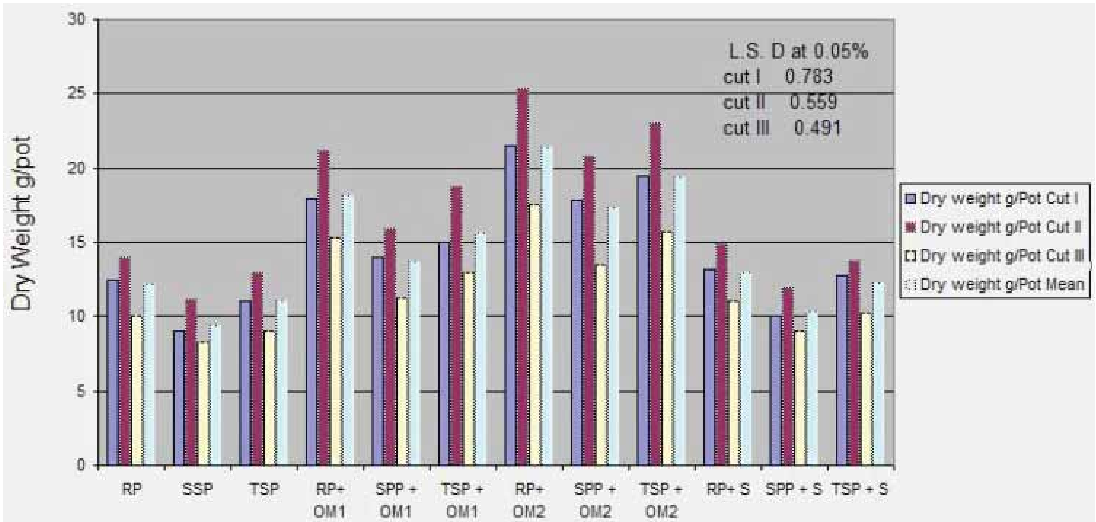


**Fig. 3:** Dry weight (g/pot) of sorghum plants as affected by application different types of phosphorus, organic compost and sulphur fertilizer.

Furthermore, RP added with O.M when have been fertilized the soils was solubilized during composting of O.M and the solubilization was attributed to humic substances in the composts (Bengar *et al.*, 1985) and suggested that organic acids generated by the higher microbial activities associated with immature composts reduced P absorption sites and increased P content in the soil compost mixture with rock phosphate compared to the rock alone.

Data also show that application of O.M with triple phosphate increased significantly than the super phosphate with O.M. Lana *et al.* (2004) stated that triple super phosphate increased significantly for production of root dry mass and diameter of the aerial part, might be the TSP adjusting soil acidity, the accumulated level of P in leaves was higher, Triple super phosphate and simple super phosphate were used as sources of P compared the other sources of P alone or with 300 kg S.

In the same Table: data show that application of 300 kg S with different sources of P fertilizer gradually increased sorghum plant growth. Significantly on fresh and dry weight compared with the sources of P alone (controls)the mean values of the three cuts fresh weight (gm/pot)were 29.47,26.37 and 23.2 gm/pot compared to 26.27,22.9 and 19.43 gm/pot in controls of RP,TSP and SSP, respectively. In general, the above interaction can indicate that S-application as accompanied with P fertilization resulted in the most superior state of sorghum growth; this could be due to the solubilizing and acidifying effect of S fertilizer on the plant utilization of nutrients either the present native in the soil or added which was evident from the increased uptake of nutrients. The results confirmed by Sud (1996) stated that combined application of P and S is better as it increase not only, Sorghum yield but also enhanced nutrient uptake and recovery from soil and fertilizer, Data also show with application of S with rock increased significantly than the other forms of P. This may be due to RP deposit still enriched with the contribution support of P release because only a very small portion dissolved slowly (year). The continuously dissolved RP at a low rate give a steady concentration of P in the soil solution. Furthermore, plant species with low external P requirement will be most studied to this situation, such as clover, barley, sorghum (Abd El-Hamid *et al.*, 2003). Data also show that application of S with triple phosphate increased of the fresh and dry weight compared with super phosphate may be due to differences in internal efficiency of P utilization by plants.

***Macronutrients Uptake:***

Date of macronutrients uptake are given in Table (7) show a similar trend to those of fresh and dry weight on sorghum plants in all studied treatments. Irrespectively of P sources data in Table (7) show that the addition of RP application significantly increased N, P and K uptake by sorghum crop as compared to the other sources of P in the three cuts the mean values of the uptake of the three cuts of sorghum were 254,19 and 209 mg/pot for N,P and K respectively for RP(the highest) while were 147,10 and 116 mg/pot for SSP (the least) and TSP came in between (202,14 and 160 mg/pot).

**Table 7:** Macronutrients (N, P and K) uptake (mg/pot) of sorghum plants as effected by application different type of phosphorus, organic compost and sulfur fertilizer.

| Treatments | N mg/Pot | | | | P (mg/pot) | | | | K (mg/pot) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cut I | Cut II | Cut III | mean | Cut I | Cut II | Cut III | mean | Cut I | Cut II | Cut III | mean |
| RP | 263 | 336 | 163 | 254 | 21 | 25 | 12 | 19 | 213 | 273 | 140 | 209 |
| SSP | 140 | 189 | 111 | 147 | 9 | 13 | 7 | 10 | 108 | 152 | 87 | 116 |
| TSP | 209 | 260 | 136 | 202 | 14 | 20 | 9 | 14 | 160 | 208 | 111 | 160 |
| RP+ $OM_1$ | 494 | 658 | 373 | 508 | 47 | 70 | 32 | 50 | 413 | 562 | 306 | 427 |
| SSP + $OM_1$ | 314 | 389 | 207 | 303 | 22 | 35 | 17 | 25 | 223 | 343 | 171 | 246 |
| TSP + $OM_1$ | 368 | 534 | 286 | 396 | 33 | 54 | 23 | 37 | 300 | 450 | 225 | 325 |
| RP+ $OM_2$ | 720 | 898 | 543 | 720 | 75 | 111 | 47 | 78 | 624 | 835 | 452 | 637 |
| SSP + $OM_2$ | 490 | 659 | 328 | 492 | 37 | 62 | 20 | 40 | 356 | 488 | 211 | 352 |
| TSP + $OM_2$ | 605 | 774 | 447 | 609 | 57 | 83 | 35 | 58 | 488 | 633 | 358 | 493 |
| RP+ S | 311 | 431 | 237 | 326 | 27 | 31 | 15 | 24 | 270 | 312 | 165 | 249 |
| SSP + S | 185 | 276 | 140 | 200 | 15 | 21 | 9 | 15 | 140 | 192 | 110 | 147 |
| TSP + S | 268 | 351 | 174 | 264 | 23 | 26 | 12 | 20 | 217 | 260 | 138 | 205 |
| L.S. P at 0.05% | 42.16 | 83.20 | 16.42 | | 2.23 | 2.73 | 2.00 | | 34.36 | 39.97 | .19.30 | |

SSP: Single super phosphate, O.M1= 20 Ton/fed.
RP : Rock phosphate, O.M2= 30 Ton/fed.
TSP: Triple super phosphate, S= 300 kg S

Application of O.M at 20 ton/fed. with sources P increased significantly N, P and K uptake by sorghum plants. The highest values were observed when rock phosphate with O.M at 20 ton /fed. was applied in comparison with 396, 37 and 325 mg/pot in triple phosphate or 303, 25 and 246 mg/pot for super phosphate fertilizer of N, P, K uptake in three cuts in sorghum respectively. The use of 30 ten/fed. O.M increased N, P and K uptake with the same trend RP+O.M2 > TSP+O.M2 > SSP+O.M2.

Furthermore, composting RP with O.M resulted in higher solubility of RP as compared to the other sources of P. Also available N, P and K uptake by sorghum plants were significantly increased by the incorporation of O.M in soil may be to organic additives product organic acids during the course of decomposition which increase availability of P in soil. These results attributed to O.M supplying to the soil is used for the materials might surpass the need for the field to retain these materials on the field in order to build up the soil fertility. In the long run, the amount of nutrients returned to the soil from crop residues is depend on how the later is deposed of after harvest.

Also, in the same Table addition of 300 kg S with sources of P gave the same trend that of application of S+ RP increased significantly N, P and K uptake by sorghum plants followed triple phosphate and super phosphate the highest values as mean were 326, 24 and 249 mg/pot for RP, and the least values were 200, 15 and 147 for SSP while TSP came in between (264, 20 and 205 mg/pot). The superiority of TSP than super phosphate that TSP adjusting soil acidity and through improving the nutrients supply (Camillia ElDewiny *et al*., 2005). The application of superphosphate gave the lowest values, this is may be due to P from (SSP) dissolve rapidly and absorbed on soil constituents after few days of its application.

Generally, promotive effect of S amendment on nutrients uptake probably due to its important role in reducing pH of soils, through its oxidation to sulfuric acid by soil microorganism and subsequently resulted in solublization and availability of nutrients to plants in this connection, the availability of nutrients in soils caused by S and /or P treatments reflected on the growth and crop yield and its quality trails of sorghum grown in soil.

In this concern increased significantly concentration and uptake of plant cut I and cut II resulted nutrients composts slowly released nutrients from the organic pool and hence the less fixation losses. While sorghum plant growth and uptake of nutrients at cut III (third cut) decreased for all treatments this is may be due to microbial activity is taking some nutrients during the mineralization process. During the process of mineralization, the fixation and release can occur simultaneously and that decline in nutrients availability resulted immobilization and enhanced dilution of N, P and K by plant resulted may process by plants during stage growth. Also, the data confirmed the importance of organic materials if the soil reclamation in Egypt to continuously cropped. Little is known about dynamics of organic matter in the soils. Since the bulk of N, P and K are tide up in organic materials. It is necessary to study the rate of the organic matter decomposition which parallels the rate of released of these nutrients to the soil. Finally, it could be concluded that cotton compost and rock phosphate which is produced in a large amount can be considered as a good source of P-fertilizer.

## REFERENCES

Abdel-Hamid, M.A., S.I. Abdel-Aal, A. Abd-Elfattah, S.A. Ismaiel and A.S. Taalab, 2003. The relative residual effectiveness of superphosphate fertilizer and rock phosphate in torripsamments. Egypt J. Soil Sci., 43(1): 35-46.

Abou Seeda, M., 1997. Nitrogen efficiency as affected by natural inhibitors addition in rice ecosystems. J. Agric. Sci., Mansoura Univ., 22(5): 1787-1800.

Arish, H.M.E., 1993. Growth, mineral contents and yield of pea in relation to phosphorus and potassium fertilization under sandy soil conditions. Zagazig J. Agric. Res., 20(4): 1279-1288.

Bationo A. and A.U. Mokwunye, 1991. Role of manures and crop residue in alleviating soil fertility constraints to crop production: with special reference to the Sahelian and Sudanian zones of West Africa. Fertilizer Research, 29: 117-125.

Bengar, K.C., K.S. Yadav and M.M. Mishra, 1985. transformation of rock phosphate during composting and effect of humic acid . Plant and Soil, 85: 259-266.

Black, C.A., 1982. Methods of soil analysis, Part 1 and 2 American Soc. Agron. Inc. Published, Madison Wisconsin, USA.

Borin, M., C. Giupponi and F. Osele, 1987. The effect of organic and mineral fertilizer and soil type on potato tuber formation. In formation Agraio, 43:91-92 (C.F. Field Crop Abst., 40: 8072, 1987).

Camilia Y. El-Dewiny, H.A. El-Aila and Saffe A. Mohamed, 2005. Evaluation of sorghum response to different sources and rates of phosphorus fertilizers. Egypt. J. Soil Sci., 45(1): 31-40

Cottenie, A., M. Verloo, L. Kiekens, G. Velgh and R. Camerlynech, 1982. Chemical Analysis of Plants and Soils. Lab Anal Agrochem., State Univ. Ghent, Belgium, 63.

Dawa, K., A.A. Tartoura and M.A. Darweesh, 2003. Effect of phosphorus fertilization and some growth promoters on growth and yield of pea (*Pisum sativum* L). J. Agric. Sci. Mansoura Univ., 28(2): 1327-1343.

Edmond, J.E., T.L. Senn, F.S. Znderws and R.G. Halfacre, 1981. Fundamental of Horticulture. Published by Tata MC Graw-Hill publishing co., Limited, Indian.

El-Ashmoony M.S.F., 1991. Effect of split application of phosphorus fertilizer levels on yield and grain quality of wheat. Minia J. Agric. And Dev., 13(3): 1197-1208.

Gouda, M., E.E. Kaoud, K. Matter and M.A. Khamis, 1990. Effect of some soil and water management practices on groundnut in sandy soils. Egypt. J. Soil Sci., 30: 331.

Hedley, M.J., G.J.D. Kirk and M.B. Santos, 1994. Phosphorus efficiency and the forms of soil phosphorus utilized by upland rice cultivars. Plant Soil, 158: 53.

Khasawneh, F.R. and E.C. Doll, 1978. The use of phosphate rock for direct application to soils. Adv. Agron., 30: 159.

Lana, R.M.Q., L.A. Zanao-Junior, J.M.Q. Luz and J.C.da Silva, 2004. Lettuce yield under different phosphorus use in the cerrado soil. Horticultura Brasileria, 22(3): 525-528.

Mehala, H.L. and M.S. Shaktawat, 2004. Effect of source and levels of phosphorus and FYM on yield attributes, yield and nutrient uptake of maize (*Zea mays* L.) Annals of Agric. Res., 25(4): 571-576.

Mengal, K. and E.A. Kirkby, 1987. "Principle of Plant Nutrition" International Potash Institute, Bern, Swizerland.

Miche, A. Cavigelli and J. Steve Thien, 2003. Phosphorus bioavailability following incorporation of green manure crops. Soil Sci. Soc. Am. J., 67: 1186-1194.

Mohammad, M.J. and B.M. Athamneh, 2004. Changes of soil fertility and plant uptake of nutrients and heavy metals in response to sewage sludge application to calcareous soil. J. of Agron., 3(3): 229-236.

Nour El-Dein, E.E., 1996. Effect of organic residues application to different soils on some physical and chemical characteristics of humus the humification course. M.Sc. Thesis, Fac. of Agric. Minufiya Univ., Egypt.

Parasuraman, P., 2005. Growth, grain yield, economics and residual soil fertility of rainfed sorghum (*sorghum bicolor*) as influenced by sources and levels of phosphorus in entisols. Mysore J. of Agric. Sci., 39(4): 484-489.

Puri, N.D., 1984. (in) proceedings of seminar on balanced fertilization programme with special reference to secondary and micronutrient nutrition of crops under intensive cropping , held during 30-31 March 1984 at Rajashan Agriculture University , jaipur, pp: 84-175 .

Sarkadi, J., 1995. Utilization of the nutrient contents of organic manure and mineral fertilizers in long-term experiments. IIP. Balnce. Agrokemia es. Talajtan, 44(1-2): 5.

Sarkar, S.S., P. Mondal, Kmaiti and Bnchatterjee, 1994. Sulphur nutrition of crops with and without organic manures under intensive cropping. Indian J. Agric. Sci., 64(2): 88-92.

Sheng-Mao yang, Sukhdev S. Malhi, Feng-Min Li, Dong-Rang Suo, Ming-Gang Xu, Ping Wang, Guo-Ju Xiao, Yu Jia, Tian-Wen Guo and Jian-Guo Wang, 2007. Long –term effects of manure and fertilization on soil organic matter and quality parameters of a calcareous soil in NW China J. Plant Nutr. Soil Sci., 170: 234-243.

Snedecor, G.W. and WG. Cochran, 1980. Statistical Methods.7th ed. Iowa State Univ. Press. Ames, Iowa. USA., 235-330.

Sud, K.C., 1996. Effect of phosphorus and sulphur on potato nutrition in Shimla hills. Ind J. Soc Sci., 44(3): 440-444.

Tayler, H.L., S.L. Warren, T.E. Bilderback and W.C. Fonteno, 1993. Composted Turkey litter: 1, Effect on chemical and physical properties of a pine bark substrate. Journal of environmental horticulture, 1: 131-136.

Tester, C.F., J. Sikora, J.M. Taylor and J.F. Parr, 1982. Nitrogen utilization by tall fescue from sewage sludge compost amended soils. agron. J., 74: 1013-1018.

Vanlauwe, B., J. Diels, N. Sanginga, R.J. Carsky, J. Deckers and R. Merckx, 2000. Utilization of rock phosphate by crops on a representative toposequence in Northern Guinea savanna zone of Nigeria: response by Mize to previous herbaceous legume cropping and rock phosphate treatments. Soil Biol. Biochem., 32: 2079-2090.