

EFFECT OF ORGANIC FERTILIZER, GYPSUM AND FOLIAR-CA ON YIELD, YIELD COMPONENTS AND QUALITY OF PEANUT PLANT GROWN IN SANDY SOIL

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ABSTRACT: *Two field experiment were conducted at Ismailia Experiment Research Station, Ismailia Governorate, Egypt during the two successive seasons of 2015 and 2016 to evaluate the effect of different rates of compost application (0, 12.5 and 25 Mg ha⁻¹), gypsum at rates of (0, 0.6 and 1.2 Mg ha⁻¹) and Ca-foliar (300 mg L⁻¹) and its combination application on yield and quality of peanut grown in a sandy soil. Application of compost significantly increased pods and grain yield, shelling percentage and 100 grain weight of peanut as compared to control. The increases were 29.6 and 35.4 % for pod and 35.5 and 41.40 % for grain due applications of 12.5 and 25 Mg ha⁻¹ compost. Application any of the two gypsum rates increased pods, grain yield, shelling percentage and 100 seed weight with non-significant difference between two rates. Addition any of the two rates of compost significantly increased N, K, Fe, Zn and Mn contents of straw and seed. Two rates of gypsum also increased the same nutrient with non-significant difference between two rates. Oil and protein contents of grain significantly increased due to application of compost and /or gypsum.*

Key words: *Peanut, Sandy soil, compost. Gypsum.*

INTRODUCTION

Peanut is considered one of the most important oil seeds grown in sandy soil, due to its rich seed in protein and oil. Also it is an important economical crop to agricultural producer on commercial scale. There are many aspects that must be managed properly to ensure optimum production, one of major important soil fertility. Sandy soil generally having poor hydro-physical and nutritional properties such as low water holding capacity, low cation exchange, low contains available nutrients and as well as poor structure and low level of organic matter (Chesworth 2008). These sandy soils require special management to facilitate their suitability for agriculture. An example for such management efforts is application of composted material. Over the year soil properties and crop yield have been improved by addition of different types of compost to agricultural

soil (Staffella and Great 2000; Mobark *et al.* 2000). Addition organic manure to sandy soil improve soil fertility and hence its contents of NPK and micronutrients which is consequently reflected in plant growth and yield (Ismail 2002; Khater *et al.* 2004 and Hussein *et al.* 2011). Organic manure also improves the water holding capacity of sandy soil, improve soil structure and soil aeration (Abou El-Maged *et al.* 2006, Bayu *et al.* 2006 and Agegnehu *et al.* 2015).

Calcium is indispensable nutrient for peanut seed and pods development. Peanut lacking Ca may form undeveloped pods called "POP" or have poor germination and vigor. These occurrences can greatly reduce yield and grad factors of peanut. Pods must have obtained Ca from surrounding soil because Ca is generally immobile in the phloem (Keisling and Walker 1982). Thus adequate Ca in pegging zone is essential

for proper peanut development (Summer *et al.* 1988). Addition of gypsum as Ca fertilizer therefore is common practice to increase Ca in pegging zone and improve peanut yield and grade (Hallock and Allison 1980 a). Calcium also affect the water status and membrane permeability of peanut leaves under moisture stress condition. The extent of membrane and loss of water is less severing in leaves of Ca compared to no receiving a Ca supplement (Chari *et al.* 1986).

The aim of this study to evaluate the effect of different rates of compost, gypsum and Ca-foliar on peanut yield and its quality grown in sandy soil.

MATERIALS AND METHODS

Two field experiment were conducted during two the successive seasons of 2015 and 2016 at Ismailia Research Station, Ismailia governorate, to study the effect of different rates of compost, gypsum and Ca-foliar application and its combinations on peanut yield and its quality. The experimental treatments were arranged in a complete randomized block design. The experiment included 12 treatments with three replicates as follow:

- (1) Control (without application).
- (2) Compost application at rate of 12.5 Mg ha⁻¹ (C₁).
- (3) Compost application at rate of 25 Mg ha⁻¹ (C₂).
- (4) Gypsum application at rate of 0.6 Mg ha⁻¹ (G₁).
- (5) Gypsum application at rate of 1.2 Mg ha⁻¹ (G₁).
- (6) Ca-chelate at rate of 300 mg L⁻¹ as foliar application (Ca_{foliar})
- (7) C₁ + G₁
- (8) C₁ + G₂
- (9) C₂ + G₁
- (10) C₂ + G₂
- (11) C₁ + Ca_{foliar}
- (12) C₂ + Ca_{foliar}

The levels of compost were added at two weeks before sowing, gypsum was applied in furrow at sowing on both sides of crop row. Foliar Ca-chelate was sprayed at 30, 45 and 60 days after sowing. Physical and chemical characteristics of the studied soil and applied compost were presented in Tables 1 and 2 which analyzed according to Klute (1986). After harvesting soil samples were collected from each plot air dried and analyzed for N, P and K.

Table 1. Physical and chemical properties of the studied soil.

Particle size distribution (%)				Texture class	Field capacity	CEC (cmolc kg ⁻¹ soil)	CaCO ₃ (%)	*pH	O.M (%)	EC (dSm ⁻¹)
Coarse sand	Fine sand	Silt	Clay							
67.6	28.1	2.2	2.1	Sandy	12.1	5.6	1.7	7.32	0.45	0.44
*Soluble cations (mmolc L ⁻¹)				*Soluble anions (mmolc L ⁻¹)				Available nutrient (mg kg ⁻¹ soil)		
Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻	N	P	K
1.2	1.7	1.25	0.2	0	2.1	1.61	0.64	19.5	9.1	38.5

* pH of 1: 2.5 soil : water suspension. EC: of soil past extract

Table 2. Physical and chemical analysis of the applied compost

Density	O.M (%)	Organic C	Total N (%)	Total P (%)	Total K (%)	C/N ratio	EC (dSm-1)	pH
0.62	38.8	22.5	1.2	0.27	0.32	18.75	2.6	7.48

Seed of peanut (C.V. Giza) were sown at 15 may. All treatments were fertilized with 250 kg ha⁻¹ P₂O₅ as calcium super phosphate during soil preparation, Nitrogen fertilizer was applied at rate of 70 kg ha⁻¹ as ammonium nitrate. Potassium was applied at a rate of 200 kg ha⁻¹ as potassium sulfate.

Peanut plants were harvested after 140 days from sowing. The yield for each grain and straw were calculated. pod yield at first mature pods were harvested from each plot. Then they located outside for a week then were weighted. 250 gm of dried mature pods was selected as a sample. The shell and seeds were separated and weighted. The ratio of these weighted grain and pods define as shelling percentage. Peanut grain yield was also calculated as pods yield multiply shelling percentage. Plant samples were oven dried at 70 C°, grounded and wet digested using mixture of H₂SO₄ and HClO₄ according Page *et al.* (1982). Contents of macro and micro nutrients were determined in grain and straw yield according to Black (1982). Oil content of grain was determined by using a soxhlet apparatus according A.O.A.C. (1990). Crude protein was calculated by multiplied total N content by 6.25. bulk density was determined according to Singh (1980). Organic C was determined using Walkley and Black method (Jackson 1973). Total N, P and K were determined as mentioned regarding plant analysis. The obtained results were statistically analyzed according to Sedecor and Cochran (1980), to define the values of L.S.D.

RESULTS AND DISCUSSION

Data in Table 3. Show the effect of compost, gypsum, Ca foliar and their combination on peanut pods and grain yield. Compost addition significantly increased pods and grain yield relative to the control. The increases were 29.6 and

35.4 % for pods and 35.5 and 41.42 % for grain to application of 12 and 25 Mg ha⁻¹ compost, respectively without significant difference between both two rates. The beneficial effect of compost on pods and grain yield of peanut may be due to these applied organic materials augmented soil organic matter content that led to improve soil physio-chemical, biological and hydrological characteristics and their its fertility status. Khater *et al.* (2004), Ewees *et al.* (2008) and Ewees and Abd El-Hafez (2010) stated that the highest dry matter accumulation, grain yield and oil percentage in seed yield were achieved by addition of 0.6 ton/fed farmyard manure. Radwan and Awad (2002) found that compost addition increased pods and grain yield of peanut. Salama and Rovira. (1994) found that highest number of flower/plant and pods yield of peanut was obtained by using of 20 m³/fed organic manure. These data confirm with obtained by Radwan and Awad (2002) and Aza and Abdel Wahab (2013).

The different gypsum application significantly increased pods and grain yield and weight of 100 seed compared to control (Table 3). The relative increases were 21.2 and 23.8 % for pods and 30.8 and 35.5 % for grain due to application of 0.6 and 1.2 Mg ha⁻¹ gypsum, respectively with non-significant difference between the two application rates. These data confirmed with those obtained by Aza and Abdel-Wahab (2013); Arnold (2014) and Yang (2015). Safarzadeh *et al.* (2002) and Safarzadeh (2004) stated that calcium is most critical element in growth and development of peanut seeds. Enough calcium content in the soil around the peanut pods leads to increase yield, oil and protein content of the grain. It decreases decayed pod and increase absorption of other nutritional elements from the soil. On the other hand, low content of calcium around the peg zone of peanut leads to several serious problems

for peanut including the production of immature pod, black embryo seed, weak germination of seed and increase production of aflatoxin (Grichar *et al.* 2002).

Ca-foliar sprayed showed no significant effects on pods and grain of peanut. As stated by Safarzadeh *et al.* (2002) it may be due to calcium is absorbed through leave and root of peanut and then transmitted to the aerial part of plant but is not transmitted from the aerial parts of the plant to the pods, so the calcium must be adequate around the growing pods. Summer *et al.* (1988) pointed out that peanut pods cannot be received calcium from the plant, it must be delivered to the pods directly from the soil.

Combined applications of C₁ or C₂ with any of G₁ or G₂ or Ca-foliar achieved the

highest yields for both of pods and grain comparing with any of the solo experimental treatments. For example, the highest pods yield of 4.5 Mg ha⁻¹ recorded due to application of C₂+G₂ compared to solo application of compost or gypsum. The relative increase over the control were 27.8 and 39.8 %, respectively. The corresponding relatively increases of the highest grain yield of 3.15 Mg ha⁻¹ were noticed under (C₂+G₂) and recorded 31.8 and 37.6% relative to C₂ and G₂, respectively. The significant effect of combined application of compost and gypsum may be due to that compost led to improve chemical and physical properties of sandy soil, while gypsum increase calcium in the pegging zone where pods take Ca for development (Walker 1978).

Table 3. Effect of compost, gypsum and foliar-Ca application on peanut yield and yield component (combined over the two seasons).

Treatments	Pods yield (Mg ha ⁻¹)	Grain yield (Mg ha ⁻¹)	Shelling yield (Mg ha ⁻¹)	100 grain weight (g)	Protein (%)	Oil (%)
Control	2.60	1.69	65	88.2	21.2	43.2
C ₁	3.37	2.29	68	92.5	24.5	46.5
C ₂	3.52	2.39	68	93.1	24.7	47.1
G ₁	3.15	2.21	70	92.5	23.6	45.3
G ₂	3.22	2.29	71	92.6	23.8	46.6
Ca foliar	2.76	1.78	66	89.3	22.0	43.9
C ₁ + G ₁	4.10	3.03	74	95.5	25.6	48.2
C ₁ + G ₂	4.20	3.15	75	95.4	25.9	48.5
C ₂ + G ₁	4.30	3.09	75	95.7	26.8	49.1
C ₂ + G ₂	4.50	3.15	76	95.7	26.9	47.8
C ₁ + Ca foliar	3.42	2.36	69	93.5	25.1	47.3
C ₂ + Ca foliar	3.69	2.4	69	94.1	25.3	47.8
LSD _{0.05}	0.22	0.18	2.3	2.2	1.1	2.2

C₁: compost at rate of 12.5 Mg ha⁻¹ compost, C₂: compost at rate of 25 Mg ha⁻¹ compost, G₁: gypsum at rate of 0.6 Mg ha⁻¹, G₂: gypsum at rate of 1.2 Mg ha⁻¹, Ca foliar: Ca-chelate at rate of 300 mg L⁻¹ as foliar application, ns: non-significant at the 5% levels of probability at L.S.D test.

Protein and oil content of grain

Data in Table 3 show that protein and oil grain content significantly improved by different application of compost and / or gypsum and their combination compared to control. It worth to mention that generally, the highest values of protein and oil content in grain were obtained with treatment of C₂ + G₂. However, there were non-significant difference between C₂ + G₂ and C₂ + G₁ treatment.

Nutrient contents

As shown in Tables 4 and 5 application of compost significantly increased grain and straw NPK concentration. Similar trends were noticed by Radwan and Awad

(2002); Rao and Shaktawat (2005); and Aza and Abd El-Wahab (2013) who reported that application of organic manure increased N, P and K contents in various parts of peanut and their uptake. They concluded that organic manure improves moisture retention of sandy soil and nutrient use efficiency and consequently increase the amount of NPK absorbed by plant. Reducing the leaching out of nutrient and ability of active groups of organic matter (fulvic and humic acid) to retain inorganic elements in complete and chelate form which broken down slowly by microorganisms and release elements over period (Rao and Shaktawat 2005).

Table 4. Effect of compost, gypsum and foliar-Ca application on macro and micro nutrients, protein and oil contents in grain of peanut plant (combined over the two seasons).

Treatments	N (%)	P (%)	K (%)	Zn (ppm)	Fe (ppm)	Mn (ppm)
Control	3.31	0.33	0.52	30.2	81.2	11.2
C ₁	3.80	0.42	0.70	37.1	88.4	12.6
C ₂	3.91	0.44	0.76	38.2	90.1	12.7
G ₁	3.94	0.35	0.63	35.7	85.8	11.4
G ₂	3.95	0.32	0.65	35.6	85.7	11.6
Ca foliar	3.70	0.35	0.60	31.5	85.4	11.5
C ₁ + G ₁	4.12	0.45	0.71	37.5	89.4	12.8
C ₁ + G ₂	4.16	0.46	0.72	37.6	89.9	12.7
C ₂ + G ₁	4.40	0.47	0.85	38.9	89.8	12.9
C ₂ + G ₂	4.34	0.46	0.82	39.1	88.8	12.9
C ₁ + Ca foliar	3.95	0.43	0.66	38.3	89.8	12.7
C ₂ + Ca foliar	4.35	0.47	0.72	39.1	89.9	12.8
<i>LSD</i> _{0.05}	0.32	0.05	0.10	1.9	4.1	0.95

C₁: compost at rate of 12.5 Mg ha⁻¹ compost, C₂: compost at rate of 25 Mg ha⁻¹ compost, G₁: gypsum at rate of 0.6 Mg ha⁻¹, G₂: gypsum at rate of 1.2 Mg ha⁻¹, Ca foliar: Ca-chelate at rate of 300 mg L⁻¹ as foliar application, ns: non-significant at the 5% levels of probability at L.S.D test.

Table 5. Effect of compost, gypsum and foliar-Ca application on N, P, K, Zn, Fe, and Mn in straw of peanut (combined over the two seasons).

Treatments	N (%)	P (%)	K (%)	Zn (ppm)	Fe (ppm)	Mn (ppm)
Control	1.40	0.27	1.41	23	105	9
C ₁	1.55	0.28	1.7	28	120	15
C ₂	1.63	0.3	1.85	29	122	16
G ₁	1.51	0.27	1.54	26	116	10
G ₂	1.52	0.27	1.55	26	112	11
Ca foliar	1.46	0.27	1.56	24	107	10
C ₁ + G ₁	1.68	0.28	1.82	29	122	16
C ₁ + G ₂	1.69	0.28	1.85	29	123	17
C ₂ + G ₁	1.69	0.29	1.85	31	131	18
C ₂ + G ₂	1.72	0.3	1.90	32	133	18
C ₁ + Ca foliar	1.67	0.27	1.82	26	123	15
C ₂ + Ca foliar	1.70	0.27	1.83	32	130	17
LSD _{0.05}	0.10	n.s	0.14	2.3	4.2	1.3

C₁: compost at rate of 12.5 Mg ha⁻¹ compost, C₂: compost at rate of 25 Mg ha⁻¹ compost, G₁: gypsum at rate of 0.6 Mg ha⁻¹, G₂: gypsum at rate of 1.2 Mg ha⁻¹, Ca foliar: Ca-chelate at rate of 300 mg L⁻¹ as foliar application, ns: non-significant at the 5% levels of probability at L.S.D test.

In general, the combination treatments significantly increased NPK concentration on peanut straw and grain compared to control or solo treatments, without significant difference between two rates of gypsum or compost. On the other hand, the positive influence of gypsum application owing to be results of improved nutritional environment in the rhizosphere, as well as in the plant system which to translocation of NPK to reproduction parts which ultimate increased the concentration of these nutrient (Safarzadeh, 2004; Rao and Shaktawat 2005 and Alcorado and Rechcigl 1993). The combined between compost and gypsum were significant towards the NPK concentration of these nutrient in straw and grain. The positive effect of addition gypsum and compost on nutrient contents of plant may be due to

biological oxidized of gypsum in presence of organic matter in soil produce H₂SO₄ which lowers the soil pH and improving physical and chemical properties of sandy soil which effect on both water and nutrients availability (El-Banna *et al.* 2004; Aza and Abdelwahab 2013 and Mahrous *et al.* 2015).

With respect to micronutrients of straw and grain they mannered trends similar to the pervious discussed trends for NPK.

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تأثير إضافة السماد العضوي والجبس والرش بالكالسيوم على محصول وجودة نبات الفول
السوداني النامي في أرض رملية

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الملخص العربى

أجريت تجربتان حقليتان فى محطة الأسماعيلية التابعة لمركز البحوث الزراعية – مصر. لموسمين متعاقبين صيف ٢٠١٥، ٢٠١٦ وذلك لتقييم تأثير معدلات مختلفة من سماد الكمبوست والجبس والكالسيوم رشاً على الأوراق على المحصول ومكوناته وجودة نبات القول السودانى النامى فى أرض رملية واشتملت التجربة على ١٢ معاملة بثلاثة مكررات بنظام القطاعات تامة العشوائية كالتى:

- 1- Control (without application)
- 2- Compost application at rate of 12.5 Mg ha⁻¹ (C1)
- 3- Compost application at rate of 25 Mg ha⁻¹ (C2)
- 4- Gypsum application at rate of 0.6 Mg ha⁻¹ (G1)
- 5- Gypsum application at rate of 1.2 Mg ha⁻¹ (G1)
- 6- Ca-chelate at rate of 300 mg L-1 as foliar application (Ca foliar)
- 7- C1+ G1
- 8- C1 + G2
- 9- C2 + G1
- 10- C2 + G2
- 11- C1 + Ca foliar
- 12- C2 + Ca foliar

أدى إضافة الكمبوست إلى زيادة معنوية فى محصول الحبوب والقش وعدد القرون ووزن ال ١٠٠ حبة حيث كانت الزيادة ٢٩,٦ ، ٣٥,٤ % للقرون ، ٣٥,٥ ، ٤١,٤٠ % لوزن ال ١٠٠ حبة وذلك لمعدلات ١٢,٥ و ٢٥ طن / هكتار على التوالي. كما أوضحت النتائج بأن إضافة الجبس بمعدلاته أدى إلى زيادة معنوية فى المحصول ومكوناته ومحصول القش مع عدم وجود فرق معنوى بين معدلات الجبس. أيضا إضافة الكمبوست والكالسيوم رشاً والجبس أدى إلى وجود زيادة معنوية فى محتوى العناصر الكبرى والصغرى ، كما أن محتوى الحبوب من الزيت ونسبة البروتين زاد معنوياً بإضافة السماد العضوى والجبس.

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