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EFFECT OF GYPSUM, HUMIC ACID AND ASCORBIC ACID ADDITION ON PROPERTIES AND PRODUCTIVITY OF PEANUT CROP UNDER SANDY SOIL CONDITIONS

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ABSTRACT

Two field experiments were conducted in a private farm at EL-Ismailia Governorate in two successive summer seasons of 2006 – 2007 to study the effect of application of gypsum, humic acid and foliar ascorbic acid at rates of 250 and 500 ppm on some nutrients uptake and peanut productivity (*Arachis hypogaea* L cv. Giza 6). The gypsum was added to the soil at a rate of 500 kg fed^{-1} before sowing. Nitrogen, phosphorus and potassium fertilizers were applied at the recommended doses. Humic acid was mixed thoroughly with water (2kg / 100 L of water). The mixture was applied at a rate of 5ml /L after 30 days from sowing and repeated two months later. Ascorbic acid was applied at rates of 250 and 500 ppm and sprays after 25 and 50 days after seed sowing and the spraying solution volume was 200 L fed^{-1}.

Results showed that the application of gypsum + humic and ascorbic acid at rates of 250 and 500 ppm led to increase seed and straw yields. The values of seed yield were ranged from 540 to 1202 kg fed^{-1} , weight of pod , 817 to 1576 kg fed^{-1} , weight of 100-seed 62.15 to 74.47 and weight pods 130.31 to 231.29 g for those treated with gypsum +humic acid + ascorbic acid at rates of 250 and 500 ppm compared with control in both seasons. Seed oil (%) showed a significant difference for all the applied treatments compared with control (NPK recommendation). Macronutrients and micronutrients uptake in seed and straw increased with increasing ascorbic rates from 250 t0 500 ppm, particularly when combined with gypsum and humic.

Keywords: Peanut (*Arachis hypogaea* L) - gypsum - ascorbic acid - humic acid – peanut production**.**

INTRODUCTION

Peanut is an important oil and protein crop; it contains about 40-50% oil, 25 – 30% protein, 20% carbohydrates and 5% fiber and ash, and makes a substantial contribution to human nutrition (Fageria *et al.*, 1997). In Egypt, peanut is known to be successfully cultivated in the newly reclaimed sandy soils. Production of oil crops in Egypt is insufficient for local consumption. So, it is of great importance to improve peanut production, which could be achieved by several agricultural practices, i.e., choosing the promising varieties and foliar spraying with K and boron. Under sandy soil conditions, peanuts may need P, K and micronutrient fertilizers to improve pod production and quality (Ali and Mowafy, 2003). Wang *et al.* (1995) reported that the addition of humic acids to the soil with P fertilizer increased significantly the amount of water soluble phosphate and strongly retarded the formation of occluded phosphate and increased P uptake by 25%. Application of 10 kg humic acid ha^{-1}as potassium humate along with 75 per cent of the recommended dose of N fertilizer found to increase the crude protein content and mineral nutrition (P, K, Ca, Mg, Zn, Cu, Fe and Mn) of amaranthus (Bama and Selvakumari, 2001). Govindasamy and Chandrasekaran (2002) reported that, addition of humic acid was found to increase the nutrients content and enhance the uptake of N, P, K, Ca, Mg, Fe, Mn and Zn by rice. Samira *et al.* (2000) reported that gypsum application at a rate of 500 kg/fed before planting increased significantly number of pods/plant, pods weight/plant, 100-seed weight, shelling % and pods yield of peanut. Dahdouh (1998) found that the application of gypsum to the soil cultivated with peanut caused a significant increase in seed N content. Ismail (2005) indicated that the addition of gypsum to soil did not show significant effect on oil percentage of peanut seeds in both seasons. El-Saadany and Abd El-Rasoul (1999) found that gypsum application to the soil at a rate of 500 kg fed^{-1} increased significantly N, P and K uptake in both peanut seed and straw. Nasef (2004) reported that application of gypsum combined with NPK at the recommended rates gave significant increases in N, P and K uptake in peanut seeds and straw as well as increase of seeds oil per cent in two successive seasons. Singaravel *et al.* (1998) found that the humic acid contains auxins, which influence cell division and stem that gave the cell walls the ability to expand. So, humic acid can contribute in increasing seed yield and improving both its protein and oil contents. Mahmoud (2006) found that the individual treatment of humic acid increased seeds and straw yields, oil and protein contents in peanut crop.

Ascorbic acid is a product of D-glucose metabolism, which affects nutritional cycle's activity in higher plants and plays an important role in the electron transport system (Nassar and Ismail, 1999). Zahran (1993) reported that spraying lentil plants with ascorbic acid (a trade compound containing 500 ppm ascorbic acid) increased significantly plant height, pod dry weight seed and straw yield as well as seed protein content. Mousa *et al.* (1993) noticed that the maximum lettuce growth was attained by seed soaking and foliar spray with 1000 ppm ascorbic acid. N, P and K concentrations and uptake were positively affected by previous treatment.

The present work aims to study the effect of gypsum, humic acid and ascorbic acid application and / or their combination with different levels on peanut growth, seed and straw yields and seed oil yield, its components, macro and micronutrients contents of both seeds and straw cultivated in newly reclaimed sandy soil.

MATERIALS AND METHODS

The present investigation was carried out at a private farm in Ismailia Governorate, during the two successive summer seasons of 2006 and 2007. It aimed to evaluate the effect of humic acid, ascorbic acid applied at rates of 250 and 500 ppm, gypsum applied at rate of 500 kg fed^{-1} into the soil on peanuts productivity. Table (1) shows some soil physical and chemical properties of the experimental field in both seasons. The soil is sandy in texture, non saline, poor in organic matter and available macro and micronutrients. In both seasons, the experimental design was in a complete randomized blocks design, with three replicates**.** The seeds of peanut *(Arachis hypogaea* L*)* cv. Giza 6 were obtained from Agric. Res. Center, Giza, Egypt. The seeds were sown on May 5th in the first and second seasons. The experimental unit area (plot) was 3 X 3.5m' containing five rows. The distance between rows was 50cm and 25 cm between plants. At harvest seed yield was recorded in September 21st in both seasons. The weight of pods, seeds, husk and straw yield in kg fed^{-1}, weight 100-pods and 100- seed weight, shelling or oil percentage were also determined at harvest. Gypsum was added at a rate of 500 kg fed^{-1} before sowing during the soil tillage. Nitrogen, phosphorus and potassium fertilization was applied at the recommended rates of 30 kg N , 30 kg P_2O_5 and 24 kg K_2O fed^{-1} in the form of ammonium nitrate 33.5 % N , calcium super phosphate 15 % P_2O_5 and potassium sulphate (48 % K_2O) , respectively . The experiment comprises the following treatments:

T1: N, P and K (control). T2: N, P and K + 500 kg gypsum.
T3: N, P and K + 500 kg gypsum + 250 ppm Ascorbic acid.
T4: N, P and K + 500 kg gypsum + 500 ppm Ascorbic acid.
T5: N, P and K + 500 kg gypsum + humic acid.
T6: N, P and K + 500 kg gypsum + humic acid + 250 ppm Ascorbic acid.
T7: N, P and K + 500 kg gypsum + humic acid + 500 ppm Ascorbic acid.

Table (1): Some physical and chemical analysis of the experiment soil studied

Seasons	**2006**	**2007**
Coarse sand (%)	69.25	67.75
Fine sand (%)	24.11	25.93
Silt (%)	2.81	2.73
Clay (%)	3.83	3.58
Soil texture	Sandy	Sandy
$CaCO_3$ (%)	1.33	1.36
O.M (%)	0.27	0.38
pH (1:2.5)	7.78	7.72
EC (dSm^{-1})	0.21	0.23
Cations (meq L^{-1})		
Ca^{++}	0.42	0.45
Mg^{++}	0.10	0.11
Na^{+}	0.19	0.16
K^{+}	0.07	0.08
Anions (meq L^{-1})		
CO^{--}_3	nil	nil
HCO^{-}_3	0.13	0.14
Cl^{-}	0.50	0.48
SO^{--}_4	0.15	0.18
Available Macronutrients (mg kg^{-1})		
N	25.05	27.15
P	3.23	3.19
K	72.40	75.37

Humic acid was dissolved in water (2kg / 100 L of water). The mixture was added to the soil at a rate of 5ml /L after 30 days from sowing and repeated two months later. Ascorbic acid solution was applied as foliar spray at rates of 250 and 500 ppm after 25 and 50 days from sowing and the spraying solution volume was 200 L fed^{-1}. Soil surface (0- 30 cm) samples were taken from the experimental field before sowing to determine some soil chemical and physical properties according to Black (1965) and Page *et al.* (1982) (Table 1) .

Plant analysis: Peanut seeds and straw were wet digested by a mixture of $HClO_4$ and H_2SO_4 acids (1:1 v/v) according to Sommers and Nelson (1972). The digest was then exposed to determine N, P and K as described by Chapman and Pratt (1961). In the same digest, Fe, Mn and Zn determined as described by Page *et al.* (1982) and Soltanpour and Schwab (1977) using Atomic Absorption model GBC 932. Plant uptake of Macro and micronutrients were obtained by multiplying the nutrient % by the plant dry matter weight (peanut seeds and straw). Determination of oil percentage in dry seed was estimated using soxhlet apparatus according the methods described by A.O.A.C. (1990). Statstical analysis of the obtained data was analyzed according to Sendecor and Cochran (1982), using L.S. D. at 5% levels for comparison between means of the different treatments.

RESULTS AND DISCUSSION

Effect of gypsum, ascorbic acid and humic acid on the yield components

The beneficial effects of gypsum, ascorbic acid and humic acid in combination with the recommended NPK fertilizers on peanut yield in the studied soils are presented in Table (2). Results showed that peanut straw and seed yields tend to increase in soil treated with gypsum in combination with humic acid and ascorbic acid applied at a rate of 500 ppm than the other tested treatments in both seasons. Studied treatments led to increases in all parameters. Moreover, the treatment of ascorbic acid + 500kg gypsum increased the dry matter yield of pods, straw, seed (kg fed^{-1}) and weight of 100-seeds (g) more than control during two seasons. The promotive effect of ascorbic acid can be attributed to its effect on many metabolic and physiological processes as well as the increase of the organic acid exerted from the roots into the soil. These results are in agreement with those obtained of Negm *et al.* (1996) and Nassar and Ismial (1999). Also, the combination of gypsum and the recommended NPK (T2) led to increase the peanut seeds yield by 41.4 and 42.00 % over the control treatment for the 1st and 2nd seasons, respectively. While, the use of 500kg gypsum + recommended NPK + 250 ppm ascorbic acid gave peanut seed increases of 48.52 % (1st season) and 55.52 % (2nd season) for recommended NPK + 500 kg gypsum + 500 ppm ascorbic acid treatment over the control treatment. Due to the use of the recommended NPK + 500 kg gypsium + humic acid (T5), results revealed that this treatment increased the peanut seed yield by 53.70 % (1st season) and 57.45 (2nd season) over the control treatment. While, T6 increased the peanut seed yield by 113.14 and 114.36 % over the control in respective to the first and second seasons. These increases were also attained by 117.0 and 121.36 % over the control treatment due to T7. According to the obtained relative increase values of

seeds and straw yields, pods yield and 100-seed weight of peanut crop for both seasons, it could be categorized into the following orders:
T7 > T6 > T4 >T3 > T2 for seed yield, T6 > T7 > T4 > T5> T3 > T2 for straw yield; T7 > T6 > T4 > T5 > T3 > T2 for pods yield. On the other hand the weight of 100-seed as affected by all tested treatments, the ranking order was as the following: T7 > T4 > T3 > T5 > T6 > T2 > T1 in 1st and T5 > T6 > T4 > T3 > T2 > T6 > T1 in the 2nd season. These results could be explained on the basis of the important role of ascorbic acid as an activator of some enzymes regulating of photosynthetic carbon reduction. These results are in full agreement with those obtained by El-Saadany *et al.* (1999), Nasef (2004) and Mahmoud (2006).

These results clarified the grand role of humic and ascorbic acids mixed with gypsum and NPK fertilizers to enhance the productivity of peanut pods, seeds and straw yields, in addition of increasing seeds weight of 100-pods (g), weight of 100-seed(g) and selling (%) . The increases of seeds weight of 100- pods (g), weight of 100- seed (g) and selling % were non significant. The beneficial effect of those interactions could be attributed to the enhancing of easily nutrients release into soil solution and to encourage their penetration through plant roots, as well as to develop antagonistic impacts toward pests and plant diseases (Ho and Hwan, 2000) .These results are in agreement with those recorded by Singaravel *et al.* (1998).

In conclusion, the study shows the possibility to add gypsum in combination with ascorbic acid, humic acid and the recommended doses of NPK fertilizers to sandy soil to improve the soil physical and chemical properties, which in turn leads to obtain good quantity and quality peanut yield.

Nitrogen, phosphorus and potassium uptake by peanut seeds and straw:

The effect of gypsum added in combination with both ascorbic acid and humic acid along with the recommended doses of N,P and K fertilizers on NPK uptake by both peanut seeds and straw are presented in Table (3). Results indicated that the addition of gypsum in combination with both ascorbic acid and humic acid along with recommended NPK fertilizers led to increase significantly N, P and K uptake by both peanut seeds and straw in both tested seasons. The highest values of N, P and K uptake in seed were 46.52 (T6) in 1st and 47.31(T6) in 2nd for N, 5.53 (T7) in 1st and 5.76 (T7) in 2nd for P and 5.91 (T7) in 1st and 6.75 (T6) in 2nd kg fed^{-}1 for K. The highest values of N, P and K uptake (kg fed^{-1}) by peanut straw were 28.50 (T5) in 1st and 31.23 (T5) in 2nd for N , 6.81(T7) in 1st and 5.91 (T7) in 2nd for P and 43.71 (T5) in 1st and 47.10 (T5) in 2nd for K All these increases in N, P and K uptake by both peanut seeds and straw in response to the applied treatments were significantly higher than those recorded by the control treatment that received the recommended amounts of NPK fertilizers only . These results are in agreement with those obtained by Nasef (2004) and Mahmoud (2006).

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Moreover, the increases of N, P and K uptake in peanut seeds in response to the applied treatments can be ranked as T1 > T7 > T3 > T2 for N respectively in both seasons , and T7> T6> T5 > T4> T3> T2 for P in both seasons, and T7 > T3 > T2 for K in two seasons. Similar results were obtained by Govindasamy and Chandrasekaran (2002), Ismail (2005) and Mahmoud (2006). On the other hand, the corresponding increases for N, P and K uptake in straw peanut followed the order: T5 > T7 > T6 > T4 > T3 > T2 > T1 for N, T7 > T6 > T5 > T4 > T3 > T2 > T1for P and T5 > T7 > T6 > T3 > T4 > T2 > T1 for K in both seasons, respectively.

Concerning the oil content in peanut seeds as affected by the tested treatments, data in Table (3) noted that the oil percentage in seed peanut increased significantly in response to applied treatments in both seasons. Also, peanut oil seed percentage increases can be ranked according to their amounts resulted in response to the tested treatment as in the following order: T7 > T3 > T5 > T2 > T6 > T4 >T1, in both seasons. These results are in agreement with those recorded by Singaravel *et al.* (1998), Nasef (2004) and Mahmoud (2006).

Trace element concentrations in peanut seed and straw:

The effect of the tested treatments on the peanut seed and straw uptake of Fe, Mn and Zn in both tested seasons is presented in Table (4). Results exhibited that different applied treatments caused markedly increases in the uptake of Fe, Mn and Zn in both peanut seeds straw yields.

Table (4): Micronutrients uptake by peanut seeds and straw as affected by the different applied treatments, in two seasons of 2006 / 2007

Treatments*	Seed						Straw					
	Fe (g fed^{-1})		Mn (g fed^{-1})		Zn (g fed^{-1})		Fe (g fed^{-1})		Mn (g fed^{-1})		Zn (g fed^{-1})	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
T1	55.46	58.38	8.37	9.16	19.25	23.25	1270	1273	75	78	51	53
T2	64.50	67.27	7.73	8.83	13.46	16.38	1318	1322	88	93	69	72
T3	63.40	64.32	6.15	6.80	17.32	20.62	15.02	1509	95	96	75	77
T4	73.49	78.11	6.84	6.58	17.94c	19.49	1469	1473	89	92	78	80
T5	80.37	86.18	7.83	6.69	24.16	26.35	1603	1610	96	97	82	85
T6	78.24	83.30	6.91	7.61	24.18	23.55	1675	1677	98	99	85	86
T7	96.78	103.61	7.15	6.93	27.30	24.78	1720	1725	98	99	87	89
Significant	**	***	ns	*	***	***	***	***	**	***	**	***
LSD % 5	17.51	16.33	ns	1.75	1.75	1.95	179.36	175.12	11.54	7.16	17.51	17.50

*** T1 : N, P and K (control) .**
T2 : N,Pand K + 500 kg gypsum .
T3 : N,P and K + 500 kg gypsum + 250 ppm Ascorbic acid.
T4 : N,P and K + 500 kg gypsum + 500 ppm Ascorbic acid.
T5 : N,P and K + gypsum + humic acid .
T6 : N,P and K + gypsum + humic acid + 250 ppm Ascorbic acid.
T7 : N,P and K + gypsum + humic acid + 500 ppm Ascorbic acid

Results revealed that peanut seed Fe uptake in 1st season increased over the control treatment in response to all tested treatment with priority to T7 that recorded the highest seed Fe uptake of 96.78 g fed^{-1}. This high Fe uptake value was higher and significantly different from those recorded by T2 and T3, while it was slightly than those recorded by T4, T5 and T6 without reaching the level of significance. Same trend was observed in the 2nd season, while the highest value of 103 g Fe fed^{-1} was recorded by T7. This high Fe uptake value was significantly different from those recorded by T2 only but not from those due to T3, T4, T5, T6 and T7. Concerning, the uptake of Mn in seed peanut plant relative decreases were T4 < T7 < T5 in both two seasons but T3 < T6 < T2 in 1st season. While the uptake of Zn in peanut seeds relative increase were T7 > T6 > T5 in both seasons but relative decreases were T2 < T3 < T4 in both seasons compared with control (T1), respectively. Also, the relative increases of Fe, Mn and Zn uptake in peanut straw were followed order: T7 > T6 > T5> T3 > T4 > T2 in both seasons respectively compared with control (T1) for Fe, Mn and Zn uptake in straw. These results are agreement by Wang *et al.* (1995)

From the present study, it could be concluded that peanut plant grown on sandy soil should receive either two sprays of 250 and 500 ppm ascorbic acid solution at 25 and 50 days from sowing along with the addition of 500 kg fed^{-1} gypsum in combination with humic acid for raising the yield quantity and quality of peanut.

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تأثير إضافة الجبس وحمض الهيوميك وحمض الاسكوربيك على صفات وإنتاجية محصول الفول السوداني تحت ظروف التربة الرملية

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أجريت تجربتين حقليتين في مزرعة خاصة بمحافظة الاسماعلية لموسمين صيفيين متتالين ٢٠٠٦ و ٢٠٠٧ م بهدف دراسة تأثير إضافة الجبس الزراعي و كل من حمض الهيومك بمعدل ٢ كجم / فدان في ١٠٠ لتر ماء و حمض الاسكوربيك بمعدل ٢٥٠ ملليجرام /لتر و٥٠٠ ملليجرام /لتر على امتصاص العناصر و إنتاجية محصول الفول السوداني صنف جيزة ٦ المنزرع في تربه رملية . وأضيف الجبس بمعدل ٥٠٠ كجم للفدان قبل الزراعة وأثناء عمليات الخدمة للتربة وإضافة المعدل الموصى به من الأسمدة المعدنية النيتروجين والفسفور والبوتاسيوم . أضيف الهيومك بمعدل ٢ كجم / فدان في ١٠٠ لتر ماء وكذلك تم رش حمض الاسكوربيك بمعدل ٥٠٠ - ٢٥٠ جزئ في المليون على فترتين بعد الزراعة بـ ٢٥ و ٥٠ يوم . وكانت النتائج كالتالي :
أدت إضافة الجبس + الموصى به من NPK + حمض الهيومك وحمض الاسكوربيك إلى زيادة محصول الفول السودانى وتراوحت الانتاجية بين ٥٤٠ كجم للفدان في معاملة الكنترول و ١٢٠٢ كجم للفدان في معاملة الجبس مع ٥٠٠ ملليجرام /لتر من حمض الاسكوربيك و حمض الهيومك في الموسم الاول. وكذلك ادى استخدام كل المعاملات تحت الدراسة الى زيادة معنوية فى كل من وزن القرون ووزن ١٠٠ حبة ووزن محصول القرون للفدان. ايضا كان للمعاملات تأثيرا معنويا على النسبة المئوية للزيت فى كلا الموسمين.
أدى استخدام معاملات الجبس والهيومك والاسكوربيك والخلط بينهما إلى زيادة امتصاص العناصر الكبرى(النيتروجين والفسفور والبوتاسيوم) ، و كذلك عناصر الحديد والمنجنيز والزنك .
كانت أفضل معاملة هى معاملة جبس + حمض هيومك + حمض الاسكوربيك بمعدل ٢٥٠ ملليجرام / لتر حيث كان لها تأثيرا معنويا بالمقارنة لباقى المعاملات والكنترول .

قام بتحكيم البحث

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Table (2): Yield components of peanut as affected by the different applied treatments in two seasons of 2006 /2007

Treatments*	Pods yield ($Kg\ fed^{-1}$)		Seed yield ($Kg\ fed^{-1}$)		Husk yield ($Kg\ fed^{-1}$)		Straw yield ($Kg\ fed^{-1}$)		Weight of 100 pods (g)		Weight of 100 seeds (g)		Shelling (%)	
	2006	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**
T1	817	828	540	543	277	285	1227	1225	130.31	137.48	62.15	59.52	66.18	66.37
T2	991	1076	764	771	287	305	1696	1727	167.45	169.62	65.84	67.86	77.18	71.65
T3	1218	1331	802	843	416	488	1780	1885	187.51	197.36	68.32	68.23	65.23	63.33
T4	1371	1505	1010	1018	361	587	1902	2208	192.42	193.40	69.77	70.73	73.67	60.99
T5	1286	1362	830	855	456	607	1859	2103	203.67	205.52	73.47	74.46	64.54	55.43
T6	1483	1510	1151	1164	332	466	2400	2446	217.39	222.63	67.38	71.11	77.61	69.14
T7	1511	1576	1172	1202	339	374	2141	2351	187.20	231.29	71.50	65.23	77.56	76.27
Significancy	***	***	***	***	ns	**	***	***	ns	ns	ns	ns	ns	ns
LSD. 5%	93.61	66.20	132.55	132.38	ns	175.12	175.11	175.12	ns	ns	ns	ns	ns	ns

*** T1 : N, P and K (control) . T2 : N,Pand K + 500 kg gypsum . T3 : N,P and K + 500 kg gypsum + 250 ppm Ascorbic acid.**
T4 : N,P and K + 500 kg gypsum + 500 ppm Ascorbic acid. T5 : N,P and K + gypsum + humic acid .
T6 : N,P and K + gypsum + humic acid + 250 ppm Ascorbic acid. T7 : N,P and K + gypsum + humic acid + 500 ppm Ascorbic acid

Table (3): Nitrogen, phosphorus and potassium uptake of peanut seeds and straw ($mg\ kg^{-1}$) of peanut as affected by the different applied treatments, in two seasons of 2006 / 2007

Treatments*	Seed						Straw							
	N ($Kg\ fed^{-1}$)		P ($Kg\ fed^{-1}$)		K ($Kg\ fed^{-1}$)		N ($Kg\ fed^{-1}$)		P ($Kg\ fed^{-1}$)		K ($Kg\ fed^{-1}$)		Oil (%)	
	2006	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**
T1	17.45	21.52	1.68	1.93	2.28	2.52	13.17	14.32	0.94	1.28	22.06	25.31	42	43
T2	27.73	32.12	2.46	2.31	4.35	4.17	15.88	17.83	2.13	1.89	28.75	32.58	46	49
T3	32.10	29.43	3.07	2.72	5.38	4.83	16.72	17.58	2.77	2.73	36.24	34.45	48	49
T4	41.84	37.89	3.33	3.64	4.72	4.63	20.14	23.91	2.94	3.12	33.36	31.13	43	44
T5	38.26	41.25	3.75	4.24	6.33	5.84	28.50	31.23	3.18	3.32	43.71	47.10	49	50
T6	46.52	47.31	4.85	4.52	5.76	6.75	23.70	27.43	5.23	5.44	37.58	36.27	45	47
T7	41.96	43.10	5.53	5.76	5.91	6.21	26.53	25.46	6.81	5.91	39.24	41.15	51	53
Significant	*	***	**	**	**	**	***	**	***	***	***	***	***	***
LSD %5	14.83	9.47	1.75	1.75	1.76	1.75	1.75	6.81	1.62	1.75	1.62	1.75	1.75	1.75

*** T1 : N, P and K (control) . T2 : N,Pand K + 500 kg gypsum . T3 : N,P and K + 500 kg gypsum + 250 ppm Ascorbic acid.**
T4 : N,P and K + 500 kg gypsum + 500 ppm Ascorbic acid. T5 : N,P and K + gypsum + humic acid .
T6 : N,P and K + gypsum + humic acid + 250 ppm Ascorbic acid. T7 : N,P and K + gypsum + humic acid + 500 ppm Ascorbic acid