

ASSESSMENT OF THE ORGANIC AND INORGANIC FERTILIZERS APPLICATION ON MAIZE/WHEAT PRODUCTION IN CALCAREOUS SOIL

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ABSTRACT

Maize and wheat are the most important cereal crops in Egypt. A field experiment was carried out at the Noubaria Farm Agricultural Research Station during summer 2009 followed by winter 2009/2010 for maize and wheat, respectively. This study was conducted to evaluate the impacts of the integrated individual use of sole mineral NPK fertilizers, or combinations of either single type or various mixtures of NPK and compost types. The standard different fertilization treatments were rates of 75% or 100% (as a recommended dose by the Ministry of Agriculture and Land Reclamation (Egypt). Maize was grown single cross 10 to study the effect of these treatments and their residual effect on followed wheat (C.V. Sakha 93). The results could be summarized as those due to the case of the above mentioned rates of 100% and 75%. However, the application of 100% (NPK) and compost were indicated a better yield of maize grain, stover, wheat grain and straw. Moreover, this preferable rate 100% has left higher availability percentages of macronutrients in both cases of maize and wheat, as compared to rate of 75%. Significant increase of all parameters i.e., grain and stover yields, macronutrients content and the availability of macronutrients for maize soil, were achieved by the application of the mineral NPK solely. While lower values of this parameters, were recorded when applying any single compost types. On the other hand, the trend for residual effect and the resulting availability of macronutrient content of wheat grains, and straw was greatly enhanced by the addition of any organic manures. Interaction between factors under study, shows that the complementary organic and inorganic fertilizers under the high level was more effective than individual application of either organic or mineral (NPK) fertilizers alone for macronutrients content of maize and wheat grains, as well as in soil after harvesting both crops.

Key words: Compost, NPK mineral fertilizer, calcareous soil, maize, wheat, yield, macronutrients.

INTRODUCTION

It has known that fertility of soil is also related to soil organic matter content and added organic matter. Fertilizer application can guarantee the high yield of crop, it method to enhance crop yield. There is no doubt that fertilizers play a very active role in increasing crop yield and nutrients availability of wheat and maize (Baloch *et al.*, 2004; Rajput *et al.*, 2004; Ayodele and Omotoso, 2008 and Zhang *et al.*, 2009). Recycling organic waste such as organic crop residues and animal wastes in agriculture may have a role in decreasing the enormous consumption of chemical fertilizers in Egypt. Chemical fertilizer pollute environment with chemical elements and contaminate ground water with successive uses. The newly reclaimed soils in

Egypt are sandy and calcareous soils which are mostly poor in available nutrients. To increase their productivity, organic matter application plays an important role to retain the inorganic elements in complex and chelate forms. In this concern, organic manures are well established for fertilizing plants due to their beneficial effects on the physical-chemical and biological characteristics of the soils worldwide. These in turn influence the growth and increase plants production (Jimenez *et al.*, 2002, Nardi *et al.*, 2004, Celik *et al.*, 2004, Weil and Magdoff, 2004, and Yassen *et al.*, 2010).

Response of crops to apply fertilizer depends on soil organic matter. The quantity of soil organic matter depends on the quantity of organic material which can be introduced into the soil either by natural returns through roots, stubbles, sloughed-off root nodules and root exudates. Also, by artificial application in the form of organic manure which can otherwise be called organic fertilizer (Agboola and Omuetti, 1982). Nitrogen, essential to plant growth is taken up by plant from the soil in simple inorganic form, i.e. as nitrate and ammonium. These are released from complex organic compounds by the action of decomposing microorganisms, a process known as mineralization. The amount of nitrogen supplied to a crop after application of manure depends on the interaction of several processes (immobilization, leaching, mineralization, nitrification, volatilization, denitrification), which are markedly affected by manure type, time and rate of application and management (Shepherd, 1993). However, during decomposition of organic matter, organic acids and carbon-dioxide are formed (Tisdale *et al.*, 1985) and added organic materials appear to have a solubilizing effect on Fe, Al and Ca phosphate due to the increase in biological activities (Trono, 1986). Nutrient recycling is a dynamic process and it is not easy to assess fertility decline, as it requires long-term monitoring of the soils. (Tripathi and Tuladhar, 2001) found that farmyard manure (FYM) to be an effective N-source for maize and wheat. Since it may supply sufficient nitrogen in synchrony manure when mixed with compost. If the mineral N pool in soil is produced too early, it can potentially be lost through leaching and/or denitrification. If released too late, N application will not benefit the crop and possesses a potential threat to groundwater quality via leaching. (Prasad and Sinha, 2000) stated that, the effect of FYM or FYM + crop residues could substitute 50% NPK for wheat production and their residual effect was equivalent to 50% of the recommended dose of NPK as a mineral fertilizer on the yield of succeeding rice crop. Available N, P, S, Zn, Fe, Cu, Mn, B, and Mo in soil increased when different levels of fertilizers were applied along with crop residues and organic manure. The efficiency of applied nutrients by rice and wheat were higher in plots treated with crop residues than that of FYM treated plots. (Bar-Tal *et al.*, 2004) concluded that, large amount of compost was required in the short term to supply the inorganic N for wheat because of the low net mineralization rate of organic N. They also reported that the main constraint to compost application should be the contents of P, soluble salts, and some hazards elements. (Singh *et al.*, 2011) stated that, the effect combined application of organic manures and inorganic fertilizer increased the dry matter, grain yield, straw yield and NPK uptake by wheat crop. (Fateh *et al.*, 2009) determined the chemical and manure fertilizer levels and mixture of different ration of chemical and manure together. They declared that fertilization treatments significantly affected forage quantity, quality of artichoke and NPK content in globe artichoke.

Therefore, the main objective of this study was to reduce the uses of mineral fertilizers by adding compost to calcareous soil in order to avoid the possible pollution of environment and ground water.

MATERIALS AND METHODS

A field experiment was carried out at Nubaria Agriculture Research Station Farm during two successive seasons; summer 2009 for maize (*Zea mays* L.) and winter 2009/2010 for wheat (*Triticum* spp.), cultivated in calcareous soil under surface irrigation system. Soil surface samples from the layers (0- 20 cm) were taken, air-dried and ground to pass through a 2.0 mm. sieve and thoroughly mixed for analysis. Some physical and chemical properties of soil and compost were analyzed and shown in Table 1. The experimental details are given in Table 2.

A randomized complete block in the split plot design with three replications was conducted. The two factors of the study were (A) two rates of any fertilizers (mineral NPK 75 (MF1) & 100 (MF2) % from recommended dose and/ or compost type 3 and 4 t/fed.) i.e., and (B) treatments were as follows:

1. Mineral fertilizers (NPK) (MF)
2. Compost 1 : Com. (1)
3. Compost 2 : Com. (2)
4. Compost 3 : Com. (3)
5. Compost 1 + Mineral fertilizers [Com. (1) + MF].
6. Compost 2 + Mineral fertilizers [Com. (2) + MF].
7. Compost 3 + Mineral fertilizers [Com. (3) + MF].
8. Compost 1 + Compost 2: [Com. (1) + Com. (2)].
9. Compost 1 + Compost 3: [Com. (1) + Com. (3)].
10. Compost 2 + Compost 3: [Com. (2) + Com. (3)].

Maize, single cross 10 was sown during the first week of June 2009 on a plot area of 10.5 m². All the organic materials were incorporated during the land preparation for maize sowing. Nitrogen fertilizer was added as ammonium nitrate (33.5% N) at the rates of 90 or 120 kg N fed.⁻¹ in two equal doses; 30 days after planting and 25 days later. Phosphorus fertilizer, in the form of Super phosphate (15.5 % P₂O₅), was applied at planting at the rates of 23.3 or 31 kg P₂O₅ fed.⁻¹. Potassium fertilizer was added as potassium sulphate (48% K₂O) at the rates of: 36 and 48 kg K₂O fed.⁻¹ with the second dose of N fertilizer.

At the end of the experiment (lasting 120 days), soil samples and maize plants were taken, i.e. five random plants per plot from all the treatments, thoroughly washed with tap water followed by distilled water, dried in an oven at 65°C for 72 hours, ground and stored for chemical analysis. Wheat was planted during the third week of November 2009, the same plot were used without applied fertilizers to study the residual effect in the soil from previous season (Maize plants experiment). At the end of wheat experiment (lasted 180 days), soil samples and wheat plants were taken, i.e. ten random plants per plot from all the treatments, thoroughly washed with tap water followed by distilled water, dried in an oven at 65°C for 72 hours and ground in stainless steel mill then stored for chemical analysis.

Soil samples and compost analysis:

Physical and chemical analyses of both soil and compost were carried out according to (AOAC, 1995). Available $N-NH_4^+$ and $N-NO_3^-$ were extracted with KCl (2N) and measured by Technician Auto Analyzer according to (Markus *et al.*, 1982). Available macro and micro nutrients in soil samples and compost were extracted with AB-(DTPA), according to Soltanpour and Schwab, (1991). Plant samples were digested using ($HClO_4+H_2SO_4$) acids according to the procedure of (Cottenie *et al.*, 1982). (P and K) in soil and plant were determined in this extract using Inductively Coupled Plasma (ICP) Spectrometry model JY -Ultima2. Total nitrogen in soil and plant was determined using Kjeldahl method according to (Chapman and Pratt, 1961). K in soil and plant was determined using flame photometer. Extraction of humus was performed according to the method of (Kononova, 1966).

Table 1: Physical and chemical properties of soil and compost used in the study

Items	Soil	Com.(1)	Com.(2)	Com.(3)
Coarse sand %	42.00	----	----	----
Fine sand %	12.00	----	----	----
Silt %	16.00	----	----	----
Clay %	30.00	----	----	----
Texture class	Sandy clay loam	----	----	----
Saturation percent %	45.00	100	74.67	92.00
CaCO ₃ %	31.25	3.31	7.74	5.83
pH: In suspension. (1:2.5) for soil, (1:10) for compost	8.10	7.20	6.85	7.75
EC dS/m	3.44	24.3	21.3	59.7
meq.100g l⁻¹				
Ca ²⁺	0.40	9.90	7.39	4.55
Mg ²⁺	0.32	7.70	2.46	11.64
Na ⁺	0.61	11.25	6.35	39.56
K ⁺	0.40	8.00	0.67	28.70
CO ₃ ⁻	0.00	0.00	0.00	0.00
HCO ₃ ⁻	0.16	2.74	4.09	6.72
CL ⁻	0.36	19.60	7.69	47.38
SO ₄ ⁻	1.21	14.51	5.10	30.36
Humic acid %	----	21.50	24.50	26.30
Fulvec acid %	----	11.50	12.70	13.03
(CEC) meq.100g ⁻¹	15.29	48.40	32.60	62.50
Organic matter %	1.11	32.75	33.93	35.38
Organic carbon %	0.645	18.99	19.68	20.52
C:N ratio	1:56	18.09	16.40	11.40
Total.N %	0.12	1.05	1.20	1.40
Available mg. kg⁻¹				
N	23.07	2179	5955	3430
P	9.79	22.23	55.56	56.94
K	480.46	6452	1134	17204
Fe	12.29	111.8	308.4	343.2
Mn	8.29	82.75	16.65	35.37
Zn	0.85	28.99	79.02	45.00
Cu	1.42	4.358	8.488	4.456

Table 2. Treatment details for the experiment

Treatments	Fertilizer levels	
	75% (MF1)	100% (MF2)
MF	90:22.5:36 (NPK)	120:30:48 (NPK)
Compost 1	3 t/fed.	4 t/fed.
Compost 2	3 t/fed.	4 t/fed.
Compost 3	3 t/fed.	4 t/fed.
0.5 MF + 0.5 Com. 1	45:11.25:18 (NPK) + 1.5 t/fed. (Com. 1)	60:15:24 (NPK) + 2 t/fed. (Com.1)
0.5 MF + 0.5 Com. 2	45:11.25:18 (NPK) + 1.5 t/fed. (Com. 2)	60:15:24 (NPK) + 2 t/fed. (Com.2)
0.5 MF + 0.5 Com. 3	45:11.25:18 (NPK) + 1.5 t/fed. (Com. 3)	60:15:24 (NPK) + 2 t/fed. (Com.3)
0.5 Com.1 + 0.5 Com.2	1.5 t/fed. (Com. 1) +1.5 t/fed. (Com. 2)	2 t/fed. (Co 1) +2 t/fed. (Com.2)
0.5 Com.1 + 0.5 Com. 3	1.5 t/fed. (Com. 1) +1.5 t/fed. (Com. 3)	2 t/fed. (Co 1) +2 t/fed. (Com.3)
0.5 Com.2 + 0.5 Com.3	1.5 t/fed. (Com. 2) +1.5 t/fed. (Com. 3)	2 t/fed. (Co 2) +2 t/fed. (Com.3)

Statistical analysis:

The data were subjected to statistical analysis according to the randomized complete block design. Differences between treatment means were compared at P=5% with ANOVA in order to find the statistically significant differences and then LSDs were used to compare the plots (Snedecor and Cochran, 1976). The statistical analysis of the data was realized using the Statistical Analysis System (SAS) program SAS, (1994).

RESULTS AND DISCUSSION**Yield of maize followed by wheat plants**

Data presented in Table 3 show the maize grain & stover yields as well as wheat grain & straw yields as influenced by different fertilizer treatments. As a general pattern, the highest level of organic and inorganic fertilizers gave high significant values of maize grain & stover yields compared with the lowest one. While, the residual effect on wheat grain yield was significantly increased with the high level of organic and inorganic fertilizers compared to low level application. On the other hand, straw yield was not affected by the applied organic and inorganic fertilizers. These results may be attributed to the high rates of organic and inorganic fertilizers equal the recommended doses of maize plants were sufficient to this plant under study.

The treatment of 100% inorganic (mineral) fertilizer sole or 50% mineral + compost (3) gave the highest significant values of grain and stover maize yields, while, the treatment of compost (2) alone achieved the lowest significant ones. On the other hand, results of the residual effect of such fertilizers on wheat plant reveal that the treatment of compost (2) give the best significant values of grain and straw yield of wheat after maize. Meanwhile, the lowest ones were recorded when sole mineral fertilizer 100% was applied. These results may be due to utilize from mineral fertilizer is completed in the first season only, while organic fertilizer so appears in the second one looked for slow release of organic matter and availability of its nutrients favored to yield increase in the second season. Nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Sharma and Mitra, 1991). Improvement of environmental conditions and public health as well as the need to reduce costs of fertilizing crops are also important reasons for advocating increased use of organic materials (Seifritz, 1982). Application of organic manures also

improves the soil microbial properties (Belay *et al.*, 2001). High and sustained crop yield could be obtained with judicious and balanced NPK fertilization combined with organic matter amendments (Makinde *et al.*, 2001; Bayu *et al.*, 2006; Ayoola and Makinde 2007). Maize performed best in terms of growth and yield with complementary application of mixture inorganic and organic fertilizers. This is in agreement with the findings of (Titiloye, 1982) who reported that the most satisfactory method of increasing maize yield was by judicious combination of organic wastes and inorganic fertilizers.

Table 3. Maize and wheat yields as affected by organic and inorganic fertilizers under two levels of application rates

Treatments (B)	Maize plant					
	Grains yield kg/ fed.			Stover yield kg/ fed.		
	MF1	MF2	Mean(A)	MF 1	MF 2	Mean
MF	2391	2659	2525	3431	3816	3624
Compost 1	2126	2341	2234	3050	3360	3205
Compost 2	1950	2352	2151	2800	3376	3088
Compost 3	2299	2501	2400	3299	3628	3464
0.5 MF + 0.5 Com. 1	2264	2470	2367	3248	3545	3397
0.5 MF + 0.5 Com. 2	2183	2516	2349	3132	3610	3371
0.5 MF + 0.5 Com. 3	2445	2619	2532	3509	3759	3634
0.5 Com.1 + 0.5 Com.2	2252	2229	2240	3231	3199	3215
0.5 Com.1 + 0.5 Com. 3	2296	2248	2272	3295	3226	3261
0.5 Com.2 + 0.5 Com.3	2327	2336	2331	3339	3352	3346
Mean	2253	2427*		3234	3487*	
LSD at 0.05		B: 35 AB:49			56 79	
Treatments (B)	Wheat plant					
	Grain yield kg/ fed.			Straw yield kg/ fed.		
	MF1	MF2	Mean(A)	MF 1	MF 2	Mean
MF	787.7	826.7	807.2	2009	2109	2059
Compost 1	1264	1277	1271	3222	3255	3239
Compost 2	1378	1492	1435	3512	3802	3657
Compost 3	1284	1453	1369	3273	3702	3487
0.5 MF + 0.5 Com. 1	1247	1307	1277	3177	3331	3254
0.5 MF + 0.5 Com. 2	1133	1226	1179	2887	3125	3006
0.5 MF + 0.5 Com. 3	1364	1381	1373	3475	3521	3498
0.5 Com.1 + 0.5 Com.2	1218	1263	1241	3105	3219	3162
0.5 Com.1 + 0.5 Com. 3	1192	1253	1222	3037	3192	3114
0.5 Com.2 + 0.5 Com.3	1252	1294	1273	3190	3299	3244
Mean	1219	1277*		3088	3255	
LSD at 0.05		B: 0.31 AB: 0.44			0.21 0.30	

Concerning the effect of interacted factors under study, data in Table 3 reveal that the treatment of 100% inorganic (mineral) fertilizer sole or/ and 50% mineral + compost (3) with the high level from fertilizer achieved a remarkable significant increase of grain and stover maize compared to the other treatments. Whereas, the lowest one were obtained when compost (2) alone under the low level of fertilizer was practiced. On the contrary, the highest significant values

for grain and straw yields of wheat plant were observed by compost (2) alone under the high level of fertilizer. Meanwhile, the lowest one was recorded when sole mineral fertilizer with the low level of fertilizer was applied. High maize and Wheat grains yields resulted from addition compost may be attributed to the composition residues contain large amount of Fe, Mn, Zn, and Cu than the other sources. The results are in agreement with those achieved by (Korim *et al.*, 2009) who reported that consequently the concentration of Fe, Mn, Zn, and Cu in grains of maize and grains of wheat were increased the yields of maize grains and stalk as well as Wheat grains and straw (kg.fed^{-1}) gave highest significant increases. These results suggest that sole application of either compost or NPK is not advisable as none of them produced maximum grains

Macronutrients content in grains of maize and wheat.

Generally, the data in Table 4 reveal that N, P and K contents of maize grains were significantly increased when high level of fertilizer was added compared to the lower one. While, the residual effect of two organic and inorganic fertilizer levels on P and K contents of wheat grains show the same trend as maize. On the other hand, the low level gave highly significant increases on N content in wheat grain as compared with the high level.

As a general view, data illustrated in Table 4 indicated that the treatment of mineral N fertilization alone at the rate of 120 kg/fed. significantly surpassed the other treatments for NP and K contents of maize grains. While, the lowest values of N content was recorded when compost (1) alone was used. On the other hand, applying compost 1 and/or 2 gave the lowest significant values of P content in maize grain but K content of maize grains was recorded by adding compost (2) alone. On the opposite, the highest values of N content of wheat grains growing after maize plant was recorded when 100% inorganic (mineral) fertilizer was applied in combined with 50% compost 3 at 75% from its recommended rate, while, the treatment of 50% mineral + compost (3) at higher rate gave the highest significant value of P content. On the other hand, the highest values of K content in wheat grain was obtained when compost (3) alone was added. The obtained results may be attributed to the higher nutrients content go in agreement with those of higher produced yields resulted from the same treatments. (Ayoola and Makinde, 2007) concluded that the maize yields with complementary inorganic + organic fertilizers and with sole inorganic fertilizer treatment were comparable because nutrients were readily released from the inorganic fertilizer and maize being an aggressive feeder, was able to utilize it for its growth and yield. Maize did not seem to benefit much from organic fertilizer probably because of low mineralization of nutrients from that source. (Adeniyi and Ojeniyi, 2005) have also reported a higher yield of maize from a combined use of NPK fertilizer and poultry manure than from sole applications.

Table 4. N, P and K contents in grains of maize and wheat as affected by organic and inorganic fertilizers under two levels of application

Grains of maize plant									
Treatments	N- Uptake kg/fed.			P- Uptake kg/fed.			K- Uptake kg/fed.		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	32.30	39.64	35.97	10.02	10.27	10.15	14.71	16.98	15.84
Compost 1	11.50	17.11	14.31	4.642	5.457	5.049	8.421	10.81	9.615
Compost 2	18.52	24.95	21.74	4.514	5.627	5.071	6.499	8.246	7.372
Compost 3	18.64	20.88	19.76	5.567	6.635	6.101	12.10	14.07	13.09
0.5 MF + 0.5 Com. 1	23.56	31.39	27.48	7.068	7.828	7.448	11.80	13.46	12.63
0.5 MF + 0.5 Com. 2	22.50	31.21	26.86	7.201	8.554	7.878	8.476	10.95	9.715
0.5 MF + 0.5 Com. 3	24.47	28.31	26.39	9.345	10.20	9.770	14.47	15.70	15.09
0.5 Com.1 + 0.5 Com.2	20.06	21.19	20.63	5.996	5.419	5.708	8.216	8.832	8.524
0.5 Com.1 + 0.5 Com. 3	15.63	18.00	16.82	6.007	5.819	5.913	11.61	12.07	11.84
0.5 Com.2 + 0.5 Com.3	19.33	20.81	20.07	6.983	6.190	6.587	10.13	11.45	10.79
Mean	20.65	25.35*		6.74	7.20*		10.64	12.26*	
LSD at 0.05	B: 0.42			0.153			0.157		
	AB:0.59			0.216			0.222		
Grains of wheat plant									
Treatments	N- Uptake kg/fed.			P- Uptake kg/fed.			K- Uptake kg/fed.		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	9.298	8.355	8.826	2.095	2.315	2.205	10.45	12.28	11.36
Compost 1	14.92	13.54	14.23	3.512	3.771	3.641	18.35	22.88	20.62
Compost 2	22.05	21.09	21.57	4.380	4.739	4.559	19.19	23.21	21.20
Compost 3	16.70	18.30	17.50	4.191	4.746	4.469	25.93	36.23	31.08
0.5 MF + 0.5 Com. 1	20.93	19.73	20.33	3.326	3.820	3.573	19.41	23.92	21.66
0.5 MF + 0.5 Com. 2	18.80	18.51	18.66	3.741	4.177	3.959	15.92	19.57	17.75
0.5 MF + 0.5 Com. 3	22.09	20.44	21.27	4.785	4.971	4.878	26.02	28.52	27.27
0.5 Com.1 + 0.5 Com.2	17.05	16.67	16.86	3.419	3.770	3.594	17.06	21.14	19.10
0.5 Com.1 + 0.5 Com. 3	14.30	13.65	13.98	3.506	3.828	3.667	21.06	23.05	22.05
0.5 Com.2 + 0.5 Com.3	19.65	17.35	18.50	3.762	4.033	3.898	22.94	26.68	24.81
Mean	17.58*	16.76		3.671	4.017*		19.63	23.75*	
LSD at 0.05	B: 0.24			0.037			0.52		
	AB: 0.34			0.052			0.73		

With regard to the interaction between factors, the treatment of sole mineral fertilizer under the high rates gave the highest significant values of N, P and K contents of maize grains while, the lowest significant value of N content of grains of maize was recorded when compost (1) at low level. Whereas, compost (1) and /or compost (2) under low level the low value of P content of maize grains, also, data reveal that the lowest value of K content of maize grains was observed when compost (2) under low level of fertilizer was applied. On the contrary, in most cases, the treatment of sole mineral fertilizer at low level of fertilizer gave the lowest values of N, P and K content of wheat grains sowing followed by maize plant. Also, data reveal that the highest value of N content in wheat grains was recorded when compost (2) alone or 50% mineral + compost (3) under low level of fertilizer were added. Meanwhile, 50% mineral + compost (3) under high level gave the highest value of P content in wheat grains. On the other hand, the best value of K content was obtained by adding compost (3) alone at high level of fertilizer.. This finding agrees with (Rehman et al., 2010) who found that the FYM and NPK used in combination improved

grain yield by increasing tillers m^{-2} , early plant vigor, spikes m^{-2} and biomass yield.

Macronutrients content of maize stover & wheat straw

Data presented in Table 5 illustrated that the N, P and K contents in maize stover and wheat straw were significantly increased by adding the high level of either organic or mineral fertilizers compared to the lower one.

Regarding the effect of organic and inorganic fertilizers on N, P and K contents in maize stover and wheat straw, results show that, the treatment of sole mineral fertilizer significantly surpassed in N and K contents of maize stover. Whereas, the treatment of sole mineral fertilizer, 50% mineral + compost (3) or 50% mineral + compost (2) gave the highest value of P content in maize stover. On the other hand, the lowest value of N content in maize stover was recorded when compost (1) alone was applied, also, P content was significantly decreased by adding any treatment of compost (1) alone, 50% mineral + compost (1), 50% from compost (1) + 50% from compost (2), 50% from compost (1) + 50% from compost (3) and 50% from compost (2) + 50% from compost (3). While, K content was significantly decreased when compost (2) alone was added. On the contrary, the highest significant value of N content of wheat straw was observed when 50% mineral + compost (1) was practiced, meanwhile, P content was increased significantly by adding the treatment of 50% mineral + compost (3). Also, results show that the highest significant value of K content was recorded when the treatment of compost (3) alone was added. On the other hand, the lowest significant values of N, P and K contents of wheat straw were recorded when sole application of mineral fertilizer was added. These findings are in harmony with those obtained by (Shawer, 2003) who found that mixing organic and chemical fertilizers up to 25% from recommended N dose gave the best results in yield and nutrients uptake.

With respect to the effect of the interaction between factors on N, P and K contents of maize stover and wheat straw, results show that the N content of maize stover was significantly increased by adding mineral fertilizer at the high level, while the lowest one was obtained when compost (3) alone under the low level fertilizer was applied. The highest value of P content in maize stover was recorded when mineral fertilizer alone, 50% mineral + compost (2) or 50% mineral + compost (3) at the high level of fertilizer were added. Meanwhile, sole application of organic fertilizer and /or half quantity of mineral fertilizer under both levels of mineral fertilizer gave the lowest value of the P content in maize stover. On the other hand, the treatment of mineral fertilizer alone at high level significantly surpassed of K content in maize stover, while, it was significantly decreased by adding compost (2) alone at low level of fertilizer. On the opposite trend, the treatment of sole mineral fertilizer under the low level of fertilizer gave the lowest values of N, P and K contents of wheat straw which was sown after maize plant. Whereas, the highest value of N content was obtained when 50% mineral + compost (1) at high level of fertilizer was added, meanwhile, the treatment of 50% mineral + compost (3) at low level of fertilizer gave the lowest value of P content. Also results reveal that the lowest value of K content was observed when used compost (3) alone under high level. In this respect, (Shah *et al.*, 2009) found that the integrated use of organic and inorganic nitrogen performed better than the use of organic and inorganic nitrogen sources alone in terms of improving yields of wheat. Shah *et al.*, (2010) concluded that the integrated use of mineral N source (urea) and organic

N sources (farmyard manure, poultry manure, filter cake) performed better than the sole application of organic N sources and mineral N source in terms of improvement of maize yield.

Table 5. N, P and K contents in maize stover and wheat straw as affected by organic and inorganic nitrogen fertilizers under two levels of application rates

Stover of maize plant									
Treatments	N- Uptake kg/fed.			P- Uptake kg/fed.			K- Uptake kg/fed.		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	44.44	54.22	49.33	1.592	2.119	1.856	80.67	97.18	88.92
Compost 1	16.10	20.13	18.11	0.799	0.940	0.869	46.67	54.03	50.35
Compost 2	21.70	28.32	25.01	0.888	1.625	1.257	36.27	48.35	42.31
Compost 3	15.08	26.30	20.69	1.130	1.799	1.464	62.95	81.05	72.00
0.5 MF + 0.5 Com. 1	33.49	40.23	36.86	0.768	1.177	0.973	53.51	66.71	60.11
0.5 MF + 0.5 Com. 2	30.54	40.18	35.36	1.324	2.158	1.741	51.60	46.77	49.19
0.5 MF + 0.5 Com. 3	32.88	39.73	36.31	1.620	2.128	1.874	70.15	89.10	79.63
0.5 Com.1 + 0.5 Com.2	24.27	24.79	24.53	0.852	0.994	0.923	47.23	47.07	47.15
0.5 Com.1 + 0.5 Com. 3	17.90	23.39	20.64	0.870	1.056	0.963	52.35	60.71	56.53
0.5 Com.2 + 0.5 Com.3	21.41	25.31	23.36	1.073	1.054	1.063	52.40	60.46	56.43
Mean	25.78	32.26*		1.092	1.505*		55.38	65.14*	
LSD at 0.05	B: 0.66			; 0.240			0.81		
	AB: 0.94			0.339			1.15		
Straw of wheat plant									
Treatments	N- Uptake kg/fed.			P- Uptake kg/fed.			K- Uptake kg/fed.		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	3.41	4.22	3.81	0.320	0.392	0.356	4.203	5.63	4.92
Compost 1	6.45	6.50	6.47	0.737	0.817	0.777	9.326	10.32	9.82
Compost 2	9.84	12.9	11.37	1.005	1.173	1.089	8.387	10.27	9.33
Compost 3	7.20	9.24	8.22	0.990	1.287	1.138	11.66	13.91	12.78
0.5 MF + 0.5 Com. 1	12.38	17.65	15.02	0.658	0.787	0.722	9.453	10.48	9.97
0.5 MF + 0.5 Com. 2	10.40	14.99	12.69	1.047	1.247	1.147	7.462	8.56	8.01
0.5 MF + 0.5 Com. 3	9.73	14.78	12.25	1.625	1.573	1.599	12.15	12.54	12.35
0.5 Com.1 + 0.5 Com.2	7.75	9.00	8.38	0.749	0.898	0.824	8.631	9.39	9.01
0.5 Com.1 + 0.5 Com. 3	6.68	7.02	6.85	0.753	0.945	0.849	9.333	10.44	9.89
0.5 Com.2 + 0.5 Com.3	7.98	9.24	8.61	0.797	0.986	0.892	10.74	11.32	11.03
Mean	8.18	10.56*		0.868	1.010*		9.134	10.29*	
LSD at 0.05	B: 0.117			0.0012			0.248		
	AB: 0.166			0.0017			0.351		

Available NO₃ and NH₄ of soil after harvesting both maize and followed wheat

According to data tabulated in Table 6 which reveal that the high level of fertilizer gave highest values of NO₃ and NH₄ in soil after harvesting maize and wheat plants compared to the lower one., results show that the highest values of soil NO₃ and NH₄ after harvesting maize crop were recorded when sole application of mineral fertilizer was added. While, the lowest one was obtained by adding compost (1) alone. Whereas soil NO₃ had the same trend when 50 % mineral fertilizer + compost (3) was added with no different significance between them. On the other hand, soil NO₃ and NH₄ were significantly increased after harvesting wheat plant by adding compost (2) alone,

while, the treatment of sole application of mineral fertilizer gave the lowest values of the same ones. These results may be due to the organic fertilizer contain nutrients (Table, 1) which slowly released for plant growth in followed seasons and save soils from pollution in second season.

Regarding to the interaction between studied factors on soil available NO_3 and NH_4 after harvesting maize and wheat plants, results in Table 6 show that for soil after maize harvesting, the highest value of NH_4 was recorded when sole application of mineral fertilizer at the high level was practiced, while the lowest one was obtained by adding compost (1) alone under the low level. Whereas, available NO_3 was significantly increased by adding mineral fertilizer alone under the low level after harvesting maize plant, meanwhile, the lowest one was observed when 50 % mineral fertilizer + compost (3) at low level was added. For soil analysis after harvesting wheat plant, available NH_4 significantly increased when compost (2) alone at the low level of fertilizer, while, the lowest one was obtained by mineral fertilizer alone under the high level of fertilizer. Concerning available NO_3 after harvesting wheat plant, the treatment of compost (2) alone under the high level of fertilizer gave the best significant value, whereas, the lowest ones were recorded when mineral fertilizer at low level or 50% mineral fertilizer + compost (3) under the high level of fertilizer was added. This behavior of N may be attributed to net immobilization of N at the first season followed by net mineralization at the second one by the microbial action. These results are in agreement with those obtained by (Bar-Tal *et al.*, 2004). Complementary use of organic manure and mineral fertilizers has been proved to be a sound soil fertility management strategy in many countries of the world (Lombin *et al.*, 1991).

Available P and K in soil after harvesting maize followed by wheat

Data presented in Table 7 show that the highest mean values of soil available P and K after harvesting of maize and wheat plants were obtained when the high level of fertilizer compared to the lowest ones. For soil analysis after harvesting maize plant, available P and K were significantly increased by adding mineral fertilizer alone, while, the lowest value of available P was recorded when 50 % mineral fertilizer + compost (1) was applied. On the other hand, the treatment of compost (2) alone had the lowest value of available K after harvesting maize plant. On the contrary that the lowest values of the available P and K after harvesting wheat plant were obtained when mineral fertilizer alone were added. Whereas, the highest value of available P was observed when 50 % mineral fertilizer + compost (3) was practiced, while, the treatment of compost (2) + compost (3) showed the highest available K after harvesting wheat plant. Using the compost or mineral may become a suitable solution for reducing the heavy use of non-friendly chemical fertilizers.

Table 6. Available NH₄ and NO₃ mg. kg⁻¹ of soil after harvesting maize and wheat as affected by organic and inorganic nitrogen fertilizers under two levels of application

Treatments	NH ₄ of maize soil			NO ₃ of maize soil		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	24.72	38.80	31.76	49.69	14.30	31.99
Compost 1	12.97	16.62	14.80	5.525	3.726	4.625
Compost 2	19.27	26.02	22.65	11.53	14.13	12.83
Compost 3	14.82	17.92	16.37	10.34	9.420	9.880
0.5 MF + 0.5 Com. 1	21.62	29.28	25.45	4.788	28.45	16.62
0.5 MF + 0.5 Com. 2	19.87	27.67	23.77	3.725	21.10	12.41
0.5 MF + 0.5 Com. 3	19.27	26.17	22.72	2.667	16.70	9.684
0.5 Com.1 + 0.5 Com.2	18.60	24.92	21.76	11.20	12.30	11.75
0.5 Com.1 + 0.5 Com. 3	14.48	17.22	15.85	5.800	4.150	4.975
0.5 Com.2 + 0.5 Com.3	18.42	21.85	20.14	10.30	12.28	11.29
Mean	18.40	24.65*		11.56	13.66*	
LSD at 0.05		B: 0.21			0.49	
		AB: 0.30			0.70	

Treatments	NH ₄ of wheat soil			NO ₃ of wheat soil		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	21.65	13.50	17.57	0.000	0.095	0.048
Compost 1	27.60	27.75	27.67	3.294	4.454	3.874
Compost 2	47.85	46.50	47.17	12.17	27.37	19.77
Compost 3	29.74	39.00	34.37	4.200	5.770	4.985
0.5 MF + 0.5 Com. 1	26.20	25.50	25.85	2.157	3.819	2.988
0.5 MF + 0.5 Com. 2	23.40	23.00	23.20	2.063	2.672	2.368
0.5 MF + 0.5 Com. 3	23.48	20.50	21.99	1.782	0.100	0.941
0.5 Com.1 + 0.5 Com.2	38.35	43.63	40.99	10.15	19.38	14.77
0.5 Com.1 + 0.5 Com. 3	27.57	31.00	29.28	5.233	5.464	5.348
0.5 Com.2 + 0.5 Com.3	36.35	40.75	38.55	6.900	18.97	12.94
Mean	30.22	31.11*		4.795	8.809*	
LSD at 0.05		B: 0.21			0.170	
		AB: 0.30			0.240	

Results in Table 7 demonstrate that the highest mean values of available P and K in soil after harvesting maize were recorded with sole application of mineral fertilizer under the high level of fertilizer. In contrast, the lowest value of available P was obtained by adding compost (1) alone at the low level of fertilizer, while, the lowest value of available K was recorded when used compost (2) alone at the low level. Quite the opposite, the lowest significant values of available P and K in soil after harvesting wheat were observed when mineral fertilizer alone under the high level of fertilizer was practiced. Also, results show that the treatment of 50 % mineral fertilizer + compost (3) under the high level of fertilizer gave the highest value of available P after harvesting wheat, while, the best significant value of available K was obtained when compost (2) + compost (3) was added.

Table 7. Available P and K mg.kg⁻¹ of soil after harvesting maize followed by wheat as affected by organic and inorganic nitrogen fertilizers under two levels of application rates

Treatments	P of maize soil			K of maize soil		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	12.67	24.57	18.62	680.3	727.3	703.8
Compost 1	7.291	10.51	8.901	396.2	414.5	405.3
Compost 2	9.810	11.85	10.83	380.6	391.0	385.8
Compost 3	10.14	13.75	11.94	477.0	539.6	508.3
0.5 MF + 0.5 Com. 1	7.723	8.998	8.360	453.6	500.5	477.0
0.5 MF + 0.5 Com. 2	10.17	18.22	14.19	406.6	457.2	431.9
0.5 MF + 0.5 Com. 3	12.52	19.41	15.97	398.8	543.5	471.2
0.5 Com.1 + 0.5 Com.2	8.143	10.81	9.476	391.0	396.2	393.6
0.5 Com.1 + 0.5 Com 3	8.684	11.05	9.867	437.9	484.8	461.4
0.5 Com.2 + 0.5 Com 3	9.770	11.08	10.43	437.9	469.2	453.6
Mean	9.692	14.025*		446.00	492.37	
LSD at 0.05		B: 0.210			0.20	
		AB: 0.296			0.28	

Treatments	P of wheat soil			K of wheat soil		
	MF 1	MF 2	Mean	MF 1	MF 2	Mean
MF	8.370	9.850	9.110	281.5	383.2	332.4
Compost 1	9.219	11.01	10.11	401.8	406.6	404.2
Compost 2	10.62	11.99	11.31	285.4	401.4	343.4
Compost 3	10.67	12.10	11.39	492.7	563.0	527.8
0.5 MF + 0.5 Com. 1	8.985	11.01	9.999	393.6	408.6	401.1
0.5 MF + 0.5 Com. 2	11.83	12.84	12.34	367.5	422.3	394.9
0.5 MF + 0.5 Com. 3	12.46	13.98	13.22	461.4	477.0	469.2
0.5 Com.1 + 0.5 Com.2	9.554	11.11	10.33	383.2	453.6	418.4
0.5 Com.1 + 0.5 Com 3	9.572	11.50	10.54	406.6	430.1	418.4
0.5 Com.2 + 0.5 Com 3	9.777	11.61	10.69	445.7	613.9	529.8
Mean	10.106*	11.70		391.95	455.97*	
LSD at 0.05		B: 0.209			0.20	
		AB: 0.296			0.28	

The variation in available P concentration throughout the growing season of maize and wheat, especially at higher rates indicates that the application of sufficient organic nitrogen sources to meet N demands as well as the mineral NPK fertilizers may resulted in accumulation of excess P in the soil after maize. However, it decreased in the soil after wheat may be due to the plant consumption, movement to the deeper layer, or precipitation with CaCO₃ or iron oxides in the soil. These results are in agreement with those obtained by (Bar-Tal *et al.*, 2004) who reported that the main constraint to compost application should be the contents of P, soluble salts, and some hazardous elements.

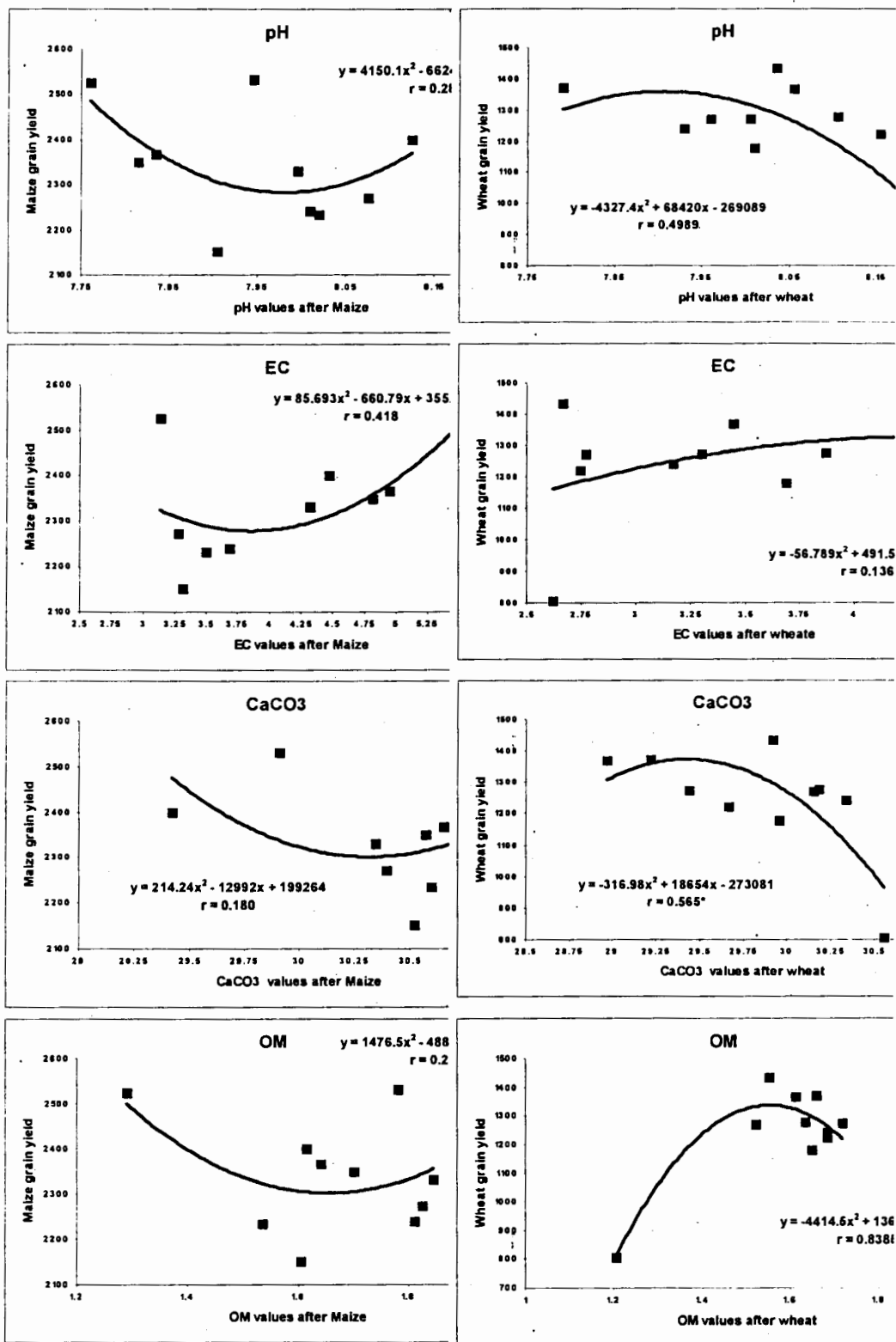


Figure 1. Correlation coefficient values between some chemical properties values for maize and wheat grains together with the corresponding equations.

Relationship between some soil chemical properties and maize and wheat grains in calcareous soil after harvesting

Data of pH, EC, CaCO₃ and organic matter (OM) were measured after harvesting both maize and wheat plants grown in calcareous soil; show that, there no significant differences among productivity of maize & wheat grains and such parameters under study with two exception on soil organic matter and calcium carbonate after wheat harvesting as illustrated in Figure 1. which shows a positive relationship between both organic matter & calcium carbonate values and wheat grains yield. Trend lines were fitted to the scattered points using linear, logarithmic, power, exponential and 2nd order polynomial regression analyses. The highest correlation coefficient values were found when a 2nd order polynomial regression was used. Equations representing the dependence of wheat grain yield on the organic matter in soil after wheat harvesting is shown via corresponding curves and the correlation coefficient values.

Conclusion

The calcareous soils are extensively deficient in nitrogen, phosphorus, zinc and organic matter, hence, application of fertilizers is considered imperative for increasing crop production. Mineral and/ or organic fertilizers play a significant role in boosting crop production on calcareous soils. It is desirable to reduce the use of mineral fertilizers, not more addition in using it and using new sources from organic fertilizers (compost) to reduce pollution of soil and ground water. The benefit is reflected on growing healthy plants, consequently better general health for human and animals.

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تقييم إضافة الأسمدة العضوية وغير العضوية على إنتاج الذرة والقمح في الأراضي الجيرية

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الذرة والقمح من أهم محاصيل الحبوب في مصر. أجريت تجربة حقلية في محطة البحوث الزراعية بالنوبارية خلال موسمين متتابعين (٢٠٠٩، ٢٠٠٩/٢٠١٠). أجريت هذه الدراسة بهدف تقييم تأثير استخدام أسمدة النتروجين والفوسفور والبوتاسيوم المعدنية مختلطة مع بعضها أو مع ثلاثة أنواع من الكمبوست بمعدل ٣، ٤ طن/فدان. وكانت المعاملات السمادية المختلفة هي ٧٥ أو ١٠٠% من الجرعات التي توصى بها وزارة الزراعة واستصلاح الأراضي المصرية. زرعت الذرة (هجين فردي ١٠) لدراسة تأثير هذه المعاملات على الذرة وكذلك تأثيرها المتبقي على محصول القمح التالي (سحا ٩٣). وكانت أهم النتائج هي:

أن معدل ١٠٠% من مخلوط السماد المعدني والكمبوست قد أعطى أعلى محصول للحبوب والقش لكلا من الذرة والقمح. وكذلك أعلى قيم للعناصر الكبرى المتبقية بعد حصاد الذرة والقمح مقارنة بمعاملة مخلوط المعدني والكمبوست عند ٧٥%. وبصفة عامة فإن ١٠٠% من الأسمدة المعدنية فقط قد سجلت قيم أكبر لجميع القياسات المدروسة وهي محصول الحبوب والقش ومحتواهم من العناصر الكبرى وصلاحية تلك العناصر في أرض الذرة بينما سجلت معاملة الكمبوست فقط قيم أقل. ومن ناحية أخرى فإن التأثير المتبقي على صلاحية العناصر الكبرى وكذلك على محتوى حبوب وقش القمح من هذه العناصر قد ازداد مع إضافة أي سماد عضوي. وقد أوضح التداخل بين المعاملات تحت الدراسة على أن التكامل بين الأسمدة المعدنية والعضوية عند المستويات المرتفعة كانت أكثر تأثيراً عن الإضافة المفردة سواء المعدنية أو العضوية على محتوى حبوب القمح والذرة من العناصر الكبرى وكذلك صلاحية تلك العناصر في التربة بعد الحصاد.