Assesment of Mineral Fertilization and Composts Amended With Different Activators on Yield and Nutrients Uptake by Wheat

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ABSTRACT

Field experiment was carried out on sandy soil in 2004 at Ismailia Agriculture Research Station to study the effect of compost and mineral fertilizers or yield and nutrients uptake (N, P, k, Fe, Mn, and Zn) by wheat plant. The experiment included three main plots as type of rice straw and maize stalk with different activators, compost A (poultry manure activator), B (farmyard manure activator) and C (mineral activator). Five sub plots were fertilization treatments (100% recommended NPK, 5 ton compost/fed +75% recommended NPK, 10 ton compost/ fed +50 % recommended NPK, 15 ton compost /fed +25 recommended NPK and 20 ton compost /fed). A highly significant effect of application rates for each compost on both grain and straw yield of wheat and weight of 1000 grains were obtained. The rate 10 ton compost/ fed +50 % NPK showed the highest beneficial effect wherever, compost A surpassed the other composts B and C on the detrimental parameter. While the highest rate of composts (20ton /fed) gave the lowest effect on plant growth and yield. The uptake of macro and micronutrients by wheat grain and straw were significantly affected either by the rates or the type of compost. The highest values of N, P, K and Zn were recorded for compost A at the rate 10 ton compost/fed +50 % NPK, while the highest values of Fe and Mn were recorded for compost B at the same rate. Uptake of N and P by grain surpassed that straw. The uptake of K, Fe, Mn and Zn by straw excelled that of grain. The combination between organic and mineral fertilizers application efficiency considerably excelled that one of the individual application of both organic or mineral fertilizer. Likewise the activator added to the composted material showed an effective roll in superiority of compost A on B and C.

Keywords: sandy soil, wheat plant, nutrients uptake, different composts.

INTRODUCTION

Recently, on the way of sustainable agriculture with minimum pollution effects, use of organic materials such as poultry manure, farmyard manure, refuse of nutritional products and crop residues which used as compost were recommended to substitute the chemical fertilizers. Therefore, from those points of view it is highly desirable that, organic wastes could be used as source of manure. So that maximum economic benefits may be obtained from its utilization as a source of organic fertilizer enrichment.

Although intensive crop cultivation require the use of chemical fertilizers, but they may be expensive and have some harmful effects on the environment. Ali (1999) reported that, significant increases in maize dry matter yield as a result of combined effect of organic plant residues compost, biogase manure and FYM and chemical NPK fertilizer applied to sandy and clay soils. Mekail (2004) reported that, yield productivity was significantly increased with poultry manure application as compared to the traditional NPK fertilization. Also Bashandy, Samah (2007) observed that dry matter yield of crops grown on date palm waste compost was significantly higher than those crops grown on the untreated soils. The study of Taha (2007) showed that, there is a significant increase in the straw and grain yields of maize crop over control (recommended NPK). Wherever, the higher yield of maize grain and straw was recorded in 50 % recommended NPK + 50 % compost. Also Nasser (2007) reported that, the yield of maize and wheat grains were increased over control. The results showed that, rice straw compost gave the highest yields and weight of grain. The highest yield of maize and wheat grain were occurred with addition of composted materials at rate of 10 ton + 50 % NPK.

Abou– Sinna et al. (2000) stated a significant increase in the concentration of N, P, and K in the sugar beet as a result of adding dry sludge and compost application to the soil. Also, the favorable effect of the organic manure may be referred to its influence on reducing the soil pH, improving soil structure and increasing the availability of certain plant nutrients. In a 3 years field experiments on sandy soils Mekail (2000) observed that, application of plant residues compost increased uptake of NPK by plants grown on the treated soils as compared with those grown on control. Also Taha (2000) found that, application of different composted organic residues significantly increased the N, P, and K uptake by corn plant over control and the increase was proportional to the increase in the composted organic residues rates.

Shalabey (2004) found that nutrient contents (N, P, K and Fe) in corn plants increased with applying of organic absorbents. Residual effect of N, P, K, and Fe in soil after harvest of corn plants generally increased in nutrient extractable from soil. Also El- Sayed et al. (2005) revealed that, there was a significant increase in N uptake by all parts of faba bean plants over the control treatment due to compost application. Also, compost addition caused significant positive effect on P and K uptake by different parts of tested plant (faba bean and maize) for the two cultivation seasons. The same positive effect was noticed for Fe, Mn and Zn uptake. In field experiments Mekail (2006) found that, treating sandy soil with poultry manure enhanced NPK uptake by plants grown on compost treated soils compared with those grown on control. Bashandy, Samah (2007) observed that, NPK uptake of crops grown on date palm waste compost was significantly higher than that of crops grown on the untreated soils.

The overall goal of the present research was to study the effect of compost and mineral fertilizers on yield and nutrients uptake (N, P, k, Fe, Mn, and Zn) by wheat plant.

MATERIALS AND METHODS

Field experiment was conducted in Experimental Farm of Ismailia Agricultural Research Station on sandy soil, chemical and physical properties of soil and composted materials used were determined according to Page (1982) and recorded in Table (1-a,b) and Table (2). Wheat crop (Giza 168) was cultivated in order to study the combined effects of adding three types of compost and mineral fertilizers on its yield components. The split plot design was adopted using three replicates. The main plots were randomly assigned to three main plots as the types of composted materials as follows:

A = Rice straw +maize stalk + organic activators (pea crust + poultry manure)

B= Rice straw +maize stalk + organic activators (pea crust +Farm yard manure)

C= Rice straw +maize stalk + chemical activators (super phosphate + urea)

The five sub -plots assigned to composts application rates as follows:

1= Control or 100 % of recommended dose (RD) of mineral N, P and K fertilizers.

2= Compost at the rate 5 ton\fed by weight + 75% of RD of NPK.

3= Compost at the rate10 ton/fed by weight + 50 % of RD of NPK.

4= Compost at the rate15 ton\fed by weight + 25 % of RD of NPK.

5= Compost at the rate 20 ton\fed by weight without mineral fertilizers.

Each plot was (3 x 3.5 m^2). The composted materials were mixed into soil surface (0-20 cm layer). The wheat grains (50 kg / fed) were planted by seed drill in November (2004). The recommended doses of mineral fertilizers were applied at the rates of 100, 30 and 48 unite\fed for N, P_2O_5 and K_2O respectively.

The used mineral fertilizers were $(NH_4)_2 SO_4$ (20% N), ordinary super phosphate (15.5 % $P_2 O_5$) and K_2SO_4 (48 % K_2O) for the three nutrients, respectively. Super phosphate and potassium sulphate were added just before cultivation, while ammonium sulphate was added in five equal doses after 2, 3, 4, 6 and 7 weeks from cultivation. Plants were irrigated by using sprinkler irrigation system .Wheat was harvested at full maturity (150 days from cultivation) and yield was determined.

Table 1: Physical and chemical properties of the tested soil.

a- Particle size distribution.

Soil property	Sand %	Silt %	Clay %	Texture
	93.07	1.59	5.34	Sandy

b-Chemical properties.

Soil property	EC dS/m	pH 1:2.5	OM	$CaCO_3$	CEC mq/100g	Available macronutrients mg/kg			Available micronutrients mg/kg		
			%			N	P	K	Fe	Mn	Zn
	0.075	7.8	0.50	2.2	2.45	12	6.0	45	10.3	5.9	0.8

Table 2: Physical and chemical properties of the used composts.

Parameters / Compost	BD g / cm^3	pH 1:10	EC dS / m	CEC meq/100g	OC	OM	T.N	C / N Ratio	N	P	K	Fe	Mn	Zn
					%				mg / kg					
A	0.639	7.54	5.36	65	27.85	40.27	2.26	12.35	1540	1500	2640	360	93	122
B	0.589	7.40	4.20	68	23.45	40.43	1.64	14.38	1120	975	2296	480	132	37
C	0.495	7.22	5.25	47	28.84	49.73	2.40	12.00	1400	1375	1820	261	103	40

Chemical analysis of plants

Representative samples were taken after harvest stage according to Mortvedt et al. (1977). The sample were dried , ground and wet digested (0.2 g) in 10 ml H_2SO_4 and 1ml $HClO_4$ as described by Jackson (1973) to determine the content of some macro and micronutrients (N, P, K, Fe, Mn and Zn). The obtained data were statistically analyzed using split –plot design according to Snedecor and Cochran (1965).

RESULTS AND DISCUSSION

Grain yields and straw:-

Data in Table (3) appeared a highly significant effect of application rates of each compost on both grain and straw yield of wheat and weight of 1000 grains. The rate of 10 ton compost + 50 % NPK of application induced the highest beneficial effect on the three determined parameters. On the other hand, compost A surpassed the other composts C and B in their influence on these three parameters. That may be due to (its higher content of NPK consequently increased its availability in soil) the positive effect of the compost A on the nitrogen availability in soil. These results are in harmony with these obtained by El- Beshbeshy (2000) and Nasser (2007) who found that, the combined effect of both compost and mineral fertilizers was very obvious an increasing both grain , straw yield and weight of 1000 grains of wheat .The improved plant growth and yield are due to the positive effect of the applied manures on soil physical and chemical properties as well as availability of nutrients and consequently, the physiological processes in plant, namely photosynthetic activity as well as the assimilation of carbohydrates (Bethlenfalvay and Pacovsky, 1983). The decrement of plant growth and yield at the highest rates of composts (20 ton /fed) may be attributed to that materials may be release slowly from decomposition of the added organic materials through the tested composts, consequently its positive effect on plant.

Macro and micronutrients uptake:-

Data in Table (3) revealed that the uptake (kg / fed) of macronutrients by wheat grain and straw were significantly affected either by the rates or the types of the tested composts. The obtained results elucidated that the second (5 ton compost/ fed +75 % NPK) and the third (10 ton compost +50 % NPK) rates of applied composts considerably enhanced the uptake of macro and micronutrients by grain of wheat plants. However, the fourth (15 ton +25% NPK) and fifth (20 ton compost) rates markedly declined this uptake. Likewise the results appeared that, the highest values were recorded for compost A at the rate 10 ton compost /fed + 50 % NPK followed by C and B at the same rate. While the lowest values were observed for compost B at the rate 20 ton compost /fed without mineral fertilizer .

Table 3: Effect of compost and mineral fertilizer on grain, straw yield and weight of 1000 grain by wheat crop in tested sandy soil .

Compost type	Treat No Treat-No	Application rate		grain yield Kg /fed	Straw yield Ton /fed	Weight of 1000 grain g
		NPK %RD	compost ton/fed			
A	1	100	00	1328	3.220	42.83
	2	75	5	1441	3.130	42.50
	3	50	10	1680	3.700	45.80
	4	25	15	1215	3.470	41.33
	5	00	20	888	2.010	38.63
		Mean		1310.44	3.110	42.22
B	1	100	00	1328	3.220	42.83
	2	75	5	1304	2.930	41.90
	3	50	10	1498	3.390	44.20
	4	25	15	742	3.130	39.20
	5	00	20	598	1.712	35.97
		Mean		1094	2.880	40.82
C	1	100	00	1328	3.220	42.83
	2	75	5	1376.6	3.170	42.08
	3	50	10	1542.0	3.490	44.88
	4	25	15	898.7	3.020	41.15
	5	00	20	668.3	2.060	36.40
		Mean		1162.7	2.990	41.47
L.S.D at 0.05			T	0.098	ns	ns
			R	0.093	0.34	1.57
			TR	0.161	ns	ns

RD = recommended dose of mineral fertilizers (NPK)
T = compost type R = application rate

The same data also declared that there is a significant positive or negative between the influences of the three composts. The same trend was observed with micronutrients (Fe, Mn and Zn) uptake by grains (Table 3) wherever, an elevation for their uptake were occurred till the third (10 ton compost +50 % NPK) rate while the higher rates (20 ton compost /fed) remarkably diminished that up take.

The pertinent results in Tables (4 and 5) pointed out that, uptake of nitrogen and phosphorus by grain surpassed that of straw, while the uptake of K, Fe, Mn and Zn by straw excelled that one of grain. That may be ascribed to the genetically properties of wheat plants which concentrate N and P in grains and other nutrients in the other parts of plants. Similar results have been reported by Nasser (2007) and Abdel Aal (2009).

The same trend for the effect of applied compost on the uptake of grain wheat were observed with the straw (Table 5). However, the positive influence of applied compost occurred till the fourth rate of application in the case of macro and micronutrients straw uptake. The data in Table (5) revealed that, addition of composts rates ascendingly increased the uptake of determined nutrients by straw till the fourth (15 ton compost/fed + 25 % NPK) rate of application. The highest rate of compost addition (fifth rate) 20 ton compost/fed depressively affected the uptake of all measured nutrients. Wherever it generally decreased by more than 30 % in comparison with the control received a mineral fertilizer only. The positive or the negative effect for the lower or the higher rates of applied composts followed the descending order of compost A, C and B. Nitrogen uptake by grain was the most affected by the highest rate of applied compost where it diminished almost by double fold compared with the control. The negative influence of the highest rate application of compost was not appeared with Zn uptake particularly with compost A that promoted Zn uptake by more than 30 % compared with control. That may be attributed to its higher content of Zn consequently reflected on plant uptake. The facts which ought to be mentioned herein from the aforesaid results that the combination between compost and mineral fertilizer at the rate of 50 % NPK and 10 ton of composted material remarkably showed the beneficial effect on augmenting either grain and straw yield or nutrients uptake by wheat plants. On the other hand the activator material added to the composted material appeared its efficacy on superiority of compost A on the other composts B and C in enhancing yield and uptake of nutrients by wheat plant.

Table 4: Effect of compost and mineral fertilizers on the uptake of N, P, K, Fe, Mn and Zn by wheat grain in sandy soil.

Compost Type	Treat No	Application rate		kg /fed			g / fed		
		NPK %RD	compost ton/fed	N	P	K	Fe	Mn	Zn
A	1	100	00	27.89	4.81	2.66	361.21	39.84	19.92
	2	75	5	32.43	6.70	3.60	418.03	44.68	28.82
	3	50	10	40.82	7.98	4.54	571.20	62.16	48.72
	4	25	15	26.61	5.54	3.52	486.00	41.31	38.88
	5	00	20	16.25	4.22	2.84	302.00	26.64	33.74
		Mean		28.80	5.85	3.43	427.7	42.93	34.02
B	1	100	00	27.89	4.81	2.66	361.21	39.84	19.92
	2	75	5	27.64	5.7	3.00	449.88	45.64	20.86
	3	50	10	33.70	6.69	3.74	614.18	74.90	26.96
	4	25	15	14.02	3.24	2.00	337.61	33.40	14.84
	5	00	20	8.97	2.72	1.73	231.4	23.92	14.35
		Mean		22.44	4.63	2.40	390.85	43.54	19.39
C	1	100	00	27.89	4.81	2.66	361.21	39.84	19.92
	2	75	5	30.70	6.15	3.02	392.33	44.05	24.10
	3	50	10	36.39	7.03	3.85	485.73	60.14	30.84
	4	25	15	19.14	3.99	2.34	337.91	32.35	19.77
	5	00	20	11.76	3.17	1.87	217.2	21.38	17.37
		Mean		25.18	5.03	2.75	358.87	39.55	22.40
L.S.D at 0.05			T	1.94	0.45	0.26	35.5	3.42	2.45
			R	1.93	0.43	0.25	32.59	3.46	2.46
			TR	3.34	0.74	0.43	56.44	5.99	4.26

RD = recommended dose of mineral fertilizers (NPK).
T = compost type R = application rate

Table 5: Effect of compost and mineral fertilizers on the uptake of N, P, K, Fe, Mn and Zn by wheat straw in sandy soil.

Compost Type	Treat-No	Application rate		kg /fed			g / fed		
		NPK %RD	compost ton/fed	N	P	K	Fe	Mn	Zn
A	1	100	00	12.88	2.41	13.53	966.0	119.20	56.40
	2	75	5	15.64	3.91	14.71	1048.1	128.30	72.0
	3	50	10	21.83	4.81	18.50	1572.0	173.90	136.90
	4	25	15	15.61	4.75	18.04	1335.0	131.80	121.40
	5	00	20	8.44	2.91	13.87	727.6	66.33	80.40
		Mean		14.80	3.76	16.00	1129.7	123.90	93.40
B	1	100	00	12.88	2.41	13.53	966.0	119.20	56.40
	2	75	5	12.30	2.01	13.18	1133.9	131.80	54.20
	3	50	10	14.92	2.54	15.93	1661.1	189.80	84.75
	4	25	15	11.89	2.50	15.65	1408.5	156.50	68.86
	5	00	20	5.99	1.75	10.10	684.8	73.62	44.51
		Mean		11.60	2.24	13.68	1170.8	134.18	61.74
C	1	100	00	12.88	2.41	13.53	966.0	119.20	56.40
	2	75	5	14.90	2.54	13.95	1014.4	133.10	60.23
	3	50	10	19.89	3.04	16.05	1448.3	171.00	94.23
	4	25	15	12.68	2.93	14.80	1108.3	120.80	72.48
	5	00	20	8.24	2.31	10.71	721.0	72.10	59.74
		Mean		13.66	2.64	13.81	1051.6	123.20	68.62
L.S.D at 0.05			T	1.46	0.29	1.45	ns	ns	7.47
			R	1.39	0.38	1.74	135.12	12.97	8.26
			TR	2.41	0.66	ns	ns	ns	16.03

RD = recommended dose of mineral fertilizers (NPK).
T = compost type R = application rate

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الملخص العربى

تقييم الأسمدة المعدنية والكمبوست المحسن بمنشطات مختلفة على إنتاج وإمتصاص المغذيات بواسطة نبات القمح

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أقيمت تجربة حقلية على أرض رملية بمحطة البحوث الزراعية بالإسماعيلية لدراسة تأثير إضافة ثلاث أنواع من المكمورات والخلط مع الأسمدة المعدنية بمعدلات مختلفة على إنتاجية المحصول وإمتصاص العناصر بواسطة نبات القمح (جيزة ١٦٨). وتم إستخدام تصميم القطع المنشقة مع إستخدام ثلاث مكررات وكانت القطع الرئيسية هى أنواع الكمبوست A و B و C والقطع تحت الرئيسية هى معدلات الإضافة كالأتي:

١.كنترول (١٠٠% NPK الموصى بها)

٢. ٥ طن / الفدان كمبوست + ٧٥ % NPK

٣. ١٠ طن / الفدان كمبوست+ ٥٠ % NPK

٤. ١٥ طن / الفدان كمبوست+ ٢٥ % NPK

٥. ٢٠طن / الفدان كمبوست بدون أسمده معدنية

كانت المساحة التجريبية (٣ x ٣,٥ متر) وتم خلط الكمبوست بالطبقة السطحية وتمت الزراعة بالسطارة فى شهر نوفمبر (٢٠٠٤) وكانت معدلات التسميد المعدنى هى ١٠٠و ٣٠ و ٤٨ وحدة للفدان للـ ن ، فو ، بو على التوالى والأسمدة المستخدمة هى سلفات نشادر (٢٠ % N) وسوبر فوسفات العادى (١٥,٥ % P_2O_5) وسلفات بوتاسيوم (٤٨ % K_2O) وتم الحصاد فى نهاية التجربة (١٥٠يوم من الزراعة) وتقدير المحصول ومكوناتة وأظهرت النتائج المتحصل عليها الأتى:-

كانت الفروق بين أنواع الكمبوست معنوية فى تاثيرها على محصول الحبوب وغير معنوية بالنسبة لمحصول القش ووزن الألف حبه بينما كانت الفروق معنوية بين معدلات الإضافة لكل من محصول الحبوب والقش ووزن الألف حبه ولكن وجد أن أعلى قيم لمحصول الحبوب والقش ووزن الألف حبة كانت عند المعاملة ١٠ طن / فدان من الكمبوست +٥٠% من الموصى به من NPK وأن أقل قيم كانت عند المعاملة ٢٠طن/ فدان من الكمبوست بدون إضافة تسميد معدنى وذلك بغض النظر عن نوع الكمبوست .

وكذلك كانت الفروق معنوية بين أنواع الكمبوست وكذلك معدلات الإضافة فى تاثيرها على إمتصاص العناصر الكبرى والصغرى تحت الدراسة ووجد أن أعلى قيم لامتصاص العناصر الكبرى (نتروجين ، فوسفور، بوتاسيوم) والصغرى (حديد ، منجنيز، زنك) كانت عند المعاملة ١٠طن / فدان من الكمبوست +٥٠ % من NPK الموصى عليه وأن أقل قيم كانت عند المعاملة ٢٠ طن / فدان بدون تسميد معدنى وذلك فى حبوب وقش القمح على السواء. واظهرت النتائج إن خلط الاسمدة المعدنية مع العضوية أدت إلى زيادة فى إنتاجية المحصول وإمتصاص العناصر وتفوقت على مثيلتها فى حالة إضافة الأسمدة منفردة دون خلطها .

كذلك أوضحت النتائج أن المنشط المضاف إلى مواد الكمبوست لعب دورا كبيرًا فى تفوق الكمبوست A فى تأثيره عن النوعين الأخرين من الكمبوست B,C.