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IMPACT OF SOME COMPOSTS ON WHEAT PLANT GROWN IN CALCAREOUS SOILS

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ABSTRACT

A pot experiment was conducted to investigate the effect of four composts on wheat (Triticum aestivum L.cv. Yecora rojo) grown in highly calcareous loamy sand soil ($CaCO_3$ = 28%). The composts were applied at five rates (0, 6, 12, 18 and 24 t ha^{-1}). All pots received 30% of the recommended amounts of inorganic fertilizers (N, P, and K).

The obtained results strongly confirmed that application of composts at the various rates increased the organic matter content, the available P and K and available micronutrients (Fe, Mn, Cu, and Zn) in the investigated soil. The results also showed that the application of composts caused a substantial increase in wheat yield (straw and grain) as well as the macronutrients (N, P, K) content and micronutrients (Fe, Mn, Cu, Zn) content by wheat plants.

Application of animal compost into the soil gave the highest yield and nutrients content by wheat plant compared with the other composts. This indicated that this compost in a good mature state.

Keywords: composts, calcareous soil, wheat plant.

INTRODUCTION

The use of organic materials in crop production is receiving renewed attention worldwide. Application of organic fertilizers is recommended for farming of desert lands. The yield and the nutrients uptake by field crops usually display high response to organic fertilizers and composts application (El-Leboudi *et al.*, 1988). On the other hand, organic materials such as crop residues, farmyard manure, and town refuse compost, etc, are available in abundance and reach tremendous amounts every day.

The influence of composts on plant growth is not just a matter of nutrients supply (Raveendran *et al.*, 1994 and Guu *et al.*, 1997), but they influence the physical characteristics of the soil (Khaled, 1993 and Khalil *et al.*,1997), the chemical properties (Abdel-Moez *et al.*, 2002). Application of composts produced positive effects on crop yield (Majid *et al.*, 1992; Rabie *et al.*, 1995 and Abdel Sabour and Abo El Seoud, 1996).

The utilization of organic fertilizers in the calcareous soil may decrease soil pollution and improves its physical and chemical properties. Abdel-Moez and Saleh (1999) found that the organic materials have different effects on modifications of the physical and chemical properties of soils as well as their influence of their nutrition status and soil fertility.

The present study was undertaken to evaluate the effect of different rates of some composts used in Saudi Arabia on some characteristics of calcareous soil as well as yield and yield components of wheat plant.

MATERIALS AND METHODS

A greenhouse experiment was conducted at the College of Food and Agricultural Sci., King Saud University. Soil samples were collected from the surface soil (0-30 cm) representing the Dirab area, 25 km southwest of Riyadh, Saudi Arabia. The soil used was highly calcareous soil. The physical and chemical properties of the investigated soil are shown in Table 1.

Table (1): Physical and chemical properties of the investigated soil

Soil property	Values
Sand,%	86.72
Silt,%	2.00
Clay,%	11.28
Soil texture	Loamy sand
$CaCO_3$,%	28.00
Organic matter,%	0.12
pH (soil paste)	7.43
Ec_e, dSm^{-1}	0.85
Available N, ppm	43.00
Available P, ppm	3.80
Available K, ppm	61.00
Available Fe, ppm	1.98
Available Mn, ppm	0.80
Available Zn, ppm	0.54
Available Cu, ppm	0.09

The soil was used to fill plastic pots that were 20 cm in diameter with a capacity of 4 kg.

Four types of organic amendments (composts) were utilized in this study: (F1): Animal compost, (F2): Plant and animal compost, (F3): Plant compost, and (F4): Sewage sludge compost. Some chemical characteristics of these composts are given in Table 2.

Table (2): Chemical properties of the composts used in this study

Compost*	pH**	EC***	OM%	Total nutrients (ppm)							Available nutrients (ppm)						
				N	P	K	Fe	Mn	Zn	Cu	N	P	K	Fe	Mn	Zn	Cu
F1	8.70	8.20	28.87	9900	3200	7290	3298	132.15	110.54	16.43	6100	2900	2500	83.20	31.76	45.84	2.48
F2	7.38	4.18	24.58	8040	2500	4200	10574	186.07	66.88	29.27	1900	1800	3900	332.00	8.64	25.44	7.04
F3	8.10	8.23	34.18	6200	3300	5400	13841	288.24	531.27	216.03	1400	2700	4600	468.00	26.80	324.80	13.44
F4	7.44	8.72	30.77	9340	4000	3500	9190	75.96	172.24	130.18	4200	3400	2700	400.00	11.36	47.41	63.20

F1*: Animal compost F2*: Plant& animal compost
F3*: Plant compost F4*: Sludge compost
** pH was determined in 1: 5 suspension. *** EC was determined in 1: 5 extract.

The composts were applied at five rates equivalent to: 0, 6, 12, 18, and 24 t ha^{-1}. Ten seeds of wheat (Triticum aestivum L. cv. Yacora rojo) were planted in each pot, and after 15 days of germination, seedlings were thinned to five plants. Soon after thinning, each pot received N, P, K fertilizers equivalent to 30% of the recommended dose for wheat plant. Nitrogen was added as urea, while P and K were applied as KH_2PO_4.

The irrigation was managed to include a 30% of leaching fraction. The treatments were arranged in a complete randomized block design with three replicates. Plants were harvested 112 days after planting, and total yield and yield components of both grain and straw were recorded. Samples of the grain yield were digested, and the nutrients content (N, P, K, Fe, Zn, Mn, and Cu) was determined according to the methods described by Chapman and Pratt (1961). Representative soil samples were taken from each pot after harvesting, air dried, and kept for analyses. Organic matter content in soil was determined by Walkly and Black method as described by Hesse (1971). Available P, K, Fe, Zn, Mn, and Cu in soil were extracted by NH_4HCO_3-DTPA (AB-DTPA) solution according to the method described by Soltanpour and Schwab (1977). P was determined colrimetrically according to Jackson (1967). K was determined by a flame photometer (Jackson, 1967). The micronutrients (Fe, Zn, Mn, and Cu) were determined by Inductively Coupled Plasma Spectrometer (ICP) (Optima 4300 DV).

The data were analyzed by using Statistical Analysis System-Analysis of Variance (SAS-ANOVA) (Statistical Analysis System Institute, 1982) with least significant difference (LSD) for the mean separation.

RESULTS AND DISCUSSION

The application of the different composts to the examined soil improved its fertility properties. The influence of these composts on the organic matter content and availability of the mineral nutrients in soil is shown in Table 3.

It appears that the addition of the composts increased the organic matter content in the soil after the harvest of wheat. Organic matter in soil plays an important role through building up soil aggregates and hence enhancing proper soil physical and physicochemical properties (Abdel Aal *et al.*, 2003).The obtained increases are due to the high content of organic matter in these composts. However, the highest values are recorded due to adding composted plant residues (F3) which has the highest organic matter content (Table, 2).The differences are found significant between the mean values calculated on the averages resulted from adding composts.

In the current study, increasing the application rate of composts from 0 to 24 t ha^{-1} significantly increased the organic matter content in the investigated soil. Such an effect was more pronounced at the higher application rate than at the lower rate (Table, 3). The significant effect of adding composts into the soil on soil organic matter is in agreement with Koriem (1994), El-Naggar (1996) and Abdel Aal *et al.*, (2003).

The data presented in Table 3 show that the application of the composts, significantly increased the available P and K as well as micronutrients (Fe, Mn, Zn, and Cu). The values of available P and K were higher for animal compost (F1) treatment compared with the other treatments. However, the application of plant compost (F3) showed higher values of available Fe, Mn, Zn, and Cu. This result may be due to the variable amounts of mineral nutrients initially present in the animal and in the plant composts (Table, 2). The increase in mineral nutrients content followed the elemental composition of the animal and plant composts. Dimitrios *et al.*, (2005) reported that fertilization with composts improved soil characteristics by lowering penetration resistance and increasing porosity, thus enhancing the development of plant root system.

Table (3): The organic matter (OM %) and nutrients availability as affected by different types& rates of composts

Treatments		O.M.%	Available nutrients (mg kg^{-1})					
Compost	Rate t ha^{-1}		P	K	Fe	Mn	Zn	Cu
F1	0	0.18	2.91	62.67	2.14	1.14	0.21	0.21
	6	0.26	10.23	97.00	2.41	1.69	0.31	0.20
	12	0.34	19.82	122.33	2.48	1.96	0.41	0.19
	18	0.40	26.45	154.67	2.62	2.43	0.53	0.14
	24	0.43	21.47	218.33	2.85	2.68	0.63	0.15
Mean		0.32	16.18	131.00	2.50	1.98	0.42	0.18
F2	0	0.23	5.84	66.33	2.08	1.15	0.10	0.13
	6	0.30	6.18	76.67	3.93	1.67	0.20	0.20
	12	0.35	5.52	82.00	3.47	1.78	0.25	0.18
	18	0.42	11.65	85.00	6.55	2.26	0.41	0.22
	24	0.50	12.66	98.00	6.56	2.17	0.36	0.23
Mean		0.36	8.37	81.60	4.52	1.81	0.26	0.19
F3	0	0.48	3.22	63.00	2.00	0.98	0.08	0.12
	6	0.49	6.46	69.33	5.37	1.89	0.56	0.37
	12	0.52	5.95	77.67	6.53	1.90	0.82	0.44
	18	0.57	19.34	91.33	11.08	2.71	2.50	1.31
	24	0.59	12.11	103.00	13.63	3.49	2.42	1.31
Mean		0.53	9.42	80.87	7.72	2.19	1.28	0.71
F4	0	0.27	5.32	72.00	2.81	1.28	0.24	0.35
	6	0.28	9.17	75.33	4.13	1.39	0.78	0.41
	12	0.29	8.24	77.67	3.89	1.34	0.88	0.36
	18	0.49	9.92	86.33	5.86	1.51	1.76	0.43
	24	0.49	9.62	96.00	4.51	1.53	1.81	0.58
Mean		0.36	8.45	81.47	4.24	1.41	1.09	0.43
LSD 5%	Fertilizer	0.054	1.218	2.444	0.419	0.112	0.248	0.116
	Rate	0.060	1.362	2.732	0.468	0.125	0.277	0.130

On the other hand, increasing the application rate of composts from 0 to 24 t ha^{-1}, significantly increased most of the available nutrients. In addition, such an effect was more pronounced at the higher application rate than at the lower rate (Table, 3). The increase in available nutrients in the studied soil due to adding the composts or organic residues may be attributed to the high available nutrients in the composts, also to lowering soil pH through yielding intermediate organic acids and finally humus materials (humic and fulvic acids), as well as increasing the activity of soil organisms to liberate more nutrients from the unavailable reserves. El-Naggar (1996) found that soil pH decreased linearly from 7.8 to 7.4 with application of different rates of plant, animal compost and sewage sludge. These findings are in agreement with those reported by El-Sirafy *et al.*, (2001).

The data presented in Table 4 show a significant increase in the straw, grain and total yield of wheat crop at the different composts application. Wheat yield (total, straw, and grain) due to animal compost (F1) application was significantly higher than that due to other composts. While, the lowest value of wheat yield was recorded due to adding sewage sludge (F4). This result may be attributed to the higher content of available nitrogen in animal compost (F1) as indicated in Table 2 and to the adverse effects of toxic materials that may be present in the sewage sludge. These findings are in agreement with the results reported by Chu and Wong (1987).

Table (4): Effect of different types& rates of composts on wheat yield and nutrients uptake

Treatments		Yield	Grain	Straw	N	P	K	Fe	Zn	Mn	Cu
Compost	Rate $t\ ha^{-1}$	gm / pot			mg/pot			ppm			
F1	0	4.70	2.17	2.53	61.01	7.37	8.23	45.27	17.93	14.67	0.60
	6	7.67	4.00	3.67	112.71	11.59	13.59	49.53	14.80	17.60	1.60
	12	8.10	4.17	3.93	127.15	12.93	14.17	51.07	16.33	17.27	0.27
	18	8.73	4.47	4.27	131.43	16.12	16.37	52.13	23.20	20.07	2.67
	24	9.60	4.60	5.00	149.40	17.19	17.81	51.87	24.33	19.33	7.40
Mean		7.76	3.88	3.88	116.34	13.04	14.03	49.97	19.32	17.79	2.51
F2	0	5.07	2.47	2.60	64.73	8.10	10.69	44.60	17.47	13.13	21.33
	6	6.97	3.73	3.23	95.01	11.45	14.45	45.33	12.47	16.00	18.80
	12	7.00	3.37	3.63	93.33	9.86	12.12	48.40	18.20	15.53	0.23
	18	7.33	3.20	4.13	83.68	8.98	11.51	56.67	15.47	15.60	1.60
	24	7.03	3.43	3.60	100.85	9.50	12.36	55.20	21.40	15.07	1.87
Mean		6.68	3.24	3.44	87.52	9.58	12.23	50.04	17.00	15.07	8.77
F3	0	5.63	2.73	2.90	68.75	9.56	11.49	53.20	19.00	16.27	1.80
	6	7.67	3.73	3.93	76.72	12.15	14.67	53.53	24.33	12.93	1.33
	12	7.20	3.37	3.83	77.23	11.45	13.26	57.93	32.93	11.93	2.40
	18	7.27	3.30	3.97	87.83	9.91	12.55	65.87	36.13	10.47	3.17
	24	5.57	2.47	3.10	61.69	7.40	9.24	66.33	34.13	9.80	5.20
Mean		6.67	3.12	3.55	74.44	10.09	12.24	59.37	29.30	12.28	2.78
F4	0	5.10	2.27	2.83	67.08	8.62	10.06	46.87	29.60	15.00	4.07
	6	6.40	2.50	3.90	70.03	7.74	10.00	66.13	30.47	10.20	4.20
	12	6.70	3.23	3.47	88.63	8.51	13.38	69.80	43.00	9.47	6.20
	18	5.97	2.70	3.27	71.44	8.56	12.04	84.33	52.33	7.93	5.23
	24	5.60	2.73	2.87	82.61	8.83	11.84	65.87	53.40	8.80	4.53
Mean		5.95	2.69	3.27	75.96	8.45	11.46	66.60	41.76	10.28	4.85
LSD 5%	Fertilizer	0.412	0.163	0.328	6.992	0.815	0.802	3.812	2.797	1.866	0.454
	Rate	0.461	0.182	0.367	7.817	0.911	0.896	4.262	3.127	NS	0.507

It should be mentioned that there are significant differences in the yield of wheat crop were obtained when the application rate of composts was increased from 0 to 24 t ha^{-1} (Table, 4). The limited effect of increasing the application rate of some composts on the yield of a variety of crops has been reported by some workers. Kelling *et al.*, (1977) observed that there was some depression in yields of some field crops due to high rates of sewage material applications. Dahiya and Singh (1980) demonstrated that increasing the application rate of farmyard manure might have an adverse effect on the dry matter yield of oats. Thus, it is obvious from the results of Table 4 that yield is in parallel with growth where the highest yield is obtained from adding the animal compost (F1). This may be explained by increasing available nitrogen and subsequently increase both growth and nitrogen uptake, where this plant save this nitrogen for both stages of formation and filling of grain, also, at this

As shown in Table 4, applying composts to the calcareous soil increased significantly nitrogen, phosphorus, and potassium content (mg/ pot) in the grain of wheat plant. It is noticeable that the highest increase of N, P, and K uptake is due to adding animal compost (F1) which is parallel with the increase of whole dry weight and yield of wheat plant, also is parallel with the increase of the available P and K elements as indicated in Table 3. Cooke (1982) stated that usually, mineral nitrogen will be formed in the first few weeks after adding organic materials to the soil if the dry weight has more than 2% N ; mineral nitrogen is not generally released initially of the waste has less than 1.5% N. The increase of N, P, and K uptake by plants due to adding composts is in agreement with the data of Abdel-Latif and Abdel-Fattah (1983), Haggag (1994) and El-Naggar (1996). Abdel Aal, *et al.*, (2003) reported that the increase in the wheat yield and yield components due to adding composts is probably due mainly to the improvement of the soil environment, which encourages proliferation of roots, which in turn draw more water and nutrients from large area and greater depth. Moreover, the decomposed organic materials release macronutrients (N, P, and K) along with micronutrients that become available to the plants and thus increase the plant uptake.

Regarding the effect of adding composts on the micronutrients content (Fe, Zn, Mn, and Cu) in wheat grain (Table, 4), it has a significant pronounced effect on micronutrients uptake. The obtained maximum uptake of Fe and Zn was recorded by applying the sewage sludge (F4). Rufus *et al.*, (1980) found that all trace elements requirements were supplied by sludge compost. Compost supplied much higher amounts of Fe, Zn, and Cu than are ordinarily added to media.

Data presented in Table 4 show that, generally, nutrients uptake (N, P, K, Fe, Zn, and Cu) by wheat plant increased significantly as the application rate of the composts was increased. It should be mentioned that no significant differences in Mn uptake were obtained when the application rate of composts was increased from 0 to 24 t ha^{-1}. The limited effect of increasing the application rate of composts on micronutrients uptake has been reported by Kelling *et al.*, (1977) and Dahiya and Singh (1980).

Thus, it can be concluded that application of different types of composts into the calcareous soil increased organic matter content, available nutrients in soil as well as yield and yield components of wheat plant. Application of animal compost gave the highest yield and nutrients content by wheat plant compared with the other composts. This indicated that animal compost which used in this study in a good mature state. Application of the different composts at either 6 or 24 t ha^{-1} increased the organic matter content and available nutrients in soils. Moreover, it increased yield and yield components of wheat plant.

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أثر استخدام بعض الأسمدة العضوية الصناعية (الكومبوست) على نبـات القمـح النامي فى الترب الجيرية

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أقيمت تجربة أصص لدراسة أثر استخدام أربعة أنواع مختلفة مـن السـماد العضـوى الصناعى (الكومبوست) على بعض صفات التربة وإنتاجية محصول القمح النامى فى الترب الجيرية. هذا وقد أضيفت الأسمدة العضوية الصناعية للتربة بخمس معدلات وهـى: صـفر ، ٦، ١٢، ١٨، و ٢٤ طن/ هكتار. وأضيفت الأسمدة الكيماوية (نيتروجين، فوسـفور و بوتاسـيوم) بمعدل ٣٠% من الكميات الموصى بها في تسميد القمح.

أوضحت الدراسة أن إضافة الأسمدة العضوية للتربة أدت إلى زيادة محتوى التربة من المادة العضوية وزيادة كمية كل من عناصر الفوسفور والبوتاسيوم والحديد والمنجنيـز والزنـك والنحاس الميسرة فى التربة والصالحة للإمتصاص بواسطة النبات. كما أوضحت النتـائج زيـادة إنتاجية محصول القمح من الحبوب والقش وانعكس ذلك على زيادة امتصاص عناصر النيتروجين والفوسفور والبوتاسيوم و كذلك عناصر الحديد والمنجنيز والزنك والنحاس بواسطة نبات القمح.

أوضحت الدراسة أيضا أن أقصى محصول للقمح وأقصى امتصاص للعناصر بواسطة نبات القمح كان عند إضافة السماد العضوى الصناعى الناتج من المخلفات الحيوانية وهذا يدل على أن هذا السماد كان فى حالة جيدة من التدبل والنضج.