J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol. 13 (1):33 - 38, 2022

Journal of Soil Sciences and Agricultural Engineering

Journal homepage & Available online at: www.jssae.journals.ekb.eg

Response of Lettuce Plant Grown on Sandy Soil to Organic and Inorganic Amendments

Omar, M. M. ; Hassnaa A. Abdrabou and A. M. El-Ghamry*

Soil sciences Department, Faculty of Agriculture, Mansoura University, Egypt.

ABSTRACT

Currently, the Egyptian government is working hard to encourage and motivate citizens to reclamation the desert soils. So, a pot experiment was carried out aiming at evaluating the effect of some organic fertilizers as main factor *i.e.*, compost, chicken manure and town refuse at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) as sub main factor as well as bentonite amendment at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) as sub-sub main factor on the performance of lettuce plants grown on sandy soil. Lettuce growth criteria *i.e.*, plant height, plant fresh and dry weights, head diameter and root length as well as concentrations of nutrients *i.e.,* N, P, K, Fe and Mn in plant tissues were measured at harvest stage. The main results showed that the lettuce plants treated with compost had the highest values of all aforementioned traits followed by that treated with chicken manure, while lettuce plants treated with town refuse possessed the lowest values. Also, the values of all aforementioned traits increased as the added rate of the studied organic amendment increased. On the other hand, the soil addition of bentonite had a positive effect on lettuce plant performance compared to the corresponding plants grown without soil addition of bentonite (control treatment), where the values of all aforementioned traits increased as the added rate of the bentonite amendment increased. It can be concluded that soil addition of organic manures in combining with bentonite amendment represents an attractive option for programs of fertilization under the sandy soil.

Keywords: Compost, chicken manure, town refuse, bentonite, lettuce plants.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is consumed as a fresh green salad, where it is considered as a brilliant nutritive source of vitamins i.e., vitamins C and A, minerals *e.g.*, N, Fe, Mn.... etc. (El-Ghamry *et al.*, 2018). Also, its leaves are a rich source of antioxidants and phytochemicals that are anti-carcinogenic. The cultivated area of lettuce plants in Egypt is about 3100 hectares producing about 70000 Mg (Darwesh *et al.*, 2019).

In Egypt, the sandy soils represent more than 90% of the total area. So, the reclamation of degraded soils *e.g.*, sandy soil is becoming a major strategy for the government. Sandy soil possesses poor physical and chemical properties as well as its low capacity to retain irrigation water and its low supplying power for nutrient elements (EI-Ghamry*et al.*, 2021).

One of the plants protective ways from the poverty of sandy soil fertility is the usage of soil organic and inorganic amendments.Organic manures possess the possibility of providing the energy of microflora, supplying nutrients and improving sandy soil properties. Soil addition of organic manures *e.g.*, compost, chicken manure and town refuse was observed to possess a positive influence that aid crop growth and improve the vegetable crops nutritional components (EI-Naggar and EI-Ghamry, 2001; Abou-Hussein *et al.*, 2002 and Hou *et al.*, 2013). Arthur *et al.*, (2012) reported that compost possesses a vital role in enhancing sandy soil performance because the organic source causes to improve the soil properties. Also,Agbede *et al.*,(2020) reported that chicken manure soil addition improved all properties of sandy soil. Besides, Fouda,(2021) reported that one of the most abundant organic materials, locally available is organic town refuse, which could easily be used as sources of organic substances and nutrients.

Bentonite is a clay mineral, a rock containing mainly montmorillonite (a smectite group clay mineral), (Pandey *et al.*,2019). The primary vital role of the bentonite amendment is to improve the soil water holding capacity and moisture content, thus contributing to the stimulation of biological activity (Zhang *et al.*, 2020). The addition of bentonite to soils leads to an increase in the mineral nutrient and colloid content of the soils which should decrease the leaching of various nutrients from the soil (Mi *et al.*, 2020).

Therefore, the objective of the current study is to assess the influence of some soil additions at different rates on the performance of lettuce plants grown onsandy soils and find out the superior combined treatment because of the importance of sandy soil reclamation in Egypt to face the growing demand of the population for food and fill the gap between food production and consumption.

MATERIALS AND METHODS

A pot trial was implemented to evaluate the response of lettuce plants grown on sandy soils to different rates of different organic fertilizers (compost, chicken manure and town refuse) and bentonite amendment.

1.Experimental site.

This research work was executed during growing season of 2018/2019 at the green house of Agricultural Faculty, Mansoura University, Egypt.

2.Soil sampling.

Sandy soil was collected from Kalapshoo Village, Belqas District, Dakahlia Governorate, Egypt, then it was analyzed before the execution of the experiment according to Peverill *et al.*, (1999) as presented in Table1.

*** Corresponding author.**
E-mail address: Aymanelghamry@mans.edu.eg
DOI: 10.21608/jssae.2022.124298.1058

Table 1. Characteristics of the studied soil before transplanting.

Particle size distribution (%)				Texture class	Available nutrients			EC**, dSm^{-1}	pH^{*}	OM	$CaCO_3$
C. Sand	F. Sand	Silt	Clay		N	P	K			(%)	
					($mg\ kg^{-1}$)						
4.50	87.00	2.90	5.60	Sandy	30.50	3.70	101.60	1.35	8.00	0.20	1.00

*** pH (1:2.5 soil suspension).**
****EC(soil extract 1:5).**

3.Studied substances.

Compost (animal residues) and chicken manure were obtained from the farm of the faculty, which located in Kalabsho. Town refuse was taken from Mansoura manufactory for organic manure. Bentonite was purchased from Al-Basteen Company for Industry – Cairo. Table 2 shows some properties of the studied amendments.

Table 2. Chemical analysis of the studied amendments.

Parameters		Compost	Chicken manure	Town refuse	Bentonite
pH		6.15	6.64	7.72	9.25
EC, dSm^{-1}		3.65	3.71	4.25	3.44
Total C, %		20.41	25.40	11.51	0.48
Total N, %		1.46	1.50	0.55	0.00
C:N ratio		13.90	16.90	20.80	0.00
Available nutrients , mg kg^{-1}	P	0.620	0.49	0.36	0.51
	K	0.950	0.93	0.65	46.71
	Fe	48.20	47.95	47.00	95.20
	Zn	24.00	18.00	9.56	20.20
	Mn	26.00	25.00	19.30	80.30

4.Lettuce seedlings

Lettuce seedlings (*Lactuca sativa* L.Cv Balady) were obtained from Ministry of Agric. and soil Rec. (MASR).

5.Pots used.

Plastic pots possessed 25 cm diameter and 25 cm depth were filled by air-dry soils equaled to 10 kg oven dry soil.

6.Experimental setup.

Pot experiment was carried out aiming at evaluating the effect of some organic fertilizers as main factor *i.e.,* compost, chicken manure and town refuse at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) as sub main factor as well as bentonite amendment at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) as sub-sub main factor on the performance of lettuce plants grown on sandy soil.Two weeks before transplanting,all pots received the studied substances in a single addition at above studied rates. Four lettuce seedlings were transplanted in each pot on December 15th then thinning process to two homogenous plants pot^{-1} was done at a period of 25 days from transplanting.

The execution of the research work was done in a split-split-plot design with three replicates. Consequently, total number of pots was 81 as follows; 3 "organic fertilizers" ×3 "levels of organic fertilization" × 3 "bentonite treatment"× 3 "replicates ".

The normal agricultural practices as well as mineral NPK fertilization were done for the lettuce production depending on the recommendation of MASR. Ammonium sulphate (21 %N) was applied in two doses at 25 and 45 days from transplanting at rate of 100 Kg fed^{-1}. Potassium sulfate (39.84 % K) was applied in a single application at rate of 50 Kg $fed^{-1}$with the second N-fertilizer dose. While, before transplanting, calcium superphosphate (6.6%P) was added in a one dose at rate of 250 Kg fed^{-1}.

The irrigation process was executed as the lettuce plants required. On 20th of March, the harvest process was done.

7.Measurements.

Growth criteria.

The following growth criteria *i.e.,* plant height (cm), plant fresh and dry weights (g $plant^{-1}$), head diameter and root length (cm) were measured at harvest stage.

Chemical constituents and quality.

To determine the concentrations of nutrients *i.e.,* N, P, K, Fe and Mn in lettuce plant tissues, 0.2 g from each sample was digested using 5 cm^3 from the mixture of H_2SO_4 and $HClO_4$ (1:1) as described by Peterburgski (1968).

Total N, P and K in lettuce were determined using Kjeldahl method, spectrophotomter and flamphotometer, respectively apparatus depending on the methods described by Walinga *et al*., (2013).

Iron and manganese were determined using atomic absorption spectrophotomer using perkin Elmer Model 370A as described by Chapman andPratt (1978).

8.Statistical analysis.

The obtained data were subjected to analysis of variance according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

To understand the strategies of lettuce plants response to some organic fertilizers and bentonite amendment under sandy soil conditions, a pot experiment was executed and the obtained results will be presented and discussed in separate topics.

1.Growth criteria of lettuce plants.

Tables 3 and 4 show that soil addition of some organic manures *i.e.,* compost, chicken manure and town refuse at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) and inorganic amendment *i.e.,* bentonite at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) pronouncedly affected all studied growth criteria *i.e.,* plant height (cm), plant fresh and dry weights (g $plant^{-1}$) (Table 3), head diameter (cm) and root length (cm) (Table 4) at harvest stage of lettuce plants.

The same Tables illustrate that the lettuce plants treated with compost had the highest values of all studied growth criteria under sandy soil conditions followed by that treated with chicken manure, while lettuce plants treated with town refuse possessed the lowest values of plant height (cm), plant fresh and dry weights (g $plant^{-1}$), head diameter (cm) and root length (cm) at harvest stage of lettuce plants.

Concerning the studied levels of organic amendments, from the same Tables, it can be noticed that the values of all aforementioned growth criteria increased as the added rate of the studied organic amendment increased.

Table 3. Effect of organic fertilizers and bentonite amendment at different rates on growth criteria of lettuce plants *i.e.*, plant height, plant fresh and dry weights at harvest stage.

Treatments			Plant height, cm	Plant fresh weight, g $plant^{-1}$	Plant dry weight $g.plant^{-1}$
Organic fertilization as main factor					
Compost			28.72a	346.37a	26.97a
Chicken manure (ChM)			28.32b	340.35b	25.86b
Town refuse (TR)			28.28c	335.09c	25.10c
LSD at 5%			0.03	0.49	0.05
Levels of organic fertilization as sub main factor					
0.0 Mg fed^{-1}			22.18c	300.49c	19.00c
10 Mg fed^{-1}			30.97b	347.74b	27.44b
15 Mg fed^{-1}			32.17a	373.58a	31.49a
LSD at 5%			0.04	1.42	0.04
Levels of bentonite amendment as sub-sub main factor					
Bentonite at rate of 0.0 Mg fed^{-1}			26.85c	316.24c	21.81c
Bentonite at rate of 10 Mg fed^{-1}			28.75b	349.95b	27.67b
Bentonite at rate of 15 Mg fed^{-1}			29.71a	355.63a	28.45a
LSD at 5%			0.07	2.77	0.07
Interaction					
Compost	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	20.29	289.80	16.00
		B (10 Mg fed^{-1})	21.31	300.65	19.77
		B (15 Mg fed^{-1})	25.20	310.54	22.00
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	29.93	323.84	24.25
		B (10 Mg fed^{-1})	31.91	369.85	30.58
		B (15 Mg fed^{-1})	32.16	373.92	31.40
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	30.78	343.04	26.66
		B (10 Mg fed^{-1})	33.33	400.31	35.93
		B (15 Mg fed^{-1})	33.56	405.38	36.18
ChM	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	20.29	292.20	15.90
		B (10 Mg fed^{-1})	21.76	300.64	19.94
		B (15 Mg fed^{-1})	23.44	306.16	20.35
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	29.69	319.63	23.48
		B (10 Mg fed^{-1})	31.48	359.10	29.01
		B (15 Mg fed^{-1})	31.67	363.64	29.73
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	30.56	336.79	25.89
		B (10 Mg fed^{-1})	32.86	390.28	33.80
		B (15 Mg fed^{-1})	33.10	394.70	34.59
TR	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	20.35	296.02	16.22
		B (10 Mg fed^{-1})	22.67	301.04	20.21
		B (15 Mg fed^{-1})	24.34	307.34	20.58
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	29.54	314.95	22.74
		B (10 Mg fed^{-1})	31.06	349.80	27.56
		B (15 Mg fed^{-1})	31.28	354.97	28.23
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	30.28	329.87	25.11
		B (10 Mg fed^{-1})	32.41	377.86	32.22
		B (15 Mg fed^{-1})	32.61	383.98	33.00
LSD at 5%			0.20	8.20	0.20

Generally, it can be said that all organic amendments had a vital role in improvement the performance of lettuce plants grown on sandy soil due to its ability in supplying nutrients to plants grown under poor soil conditions. The superiority of compost amendment compared to others amendments may be attributed to that compost had the lowest C/N ratio in addition to its high content from nutrients compared to other both organic amendments. For the same reasons, the chicken manure amendment was more effective than town refuse fertilizer. The obtained findings are in harmony with the results of Eklind *et al.,* (2001) and Alromian, (2020) on lettuce plants.

Regarding the bentonite amendment, Tables 3 and 4 indicate that the soil addition of bentonite had a positive effect on lettuce plant performance compared to the corresponding plants grown without soil addition of bentonite (control treatment), where the values of all aforementioned growth criteria increased as the added rate of the bentonite amendment increased. The superiority of bentonite amendment may be attributed to that it could increase lettuce plant biomass by increasing cation exchange capacity of sandy soil and making more exchange sites available to hold plant nutrients for lettuce plant growth as well as its nature , where it is a rock containing mainly montmorillonite (Valizadeh *et al,* 2014).A further benefits of bentonite affecting lettuce performance may be its capacity to increase plant available water as a function of increasing porosity as mentioned by Soda *et al.,* (2006).

Table 4. Effect of organic fertilizers and bentonite amendment at different rates on growth criteria of lettuce plants *i.e.*, head diameter and root length at harvest stage.

Treatments			Head diameter, cm	Root length, cm
Organic fertilization as main factor				
Compost			8.21a	12.03a
Chicken manure (ChM)			8.09ab	11.81b
Town refuse (TR)			8.02a	11.63b
LSD at 5%			0.14	0.19
Levels of organic fertilization as sub main factor				
0.0 Mg fed^{-1}			7.13c	10.24c
10 Mg fed^{-1}			8.37b	12.17b
15 Mg fed^{-1}			8.82a	13.06a
LSD at 5%			0.04	0.07
Levels of bentonite amendment as sub-sub main factor				
Bentonite at rate of 0.0 Mg fed^{-1}			7.48c	10.77c
Bentonite at rate of 10 Mg fed^{-1}			8.36b	12.24b
Bentonite at rate of 15 Mg fed^{-1}			8.48a	12.46a
LSD at 5%			0.06	0.08
Interaction				
Compost	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	6.30	9.20
		B (10 Mg fed^{-1})	7.44	10.63
		B (15 Mg fed^{-1})	7.69	10.96
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	8.05	11.46
		B (10 Mg fed^{-1})	8.76	12.85
		B (15 Mg fed^{-1})	8.83	13.03
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	8.30	11.96
		B (10 Mg fed^{-1})	9.24	14.00
		B (15 Mg fed^{-1})	9.29	14.16
ChM	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	6.20	9.14
		B (10 Mg fed^{-1})	7.45	10.62
		B (15 Mg fed^{-1})	7.62	10.85
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	7.94	11.36
		B (10 Mg fed^{-1})	8.51	12.47
		B (15 Mg fed^{-1})	8.63	12.69
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	8.24	11.82
		B (10 Mg fed^{-1})	9.09	13.57
		B (15 Mg fed^{-1})	9.15	13.79
TR	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	6.31	9.21
		B (10 Mg fed^{-1})	7.49	10.65
		B (15 Mg fed^{-1})	7.65	10.89
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	7.86	11.18
		B (10 Mg fed^{-1})	8.36	12.14
		B (15 Mg fed^{-1})	8.43	12.34
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	8.16	11.61
		B (10 Mg fed^{-1})	8.90	13.22
		B (15 Mg fed^{-1})	9.00	13.40
LSD at 5%			0.18	0.25

The results mentioned in Tables3 and 4 has been proved that the interaction among the studied treatments had highly significant effects on all the studied growth criteria of lettuce plant. Where the highest values of all studied growth criteria *i.e.*, plant height (cm), plant fresh and dry weights (g $plant^{-1}$) (Table 3),head diameter (cm) and root length (cm) (Table 4) at harvest stage were realized when plants treated with compost and simultaneously treated with bentonite conditioner at rate of 15 Mg fed^{-1} for both. While the lowest values of all aforementioned growth parameters were recorded with the corresponding plants grown without both organic and inorganic amendments.

2.Chemical constituents in leaves of lettuce plants.

The impact of studied organic amendments *i.e.*, compost, chicken manure and town refuse at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) and inorganic amendment *i.e.*, bentonite at different rates (0.0, 10.0 and 15.0 Mg fed^{-1}) on macronutrients content *i.e.*, N, P, K, % (Table 5) and micronutrients content *i.e.*, Fe and Mn, mg kg^{-1} (Table 6) in leaves of lettuce plants was significant.

Data of the same Tables show that leaves of lettuce plants grown on sandy soil amended by compost had the highest values of N, P, K (%), Fe and Mn (mg kg^{-1}), while the lettuce plants grown on sandy soil amended by chicken manure came in the second order for all aforementioned traits, whilst the lettuce plants grown on sandy soil amended by town refuse possessed the lowest values.

As for the studied levels of organic amendments, the sequence order of studied levels from the most effective to the less was as follows;

15.0 Mg fed^{-1}> 10.0 Mg fed^{-1}> control (without soil addition).

The obtained results are in harmony with those of Amaref *et al*., (2018) and El-Ghamry *et al*., (2019) who compared among different organic amendments and their impacts on plants grown sandy soil.

The investigated organic amendments increased the micro and macronutrient's availability, thus increasing their uptake by lettuce plants and their concentrations in plant tissues and this may be positively reflected on the synthesis of chlorophyll in the lettuce plant tissues and this may be the reason for raising the ability of lettuce to tolerate sandy soil conditions. As mentioned above, the superiority of compost amendment compared to others amendments may be attributed to that compost had the lowest C/N ratio in addition to its high content from nutrients compared to other both organic amendments (Eklind *et al*., 2001 and Alromian, 2020).

Tables 5 and 6 show the total content of nitrogen, phosphorus, potassium, iron and manganese nutrients in tissues of lettuce plants at harvest stage under investigated rates of bentonite. Data again indicated positive responses for bentonite conditioner particularly with high-added level (15.0Mg fed-1) compared to control treatment (without soil addition. In other words, the sequence order of studied levels of bentonite amendment from the most effective to the less was as follows;

15.0 Mg fed^{-1}> 10.0 Mg fed^{-1}> control (without soil addition of bentonite).

These findings may be attributed to the good movement of nutrients from the soil to lettuce grown plant as well as its good metabolism that indirectly reflected on the health state of sandy soil. It is known that sandy soil suffers from rapid irrigation water infiltration, therefore the favourable effects of bentonite amendment may be related to the role of bentonite in improving the water holding capacity and moisture content of sandy soil thus contributing to the stimulation of biological activity(Soda *et al.,* 2006 and Valizadeh *et al,* 2014). The obtained results agree with those of El-Etr and Hassan, (2017) who suggested that soil addition of bentonite increased the total nutrients content of pea plant which should associate with good use of nutrients in soil solution by lettuce roots.

Table 5. Effect of organic fertilizers and bentonite amendment at different rates on chemical constituents in leaves of lettuce plants *i.e.*, N, P and K at harvest stage.

Treatments			N, %	P, %	K, %
Organic fertilization as main factor					
Compost			3.39a	0.492a	3.32a
Chicken manure (ChM)			3.32b	0.486b	3.22b
Town refuse (TR)			3.27c	0.482b	3.15c
LSD at 5%			0.04	0.004	0.05
Levels of organic fertilization as sub main factor					
0.0 Mg fed^{-1}			2.83c	0.431c	2.68c
10 Mg fed^{-1}			3.44b	0.504b	3.30b
15 Mg fed^{-1}			3.72a	0.525a	3.70a
LSD at 5%			0.03	0.003	0.05
Levels of bentonite amendment as sub-sub main factor					
Bentonite at rate of 0.0 Mg fed^{-1}			3.05c	0.460c	2.89c
Bentonite at rate of 10 Mg fed^{-1}			3.44b	0.495b	3.36b
Bentonite at rate of 15 Mg fed^{-1}			3.50a	0.506a	3.44a
LSD at 5%			0.02	0.004	0.04
Interaction					
Compost	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	2.72	0.404	2.50
		B (10 Mg fed^{-1})	2.80	0.430	2.70
		B (15 Mg fed^{-1})	2.96	0.464	2.88
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	3.18	0.482	3.05
		B (10 Mg fed^{-1})	3.69	0.520	3.58
		B (15 Mg fed^{-1})	3.75	0.525	3.64
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	3.36	0.497	3.24
		B (10 Mg fed^{-1})	4.01	0.548	4.10
		B (15 Mg fed^{-1})	4.07	0.553	4.16
ChM	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	2.71	0.396	2.48
		B (10 Mg fed^{-1})	2.83	0.433	2.71
		B (15 Mg fed^{-1})	2.90	0.452	2.79
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	3.12	0.497	2.98
		B (10 Mg fed^{-1})	3.57	0.511	3.43
		B (15 Mg fed^{-1})	3.61	0.514	3.48
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	3.29	0.492	3.19
		B (10 Mg fed^{-1})	3.91	0.538	3.92
		B (15 Mg fed^{-1})	3.94	0.544	4.02
TR	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	2.75	0.409	2.53
		B (10 Mg fed^{-1})	2.85	0.437	2.74
		B (15 Mg fed^{-1})	2.92	0.459	2.83
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	3.07	0.475	2.92
		B (10 Mg fed^{-1})	3.45	0.502	3.30
		B (15 Mg fed^{-1})	3.50	0.506	3.36
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	3.25	0.489	3.12
		B (10 Mg fed^{-1})	3.82	0.531	3.76
		B (15 Mg fed^{-1})	3.86	0.534	3.83
LSD at 5%			0.07	0.011	0.12

Going along with combination treatments among organic amendments, their added levels and levels of bentonite conditioner, from the same Tables, it was obvious that the interaction among the studied treatments had highly significant effects on the total content of nitrogen, phosphorus, potassium, iron and manganese nutrients in tissues of lettuce plants at harvest stage. Where the highest values of all aforementioned traits were recorded when plants treated with compost and bentonite at the same time at rate of 15 Mg fed^{-1} for both, whilst the lowest values of all aforementioned traits were recorded with the corresponding lettuce plants grown without both organic and inorganic amendments.

Table 6. Effect of organic fertilizers and bentonite amendment at different rates on chemical constituents in leaves of lettuce plants *i.e.*, Fe, Mn at harvest stage.

Treatments			Fe, mg kg^{-1}	Mn, mg kg^{-1}
Organic fertilization as main factor				
Compost			230.39a	110.25a
Chicken manure (ChM)			225.49b	107.10b
Town refuse (TR)			220.27c	103.93c
LSD at 5%			3.45	1.47
Levels of organic fertilization as sub main factor				
0.0 Mg fed^{-1}			191.32c	85.69c
10 Mg fed^{-1}			230.69b	110.49b
15 Mg fed^{-1}			254.15a	125.10a
LSD at 5%			1.26	0.54
Levels of bentonite amendment as sub-sub main factor				
Bentonite at rate of 0.0 Mg fed^{-1}			201.80c	93.63c
Bentonite at rate of 10 Mg fed^{-1}			234.44b	112.27b
Bentonite at rate of 15 Mg fed^{-1}			239.91a	115.38a
LSD at 5%			1.61	0.71
Interaction				
Compost	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	179.29	79.88
		B (10 Mg fed^{-1})	191.35	86.32
		B (15 Mg fed^{-1})	202.02	90.20
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	209.52	98.68
		B (10 Mg fed^{-1})	249.66	121.79
		B (15 Mg fed^{-1})	255.21	125.08
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	225.74	107.41
		B (10 Mg fed^{-1})	277.73	140.03
		B (15 Mg fed^{-1})	283.02	142.91
ChM	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	179.22	80.54
		B (10 Mg fed^{-1})	193.03	86.53
		B (15 Mg fed^{-1})	198.71	89.90
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	208.04	96.00
		B (10 Mg fed^{-1})	239.85	116.53
		B (15 Mg fed^{-1})	245.07	119.14
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	221.00	104.34
		B (10 Mg fed^{-1})	270.57	134.06
		B (15 Mg fed^{-1})	273.92	136.85
TR	0.0 Mg fed^{-1}	B (0.0 Mg fed^{-1})	179.31	80.95
		B (10 Mg fed^{-1})	197.92	86.75
		B (15 Mg fed^{-1})	201.02	90.14
	10 Mg fed^{-1}	B (0.0 Mg fed^{-1})	202.68	93.21
		B (10 Mg fed^{-1})	230.40	110.49
		B (15 Mg fed^{-1})	235.79	113.48
	15 Mg fed^{-1}	B (0.0 Mg fed^{-1})	211.42	101.64
		B (10 Mg fed^{-1})	259.47	127.93
		B (15 Mg fed^{-1})	264.45	130.73
LSD at 5%			4.83	2.14

CONCLUSION

Results of the current investigation and those obtained by otherresearchers are enough to confirm that both organic manures *e.g.,* compost, chicken manure and town refuse and bentonite conditioner are beneficial for sandy soil reclamation at all studied rates.In this respect, the soil addition of compost at a rate of 15.0 Mg fed^{-1} for both of them was the best-combined treatment.

Generally,it can be concluded that soil addition of organic manures in combining with bentonite amendment represents an attractive option for programs of fertilization under the sandy soil.

REFERENCES

Abou-Hussein, S. D., El-Shorbagy, T., & Abou-Hadid, A. F. (2002). Effect of cattle and chicken manure with or without mineral fertilizers on tuber quality and yield of potato crops. In International Symposium on the Horizons of Using Organic Matter and Substrates in Horticulture 608 (pp. 95-100).

Agbede, T. M., Odoja, A. S., Bayode, L. N., Omotehinse, P. O., & Adepehin, I. (2020). Effects of biochar and poultry manure on soil properties, growth, yield and quality of cocoyam (*Xanthosoma sagittifolium Schott*) grown in sandy soil. Communications in Soil Science and Plant Analysis, 51(7), 932-947.

Alromian, F. M. (2020). Effect of type of compost and application rate on growth and quality of lettuce plant. Journal of Plant Nutrition, 43(18), 2797-2809.

Amaref, M., Ghazi, D., & El-Ghamry, A. (2018). Effect of biochar and chicken manure on soil properties and growth traits of coriander plant irrigated with saline water in sandy soil. Journal of Soil Sciences and Agricultural Engineering, 9(8), 321-328.

Arthur, E., Cornelis, W., & Razzaghi, F. (2012). Compost amendment to sandy soil affects soil properties and greenhouse tomato productivity. Compost Science & Utilization, 20(4), 215-221.

Chapman, H. D., & Pratt, P. F. (1978). Methods of analysis for soils and waters. University of California, Division of Agriculture Science, CA.

Darwesh, R. K., Farrag, D. K., & Moursi, E. A. (2019). Effect of irrigation scheduling and intercropping pattern on growth, yield, quality of green onion, lettuce and some water relations in North Nile delta region. Journal of Soil Sciences and Agricultural Engineering, 10(12), 841-850.

EI-Naggar, E. M., & EI-Ghamry, A. M. (2001). Comparison of sewage sludge and town refuse as soil conditioners for sandy soil reclamation. Pak. J. Biol. Sci, 4, 775-778.

Eklind, Y., Raemert, B., & Wivstad, M. (2001). Evaluation of growing media containing farmyard manure compost, household waste compost or chicken manure for the propagation of lettuce (Lactuca sativa L.) transplants. Biological agriculture & horticulture, 19(2), 157-181.

El-Etr, W., & Hassan, W. (2017). A study of some sandy soil characteristics treated with combinations of bentonite and vinasse which reflected on productivity of pea crop. Journal of Soil Sciences and Agricultural Engineering, 8(10), 545-551.

El-Ghamry, A. M., El-Hadidi, E. M., Abo El-Ezz, S. F., El-Sherpiny, M. A., & Harb, M. A. (2021). Response of wheat plants grown on alluvial and sandy soils to some beneficial elements.Journal of Soil Sciences and Agricultural Engineering, 12(10), 685-695.

El-Ghamry, A. M., Fouda, K. F., Abo El-Ezz, S. F. & Kattoof, S.H (2019). Organic Fertilizers Derived from Farm By-Products for Sustainable Agriculture.–A Review. Journal of Soil Sciences and Agricultural Engineering, 10(12), 815-819.

El-Ghamry, A., Ghazi, D., & Mousa, Z. (2018). Effect of titanium dioxide on lettuce plants grown on sandy soil. Journal of Soil Sciences and Agricultural Engineering, 9(10), 461-466.

Fouda, K. F. (2021). Effect of foliar application of humic acid, EM and mineral fertilization on yield and quality of carrot under organic fertilization. Journal of Soil Sciences and Agricultural Engineering, 12(1), 1-7.

Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research. John Wiley & Sons.

Hou, Y., Hu, X., Yan, W., Zhang, S., & Niu, L. (2013). Effect of organic fertilizers used in sandy soil on the growth of tomatoes. Agricultural Sciences, 4(5B), 31.

Mi, J., Gregorich, E. G., Xu, S., McLaughlin, N. B., & Liu, J. (2020). Effect of bentonite as a soil amendment on field water-holding capacity, and millet photosynthesis and grain quality. Scientific Reports, 10(1), 1-11.

Pandey, M. R., Badiger, S., & Sivakumar Babu, G. L. (2019). Effects of bentonite and polymer soil amendment on contaminant transport parameters. Journal of Hazardous, Toxic, and Radioactive Waste, 23(1), 04018034.

Peterburgski, A. V. (1968). Hand Book of Agronomic Chemistry. Kolos Puplishing House, Moscow,(in Russian, pp. 29-86).

Peverill, K. I., Sparrow, L. A., & Reuter, D. J. (Eds.). (1999). Soil analysis: an interpretation manual. CSIRO publishing.

Soda, W., Noble, A. D., Suzuki, S., Simmons, R., Sindhusen, L. A., & Bhuthorndharaj, S. (2006). Co-composting of Acid Waste Bentonites and their Effects on Soil Properties and Crop Biomass. Journal of environmental quality, 35(6), 2293-2301.

Valizadeh, G. B. A., Hossein, N. S., Ali, T., & Hojat, E. (2014). Evaluation of chlorophyll fluorescence and biochemical traits of lettuce under drought stress and super absorbent or bentonite application. Journal of Stress Physiology & Biochemistry, 10(1).

Walinga, I., Van Der Lee, J. J., Houba, V. J., Van Vark, W., & Novozamsky, I. (2013). Plant analysis manual. Springer Science & Business Media.

Zhang, H., Chen, W., Zhao, B., Phillips, L. A., Zhou, Y., Lapen, D. R., & Liu, J. (2020). Sandy soils amended with bentonite induced changes in soil microbiota and fungistasis in maize fields. Applied Soil Ecology, 146, 103378.

استجابة نبات الخس النامي على أراضي رملية لمحسنات التربة العضوية والغير عضوية

محمود موسى عمر ، حسناء عبد المقصود عبد ربه و أيمن محمد الغمرى
قسم الأراضى ، كلية الزراعة ، جامعة المنصورة ، مصر.

.

مؤخرا،تعمل الحكومة المصرية جاهدة علي تشجيع وتحفيز المواطنين على استصلاح الأراضي الصحراوية. لذلك، تم إجراء تجربة أصص تهدف إلى تقييم تأثير بعض الأسمدة العضوية مثل سماد المكمورة(الكومبوست)، زرق الدواجن، مخلفات المدن كمعاملات رئيسية بمعدلات مختلفة (٠،٠، ١٠،٠ و١٥،٠ طن/الفدان) كمعاملات منشقة اولي وكذلك محسن البنتونايت بمعدلات مختلفة (٠،٠،١٠،٠، ١٥،٠ طن/الفدان)كمعاملات منشقة ثانيةعلى أداء نباتات الخس النامية بالتربة الرملية. تم قياس معايير نمو الخس مثل ارتفاع النبات، ووزن النبات الطازج والجاف، وقطر الرأس وطول الجذر وكذلك تركيز العناصر الغذائية مثل النيتروجين والفسفور والبوتاسيوم والحديد والمنجنيز في أنسجة النبات عند مرحلة الحصاد، وأظهرت النتائج الرئيسية أن نباتات الخس المعاملة بسماد المكمورة(الكومبوست) كان لها أعلى القيم بالنسبة لجميع الصفات المذكورة أعلاه تليها تلك النباتات المعاملة بزرق الدواجن، بينما امتلكت نباتات الخس التي تمت معاملتها بمخلفات المدن أقل القيم. كما زادت قيم جميع الصفات المذكورة اعلاه كلما زاد معدل إضافة السماد العضوي المدروس. من ناحية أخرى، فإن إضافة البنتونايت للتربة كان له تأثير إيجابي على أداء نبات الخس مقارنة بالنباتات المقابلة النامية بدون إضافة البنتونايت (معاملة الكنترول)، حيث زادت قيم جميع الصفات المذكورة أعلاه مع زيادة المعدل المضاف لمحسن البنتونيت. يمكن الاستنتاج أن الإضافة الأرضية للسماد العضوي مع محسن البنتونايت يمثل خيارًا جذابًا لبرامج التسميد تحت ظروف التربة الرملية.