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EFFECT OF RICE STRAW COMPOST AND DIFFERENT SOIL TYPES ON GROWTH AND CHEMICAL CONSTITUENTS OF *Pelargonium graveolens* (L.) PLANTS

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ABSTRACT

This experiment was conducted at the Experimental Station and in the Laboratory of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University during the two successive seasons of 2004/2005 and 2005/2006 to study the effect of applying rice straw compost, at the rates of 0, 25, 50, and 75 % by weight, to four soil types on growth and chemical composition of *Pelargonium graveolens* (L.) plants. The used soil types in this research were calcareous, loamy, saline and sandy.

The obtained results showed that available N, P and K (ppm) in the growing media increased with increasing the compost rate (%). The best results in this regard were obtained from saline medium followed by loamy, calcareous then sandy ones.

Regarding the interaction effect of rice straw compost and soil type, the obtained results indicated that sandy and loamy media mixed with 75% rice straw compost gave, in general, the best values of all vegetative and root growth parameters in both seasons.

The obtained results indicated also that the best values of total chlorophyll content at the first cut of both seasons were of plants grown in loamy medium containing 75% rice straw compost, whereas at the second cut of both seasons, the plants grown in saline soil containing 75% rice straw compost gave the highest values in this regard.

The maximum increase of N (%) was determined in the leaves of the plants grown in loamy medium containing 50% rice straw compost, whereas the highest value of K (%) was obtained from the plants grown in loamy medium containing 75% rice straw compost. The best results of P (%) in the leaves were detected in the plants grown in calcareous medium containing 50% rice straw compost.

The highest essential oil percentages were obtained from the plants grown in calcareous medium containing 75% rice straw compost.

INTRODUCTION

Pelargonium graveolens (L.) with common names rose geranium, rose-scent geranium and geranium, is a perennial herb that belongs to the Geraniaceae family. Geranium plants are extremely popular garden plants grown for their fragrant leaves, and are suitable for inclusion in the herbaceous border. Their leaves and green branches, as well as fresh flowers contain essential oil of several medicinal values as anti-depresent and antiseptic effects and reducing inflammation (Bown, 1995). The oil is also used in perfumes industry due to its strong rose-like odour, and in soap industry. In addition, geranium leaves are known to have antifungal activity and repel insects (Rajeswara, 2002). Geraniaceae family is chiefly native in

South Africa and distributed in tropical Africa and Australia (Putievsky *et al.*, 1990). The main constituents of geranium essential oil are monoterpenol, geraniol, citronellol and linalool and their esters and aldehydes (Balbaa *et al.*, 1981). The two components geraniol and citronellol represent about 70% of the essential oil. Geranium plants are commercially grown in Egypt, Morocco and China where the major production of essential oil is taking place.

Agricultural wastes represent a big problem for our society. The continuous accumulation of these wastes causes a lot of harms to the environment. These wastes are suitable harbor for the propagation of harmful insects and bacteria and a source for evolution of pollutant gases in the atmosphere. The rice straw residue is one of these wastes which reach about 6.5 million tons per year and the most amount of it is disposal by burning the straw in the fields and in this way the removal causes air pollution (EEAA, 2007). The worst effects resulting from burning rice straw are the death of all beneficial living organisms and the burning of organic material in the surface layer of soil. Also open burning of rice straw causes large amounts of pollutants to be emitted including toxic gases (carbon monoxide). So, it is the actual reason of the black cloud which is very dangerous and harmful for human health.

Recycling straw will increase the quantity of organic matter in the soil. Rizk (2001) showed that organic matter contains higher levels of relatively available nutrient elements which are essentially required for plant growth and improve physical soil properties. Rodrigues *et al.* (1996) found that the application of compost has positively affected the structure, porosity, water holding capacity, compression strength, nutrients content, and organic matter content of the soil which consequently improve plant growth.

The objective of this research was to determine the effect of applying rice straw compost at different rates to some soil types on growth characteristics and chemical compositions of geranium plants.

MATERIALS AND METHODS

This experiment was carried out at the Experimental Station and in the Laboratory of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University during the two growing seasons of 2004/2005 and 2005/2006 to study the effect of mixing rice straw compost at different rates with some soil types on growth and chemical composition of *Pelargonium graveolens* (L.) plants.

Used soil types: Four different types of soil were used in this experiment. Calcareous soil was brought from Borg El Arab, Alexandria. Loamy soil was collected from Kafer Saad El Balad –Village. Saline and sandy soils were brought from different destinations near Gamassa city. Table (a) shows some physical and chemical properties of the used soil types in both seasons.

Table (a): Physical and chemical properties of the used soil types

Soil properties	Soil type							
	Calcareous		Loamy		Saline		Sandy	
	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06
Coarse sand (%)	24.40	25.39	3.4	2.3	2.65	2.9	88.3	90.5
Fine sand (%)	35.60	33.81	55.2	53.9	9.25	0.2	6.7	4.38
Silt (%)	25.60	26.11	26.1	26.2	23.75	29.1	2.3	2.37
Clay (%)	14.40	14.69	15.3	17.6	64.35	67.8	2.7	2.75
Soil texture	Silt loamy	Silt loamy	Loamy	Loamy	Clayey	Clayey	Sandy	Sandy
E. C. (dS/m)	0.69	0.70	1.39	1.33	5.07	4.77	0.57	0.58
pH	8.15	8.10	7.90	7.91	8.60	8.77	8.23	8.30
S. P.	37.00	37.74	48	49	67	65	26	26.52
O. M. (%)	0.49	0.43	0.91	0.79	0.93	0.63	0.47	0.48
Ca^{++}(meq/100gsoil)	1.24	1.26	2.92	2.66	5.83	4.55	0.96	0.98
Mg^{++}(meq/100gsoil	0.68	0.69	1.97	1.91	3.43	2.26	0.53	0.54
K^{+} (meq/100g soil)	0.16	0.16	0.15	0.09	0.56	0.28	0.08	0.08
Na^{+}(meq/100g soil)	1.45	1.48	2.08	2.15	19.22	17.33	1.35	1.39
HCO_3^- meq/100gsoil	1.43	1.45	2.11	1.93	4.3	4.15	1.39	1.43
Cl^- (meq/100g soil)	0.92	0.94	2.02	2.15	19.23	17.33	0.88	0.9
SO_4^{--}(meq/100gsoil	1.18	1.20	2.99	2.73	5.51	2.94	0.65	0.66
N (ppm)	38.00	40.16	85.00	82.00	73.00	77.00	36.00	37.08
P (ppm)	10.2	9.3	6.9	7.1	6.1	5.9	3.1	3.6
K (ppm)	281	286	378	344	399	430	187	192

* O. M.= Organic matter * E. C. and soluble ions were determined in the soil paste extract

Table (b): Some chemical properties of the used rice straw compost for 2004/2005 and 2005/2006 seasons

Properties	2004/2005	2005/2006
Organic matter (%)	47.37	46.58
C/N ratio	19.43 : 1	18.98 : 1
Total N (%)	1.65	1.66
Total P (%)	0.28	0.26
Total K (%)	0.59	0.55
Total Ca (%)	27.48	27.02
E. C. (dS/m)	3.25	3.30
P (ppm)	270	255
K (ppm)	1422	1343
Available Zn (ppm)	10.22	9.66
Available Fe (ppm)	162	153
Available Mn (ppm)	91.4	86.4

Preparation of compost: Compost from rice straw was prepared at the same sites in both seasons, 2004/2005 and 2005/2006, for using in the current research. Rice straw was collected and the composting process was carried out according to the method described by Abou El- Fadl (1960). After 120 days in each season, total carbon and nitrogen percentages of the compost were measured. Total carbon percentage was 27.48 in the first season, while in the second one was 27.02, whereas, total nitrogen percentages were 1.65 and 1.66, respectively. Therefore, C/N ratio was found to be 19.43:1 in the first season and 18.97: 1 in the second one. These

C/N ratios of the compost, which are less than 25:1, were considered to be suitable according to Cook (1982). The chemical analysis of the used rice straw compost is shown in Table (b).

Preparation of the tested soil mixtures: Rice straw compost was mixed at the rates of 0, 25, 50, and 75 % by weight with the used four soil types to form sixteen interaction treatments.

Plant materials: Uniform rooted cuttings of geranium plants, 20 cm long, were obtained from the nursery of Faculty of Agriculture, Mansoura University

Planting: The rooted geranium cuttings were planted in plastic bags, 15-cm diameter, filled with the above mentioned culture mixtures on March 15th for both seasons. Factorial experimental type in complete block randomized design was carried out during two successive seasons. Each treatment was replicated three times (5 plants in each replicate).

Irrigation: The plants were irrigated immediately after planting with a tap-water. Afterwards, they were irrigated as needed depending on the degree of temperature during the growing season. Soil moisture was always kept at 60% of water holding capacity till the end of the experiment on October 15th in both seasons.

Pinching: At the beginning of the experiment, the rooted cuttings of geranium plants had one branch and about 6 nodes. The pinching was done after 30 days from transplanting on April 15th, 2005 and 2006 to accelerate more basal branching.

Measurements of the experiment:

*** Comparative measurements of the used soil mixtures:**

Some chemical analyses of the used soil mixtures along with their influence on the growth and development of the tested plant were carried out two times for each growing season, immediately after the first and second cut (3 and 7 months from transplanting, respectively). Available N (ppm) was determined using the conventional method of kjeldahle as described by Bremner and Mulvany (1982). Available P (ppm) was measured using the method described by Olsen and Sommers (1982), whereas available K was measured by using flame photometer according to Black (1965).

*** Comparative measurements of the tested plants:**

The following data were recorded two times for each growing season, i.e. before the first and second cut: Plant height (cm) from soil surface in the pot to the farthest point of the plant, number of leaves/plant, number of lateral shoots per plant, shoot fresh and dry weights (g/plant). In fresh leaf samples taken from the various treatments in both seasons, total chlorophyll (mg/g fresh weight) was measured according to the method of Moran (1982), while in dry leaf samples (at 70° till a constant weight), the percentages of total N, P and K were determined according to the methods described by Pregl (1945), Jackson (1967) and Black (1965), respectively. Essential oil (%) was determined in the fresh leaves according to Egyptian Pharmacopoeia (1984).

Root length (cm), as well as fresh and dry weights of roots (g/plant) were determined only after the second cut of both seasons.

Statistical analysis: The collected data in both seasons were statistically analyzed using the analysis of variance (ANOVA) methods and means were

compared by L.S.D at 5% level of probability as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of the interaction between different soil types and compost rates (%) on available N, P and K (ppm) in the used soil mixtures:

Data presented in Table (1) showed that the application of rice straw compost significantly increased the available N, P and K in all growing media in the first and second cuts of both seasons. These results are in a good agreement with many such findings as those of Madejon *et al.* (2001), Sugito *et al.* (2001), Abd El-Hamid *et al.* (2004), El-Dossoky (2005) and El-Arqan *et al.* (2008) who found that the application of compost increased N, P and K in the soil.

The increments of available N, P and K in the growing media increased with increasing the compost rate (%). The best results in this regard were obtained from saline medium followed by loamy, calcareous then sandy ones. The highly significant values of available N (291.0 and 326.3 ppm), P (21.30 and 27.93 ppm) and K (488.3 and 512.0) were determined in the saline medium containing 75% rice straw compost in the first cut of both seasons.

Table (1): Effect of the interaction between different soil types and compost rates (%) on available N, P and K (ppm) in the tested soil types during the first and second cuts in 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut						Second cut					
		N		P		K		N		P		K	
		2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	20.3	30.3	2.30	4.46	145.0	176.6	14.3	15.3	1.30	2.16	128.0	155.3
	25 %	114.6	131.0	5.90	10.63	241.3	285.6	104.6	114.0	2.96	7.30	224.0	251.3
	50 %	194.3	207.0	10.43	14.83	293.0	325.6	173.3	186.6	7.30	10.56	274.6	306.0
	75 %	206.6	218.3	15.63	18.10	331.6	374.6	183.3	198.0	11.16	14.10	311.0	348.3
Loamy	0 %	53.3	58.3	3.10	4.56	210.3	230.3	41.0	42.0	1.73	2.70	199.0	209.0
	25 %	121.6	137.0	7.20	8.93	313.0	320.0	113.3	121.6	5.13	5.66	297.3	298.6
	50 %	204.6	217.0	9.66	12.30	392.6	420.0	183.3	192.6	6.66	8.83	359.3	398.0
	75 %	232.0	258.0	14.76	16.90	493.0	507.0	200.6	212.3	10.93	11.76	477.3	487.0
Saline	0 %	181.0	192.0	11.16	12.80	293.3	308.6	161.3	177.0	8.50	9.40	262.3	289.6
	25 %	263.6	283.6	15.66	18.26	381.0	383.0	200.3	139.0	10.66	11.76	327.6	370.0
	50 %	282.3	293.0	18.66	21.96	437.6	484.6	224.0	228.6	13.13	17.76	413.6	463.6
	75 %	291.0	326.3	21.30	27.93	488.3	512.0	242.3	283.6	15.20	18.20	454.0	492.0
Sandy	0 %	13.0	20.3	1.10	2.36	93.3	113.3	7.6	15.0	0.94	1.06	82.0	103.0
	25 %	39.3	57.0	2.13	3.70	145.6	173.6	34.0	47.3	1.26	2.16	134.6	162.0
	50 %	73.0	90.6	1.93	5.20	183.0	201.0	63.3	72.0	1.20	3.86	174.0	186.6
	75 %	126.3	154.0	4.00	6.26	218.3	245.3	112.6	128.0	2.66	4.03	201.6	213.0
LSD 5%		10.3	8.44	2.18	0.63	20.0	16.7	15.9	15.7	1.92	1.93	25.3	20.5

Effect of the interaction between different soil types and compost rates (%) on vegetative and root growth parameters of geranium:

1- Plant height

Data presented in Table (2) revealed that plant height was generally improved in all growing media due to the application of rice straw compost. The tallest plants in the first and second cuts of both seasons were those grown in sandy medium containing 75% rice straw compost. These results were in agreement with the results obtained by Gauthier *et al.* (1998) on *Pelargonium x hortrum* who observed that the application of compost increased plant height. Molitor *et al.* (1997) reported that application of compost showed effects on improving soil physical properties and availability of nutrients which are reflected on vegetative growth of *Pelargonium zonale* hybrids. The shortest plants, in general, were those grown in the saline medium.

Table (2): Effect of the interaction between different soil types and compost rates (%) on height (cm) of geranium plants in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut		Second cut	
		2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	12.25	18.50	11.66	16.33
	25 %	18.06	23.65	16.60	22.43
	50 %	23.85	29.02	22.12	26.70
	75 %	28.08	36.48	27.33	32.40
Loamy	0 %	25.41	32.95	23.45	30.29
	25 %	34.11	33.60	31.59	35.70
	50 %	34.82	42.33	32.12	38.33
	75 %	35.63	45.48	35.17	43.16
Saline	0 %	7.16	9.92	6.40	6.68
	25 %	11.08	14.83	10.38	11.16
	50 %	13.94	18.10	11.34	16.50
	75 %	16.79	20.58	15.48	21.82
Sandy	0 %	27.60	31.90	21.70	28.86
	25 %	31.05	34.60	30.18	30.40
	50 %	30.41	46.10	29.29	43.64
	75 %	36.10	50.03	39.61	47.03
LSD 5%		5.22	4.74	5.61	6.76

2- Number of leaves per plant

Data in Table (3) showed that the highest values of leaf number per plant were obtained from plants grown in loamy medium containing 75% rice straw compost. At the first cut, the leaf number/plant reached 88.16 and 98.43 in the first and second seasons, respectively, whereas at the second cut, this reached 107.33 and 120.30, respectively.

3- Number of lateral shoots per plant

Data presented in Table (4) showed that the highest number of lateral shoots per plant (9.46 and 10.40) at the first cut and (11.90 and 13.33) at the second one of both seasons were resulted from plants grown in sandy medium containing 75% rice straw compost.

Table (3): Effect of the interaction between different soil types and compost rates (%) on number of leaves of geranium plants in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut		Second cut	
		2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	22.29	31.43	37.80	44.90
	25 %	30.94	47.49	45.72	54.11
	50 %	40.93	58.81	60.87	68.92
	75 %	59.37	71.62	80.99	87.60
Loamy	0 %	45.80	61.00	76.21	81.34
	25 %	62.83	70.05	85.88	97.56
	50 %	74.00	82. 00	96.60	112.20
	75 %	88.16	98.43	107.33	120.30
Saline	0 %	11.27	14.20	17.36	17.59
	25 %	17.03	20.50	19.48	26.16
	50 %	17.57	27.67	23.12	29.20
	75 %	28.40	35.63	34.11	41.96
Sandy	0 %	34.01	46.41	81.26	90.63
	25 %	62.05	43.83	85.56	96.10
	50 %	79.87	79.88	100.46	102.63
	75 %	81.54	88.83	105.63	110.50
LSD 5%		20.54	29.35	17.60	39.31

Table (4): Effect of the interaction between different soil types and compost rates (%) on number of lateral shoots per plant of geranium in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut		Second cut	
		2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	2.33	2.91	3.75	3.83
	25 %	2.83	3.16	3.41	3.63
	50 %	4.00	4.25	4.08	4.93
	75 %	5.83	6.00	6.26	8.33
Loamy	0 %	3.66	3.50	8.83	7.94
	25 %	3.00	6.23	7.12	11.50
	50 %	6.44	9.00	9.78	11.33
	75 %	7.60	10.56	9.44	10.82
Saline	0 %	1.11	1.22	1.33	1.67
	25 %	2.12	2.09	2.56	2.89
	50 %	2.51	2.11	2.00	3.78
	75 %	2.67	2.22	2.44	4.45
Sandy	0 %	5.06	6.33	9.66	9.86
	25 %	8.23	7.22	10.28	11.70
	50 %	8.72	10.10	8.52	11.10
	75 %	9.46	10.40	11.90	13.33
LSD 5%		1.38	2.31	2.02	2.49

4- Shoot fresh weight

Table (5) revealed that the application of rice straw compost resulted in heavier shoot fresh weights of the plants grown in all medium types containing 75% rice straw compost in the first and second cuts of both

seasons. The highest shoot fresh weight (66.65 and 75.34 g) at the first cut and (82.71 and 93.73 g) at the second one of both seasons were obtained from plants grown in loamy medium containing 75% rice straw compost.

The increase in fresh weight may be attributed to the increase in all studied characters; plant height, number of leaves and number of lateral shoots. Also, the increase in branching, after taking the first cut, may result in higher fresh weight of plant. The above mentioned results may be related to rice straw compost content of nutrients which increase with increasing the application rates and consequently increase the fresh weight. In addition, the effect of compost on vegetative growth may be due to improving the soil structure. These are in agreement with those results obtained by Subler *et al.* (1998) and Molitor *et al.* (1997).

Table (5): Effect of the interaction between different soil types and compost rates (%) on shoot fresh weight per plant (g) of geranium in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut		Second cut	
		2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	24.87	29.41	25.48	26.16
	25 %	34.96	50.14	35.50	44.33
	50 %	46.01	59.41	59.99	63.19
	75 %	58.27	67.24	76.23	80.45
Loamy	0 %	37.90	40.56	56.45	60.56
	25 %	51.24	60.25	63.73	76.80
	50 %	66.11	72.19	78.23	80.53
	75 %	66.65	75.34	82.71	93.73
Saline	0 %	6.20	7.61	8.06	7.59
	25 %	9.90	11.79	12.13	16.02
	50 %	16.97	26.44	24.70	33.08
	75 %	25.37	37.78	36.32	42.91
Sandy	0 %	23.25	29.01	43.23	50.56
	25 %	36.37	33.24	53.18	61.73
	50 %	50.56	46.97	70.96	78.60
	75 %	53.94	68.62	82.17	79.26
LSD 5%		16.73	15.42	13.25	14.45

5- Shoot dry weight

Data presented in Table (6) indicated that the application of rice straw compost increased shoot dry weight of the plants grown in all used media at first and second cuts of both seasons. These results are in agreement with those obtained by Chen *et al.* (1988) on *Ficus bengamina* cv. Star, Wolf (1990) on Chrysanthemums and Pelargonium, Wang (1994) on *Schefflera actionphylla*, Lopez *et al.* (1998) on *Pelargonium zonale* cv. Luckly Breakfs and Sloan *et al.* (2004) on *Viola wittrackiana* cv. Purple Rain. They found that there was a significant increase in dry weight of vegetative growth when the plants were treated with compost. The same Table indicated also that the shoot dry weight increased with increasing the applied rate of rice straw compost.

The plants grown in sandy medium containing 75% rice straw compost had at the second cut of both seasons the heaviest dry weights. A similar conclusion was obtained by Perner *et al.* (2007). They found that increasing the rate of compost increased shoot dry weight of pelargonium.

The lowest values of shoot dry weight, in general, were obtained from plants grown in saline medium without rice straw compost.

Table (6): Effect of the interaction between different soil types and compost rates (%) on dry weight of aerial parts per plant (g) of geranium in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut		Second cut	
		2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	9.39	12.78	9.16	11.25
	25 %	16.10	23.49	13.86	16.41
	50 %	22.44	30.29	22.46	24.92
	75 %	36.74	37.26	31.70	37.44
Loamy	0 %	21.56	29.06	30.00	39.62
	25 %	21.83	28.01	32.62	47.47
	50 %	27.20	34.72	37.42	50.27
	75 %	33.73	44.98	38.56	58.13
Saline	0 %	3.05	3.50	3.84	4.57
	25 %	4.70	5.55	6.63	8.01
	50 %	8.12	12.76	12.50	16.64
	75 %	15.59	17.55	14.61	17.87
Sandy	0 %	10.83	15.08	24.77	30.33
	25 %	18.54	16.42	44.04	49.85
	50 %	24.80	24.08	52.46	64.46
	75 %	28.59	37.70	53.20	77.04
LSD 5%		6.70	9.20	6.42	10.77

6- Root length

In this regard, data in Table (7) pointed out that plants grown in sandy medium containing 75% rice straw compost gave significantly, in both seasons, the highest values of root length (32.84 and 35.35 cm in the first and second season, respectively) than those grown in calcareous and saline media. Meantime, there were no significant differences between root length values of the plants grown in sandy and loamy media in both seasons for two cuts.

7- Roots fresh weight

Data in the same table revealed that the application of rice straw compost increased roots fresh weight of the plants grown in all media, especially those containing 75% rice straw compost. The heaviest fresh weight of roots (16.16 and 18.66 g) were recorded from the plants grown in loamy medium containing 75% rice straw in the first and second seasons, respectively.

Table (7): Effect of the interaction between different soil types and compost rates (%) on root length and fresh and dry weights of roots of geranium plants during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	Root length (cm)		Root fresh weight (g/plant)		Root dry weight (g/plant)	
		2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	9.80	11.24	2.14	3.00	0.87	1.11
	25 %	12.35	14.15	4.08	5.48	2.16	1.68
	50 %	14.94	16.63	6.18	8.17	3.40	3.89
	75 %	17.61	18.48	8.43	10.56	4.24	5.84
Loamy	0 %	22.54	23.18	13.07	13.06	6.73	5.30
	25 %	27.15	29.50	12.39	17.03	6.25	5.04
	50 %	26.80	29.61	14.23	16.94	6.67	7.35
	75 %	30.62	31.66	16.16	18.66	8.00	8.83
Saline	0 %	5.74	6.62	1.90	1.34	0.15	1.36
	25 %	7.25	9.38	1.50	1.75	1.57	1.67
	50 %	11.87	12.43	2.38	3.17	1.91	1.89
	75 %	16.38	18.30	2.91	4.59	1.57	2.48
Sandy	0 %	23.85	29.08	8.56	9.35	4.11	6.96
	25 %	31.00	34.43	13.46	17.41	4.69	8.25
	50 %	31.43	33.85	11.34	27.46	6.99	11.83
	75 %	32.84	35.35	13.72	32.34	9.82	14.20
LSD 5%		5.15	6.57	3.53	6.02	1.68	2.33

8- Roots dry weight

It is evident from data in Table (7) that the heaviest dry weights of roots resulted from plants grown in all media containing 75% rice straw compost. The highest values in this regard were obtained from the plants grown in sandy medium containing 75% rice straw compost as they were 9.82 and 14.20 g/plant in the first and second seasons, respectively.

The positive effect of compost on root growth may be due to the effect of compost on improving soil physical properties and availability of nutrients which reflect on root growth. These results are in agreement with those obtained by Zubair *et al.* (1995) on *Monstera deliciosa*, and Malusa *et al.* (2002) on coleus and chrysanthemum plants. They found that there was a significant increase in root growth when the plants were treated with compost.

Effect of the interaction between different soil types and compost rates (%) on chemical compositions of geranium plants:

1- Total chlorophyll

Dealing with the interaction between different soil types and compost percentages on total chlorophyll, data in Table (8) showed that the highest total chlorophyll contents at the first cut (1.575 and 1.770mg/g fresh weight) in both seasons resulted from plants grown in loamy medium containing 75% rice straw compost, whereas at the second cut of both seasons, the plants grown in saline soil containing 75% rice straw compost gave the highest values in this regard.

Table (8): Effect of the interaction between different soil types and compost rates (%) on total chlorophyll (mg/g fresh weight) in the leaves of geranium plants in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut		Second cut	
		2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	0.724	0.880	0.752	0.772
	25 %	0.729	0.903	0.874	0.924
	50 %	1.128	1.226	0.962	1.157
	75 %	1.263	1.378	1.461	1.298
Loamy	0 %	0.584	0.619	0.490	0.633
	25 %	0.682	0.859	0.799	0.843
	50 %	1.146	1.261	0.842	1.427
	75 %	1.575	1.770	1.182	1.520
Saline	0 %	0.743	0.861	0.880	0.950
	25 %	0.891	0.945	1.221	1.334
	50 %	1.134	1.217	1.377	1.430
	75 %	1.318	1.229	1.378	1.526
Sandy	0 %	0.880	1.350	0.824	0.856
	25 %	0.905	1.048	1.048	1.072
	50 %	1.238	1.302	1.056	1.156
	75 %	1.408	1.607	1.234	1.328
LSD 5%		0.005	0.002	0.001	0.003

2- N, P and K percentages

Data presented in Table (9) showed that the highest values of N (1.73 and 1.89 %) at the first cut and (1.99 and 2.04%) at the second one in both seasons were resulted from plants grown in loamy medium containing 50% rice straw compost.

The same table showed that the plants grown in calcareous medium containing 50% rice straw compost gave the highest values of P in the leaves at the first cut (0.440 and 0.757%) and second one (0.677 and 0.783%) in both seasons. These results are in harmony with those of Perner *et al.* (2007) who found that increasing the rate of compost increased shoot P concentration of Pelargonium plants.

The highest values of K, as shown in Table (9), were resulted from plants grown in loamy medium containing 75% rice straw compost as they reached 2.65 and 2.80% at the first cut and 2.69 and 2.82% at the second one in both seasons. Similar results were reported by Lopez *et al.* (1998) on geranium plants who found that plants grown in compost mixtures which are rich in potassium showed that leaf potassium contents are closer to the optimum range than did control plants.

3- Essential oil percentage

It is clear from data in Table (10) that geranium plants grown in all soil types containing 75% rice straw compost had the highest oil percentages. The superior values of oil percentage at the first cut (0.450 and 0.413%) and at the second one (0.397 and 0.400%) of both resulted from plants grown in calcareous medium containing 75% rice straw compost.

Table (9): Effect of the interaction between different soil types and compost rates (%) on N, P and K percentages in the leaves of geranium plants in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut						Second cut					
		N		P		K		N		P		K	
		2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	0.97	1.08	0.023	0.127	0.90	1.02	0.91	1.08	0.113	0.136	1.21	1.21
	25 %	1.10	1.19	0.143	0.277	1.16	1.42	1.17	1.34	0.192	0.205	1.36	1.68
	50 %	1.36	1.39	0.440	0.757	1.47	1.66	1.51	1.75	0.677	0.783	2.21	2.41
	75 %	1.16	1.24	0.330	0.693	1.25	1.56	1.12	1.24	0.472	0.590	1.25	1.57
Loamy	0 %	1.35	1.46	0.135	0.169	1.27	1.41	1.44	1.63	0.211	0.241	1.92	2.12
	25 %	1.59	1.71	0.176	0.185	1.53	1.71	1.83	2.04	0.228	0.270	2.12	2.40
	50 %	1.73	1.89	0.201	0.202	1.86	2.01	1.99	2.04	0.247	0.273	2.44	2.76
	75 %	1.71	1.81	0.186	0.190	2.65	2.80	1.26	1.44	0.209	0.264	2.69	2.82
Saline	0 %	1.18	1.22	0.161	0.179	1.75	1.89	0.94	1.45	0.167	0.188	1.99	2.06
	25 %	1.28	1.47	0.217	0.242	2.15	2.35	1.52	1.55	0.254	0.263	2.32	2.36
	50 %	1.30	1.59	0.241	0.257	2.31	2.42	1.78	1.65	0.266	0.267	2.16	2.49
	75 %	1.37	1.69	0.233	0.242	2.00	1.91	1.91	1.82	0.177	0.197	1.33	1.44
Sandy	0 %	0.83	0.75	0.102	0.111	0.93	1.05	0.80	0.85	0.102	0.112	1.03	1.15
	25 %	0.91	1.04	0.126	0.133	1.12	1.30	0.98	1.13	0.133	0.152	1.17	1.31
	50 %	0.98	1.11	0.133	0.148	1.16	1.31	1.06	1.20	0.144	0.161	1.14	1.31
	75 %	0.90	0.91	0.108	0.137	1.10	1.21	0.95	1.01	0.114	0.130	1.13	1.14
LSD 5%		0.11	0.10	0.068	0.052	0.10	0.090	0.28	0.09	0.010	0.010	0.10	0.10

Table (10): Effect of the interaction between different soil types and compost rates (%) on essential oil percentage of geranium leaves in two cuts during 2004/2005 and 2005/2006 seasons

Soil type	Compost rate (%)	First cut		Second cut	
		2004/2005	2005/2006	2004/2005	2005/2006
Calcareous	0 %	0.360	0.326	0.266	0.260
	25 %	0.372	0.366	0.294	0.280
	50 %	0.400	0.387	0.380	0.374
	75 %	0.450	0.413	0.397	0.400
Loamy	0 %	0.300	0.316	0.235	0.240
	25 %	0.316	0.333	0.246	0.250
	50 %	0.370	0.362	0.250	0.259
	75 %	0.382	0.378	0.258	0.366
Saline	0 %	0.160	0.153	0.148	0.146
	25 %	0.234	0.240	0.218	0.228
	50 %	0.334	0.330	0.234	0.306
	75 %	0.340	0.335	0.244	0.324
Sandy	0 %	0.130	0.126	0.120	0.123
	25 %	0.174	0.166	0.162	0.158
	50 %	0.344	0.340	0.274	0.260
	75 %	0.366	0.360	0.274	0.300
LSD 5%		0.016	0.020	0.002	0.006

The above results are generally in harmony with Sukhmal *et al.* (2007) who studied the influence of vermicompost and zinc on the productivity of geranium and found that the compost was effective on increasing oil yield. In accordance with the same results were those reported by Hassanein *et al.* (1998) who found that *Pelargonium graveolens* plant cultivated in calcareous medium produced the highest percentages of essential oil.

According to the results of the current research, it was found that the application of rice straw compost improved the mineral composition of the used soil types, growth characters and chemical constituents of geranium plants. This improvement increased with increasing the application rate of rice straw compost. Hence, it could be recommended to apply rice straw compost at the rate of 75%t o the growing media of geranium plants planted in pots for obtaining best results in all aspects.

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تأثير إضافة كمبوست قش الأرز على النمو والتركيب الكيمائي لنباتات العتر النامية فى أنواع مختلفة من التربة

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أجريت هذه التجربة فى محطة تجارب ومعمل قسم الخضر والزينة بكلية الزراعة جامعة المنصورة خلال الموسمين ٢٠٠٤/٢٠٠٥ و٢٠٠٥/٢٠٠٦ لدراسة تأثير إضافة كمبوست قش الأرز بمعدلات صفر ، ٢٥ ، ٥٠ ، ٧٥ % بالوزن الى أربعة أنواع من التربة علي النمو الخضري ، الجذري والمحتوي الكيميائي لنباتات العتر. ولقد استخدمت فى هذا البحث التربة الجيرية، الطمية، الملحية والرملية.

ولقد أوضحت النتائج المتحصل عليها أن تركيز النيتروجين والفوسفور والبوتاسيوم (جزء فى المليون) المتاح فى بيئة النمو قد زاد بزيادة نسبة الكمبوست المضافة وكانت أفضل القيم فى هذا الصدد موجودة فى التربة الملحية يليها الطمية فالجيرية وأخيرا الرملية.

بالنسبة لتأثير تفاعل كمبوست قش الأرز مع نوع التربة على قياسات النمو الخضرى والجذرى لنبات العتر فلقد أظهرت القياسات أن التربة الرملية والطمية عند خلط كل منهما بنسبة ٧٥% كمبوست قش الأرز قد أعطيتا أفضل النتائج خلال الموسمين.

ولقد أظهرت النتائج أيضا أن أفضل محتوى للكلوروفيل الكلى خلال الموسمين كان فى أوراق الحشة الأولى للنباتات النامية فى التربة الطمية التى تحتوى على ٧٥% كمبوست قش الأرز، فى حين أن أفضل محتوى كلوروفيل للحشة الثانية وجد فى أوراق النباتات النامية فى التربة الملحية المحتوية أيضا على ٧٥% كمبوست وذلك فى موسمى الدراسة.

وجدت أعلى نسبة مئوية للنيتروجين فى أوراق النباتات النامية فى التربة الطميية والمحتوية على ٥٠% كمبوست، فى حين أن أعلى نسبة للبوتاسيوم وجدت فى أوراق النباتات النامية فى نفس نوع التربة ولكن المحتوية على ٧٥% كمبوست. أما فيما يخص الفوسفور فلقد كانت أعلى نسبة مئوية له فى أوراق النباتات النامية فى التربة الجيرية المحتوية على ٥٠% كمبوست قش الأرز.

أما بالنسبة لمحتوى الزيت العطرى فلقد كانت أعلى نسبة مئوية له فى نباتات العتر النامية فى التربة الجيرية المحتوية على ٧٥% كمبوست قش الأرز.

وبناءا على نتائج الدراسة الحالية، فلقد وجد أن إضافة كمبوست قش الأرز إلى أنواع البيئات المستخدمة فى البحث أدت إلى تحسين المحتوى الغذائى للتربة، صفات النمو والتركيب الكيمائى لنباتات العتر. هذا التحسن يزداد بزيادة معدل إضافة كمبوست قش الأرز. ولهذا فإنه يمكن التوصية بإضافة كمبوست قش الأرز بمعدل ٧٥% لبيئة الزراعة لنباتات العتر المزروعة فى أصص للحصول على أفضل النتائج لكل الصفات.

قام بتحكيم البحث

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