J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 7 (5): 365 - 373, 2016

Response of Roselle Plants (*Hibiscus sabdariffa l.)* to Pressed Olive Cake Compost Types and Potassium Fertilization Rates on Newly Reclaimed Soils at Siwa Oasis, Egypt

Khatab, A. Kh.

Soils, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt

ABSTRACT

This investigation was carried out during the two seasons of 2013 and 2014 at the experimental farm of Matrouh Agricultural Research Station, Siwa Oasis, Matrouh Governorate, Egypt, (29.11° N latitude and 25.33° E longitude). The study aiming at evaluating the effect of two types of composts pressed olive cake (POC) and POC+CM (chicken manure) combined potassium fertilizer levels and their interactions on yield, yield components and some sepals chemical constituents of Rosella plants. The obtained results could be summarized as follows:- * The investigated compost types exerted significant effects on plant height, branches No. plant^{-1}, seed yield (g plant^{-1}) and seed yield (kg fed^{-1}) of Roselle plants, and POC+CM compost exhibited the highest figures in 1st and 2nd seasons. The adopted K fertilization rates significantly affected the abovementioned parameters, which gradually increased due to increasing k fertilization ratefigures in the 1st and 2nd seasons. All the parameters were significantly influenced due to the interaction and the highest values were recorded under POC+CM compost and 48 kg K_2Ofed^{-1} rate interaction in 1st and 2nd seasons. *Sepals yield and its components of Roselle plants were significantly influenced due to the tested compost types and K fertilization rates and interaction in 1st and 2nd seasons. Both POC+CM compost and 48 kg K_2O fed^{-1} rate exhibited the highest figures of the abovementioned parameters 1st and 2nd seasons. The highest values of sepals yield and its components were attained due to POC+CM compost as interacted with 48 kg K_2Ofed^{-1} rate in 1st and 2nd seasons. *N, P and K% of roselle petals were significantly influenced due to the investigated compost types and K fertilization rates. The highest N, P and K figures were attained with both POC+CM compost and 48 kg K_2O fed^{-1} rate 1st and 2nd seasons. In addition, interaction of POC+CM compost and 48 kg K_2O fed^{-1}rate exhibited the highest values, however, the differences did not reach the significance level, and such trend was true in1st and 2nd seasons. * Chemical constituents of roselle sepals e.g. total carbohydrates, anthocyanin ascorbic acid contents and pH were significantly influenced due to K fertilization rates, whereas compost type exhibited similar trend, except with pH1st and 2nd seasons. POC+CM compost and 48 kg K_2O fed^{-1} rate interaction still exhibiting the highest values of the abovementioned parameters, however, the differences did not reach the significance level, and such trend was true in1st and 2nd seasons. On conclusion, supplying POC compost combined with 48 kg K_2O fed^{-1} resulted in higher values of sepals yield and quality and macronutrients uptake as well, however, it is advisable to replace POC compost by POC compost +CM which absolutely exhibited the highest values of the studied parameters under the present experimental conditions.

Keywords: Rosella plants (Hibiscus sabdariffa L.), growth, productivity, chemical constituents, pressed olive cake compost, potassium fertilization

INTRODUTION

Medicinal plants are valuable resources in a wide range of natural resources that occupied a prominent economic position because of the continuous increasing demand for these plants for the local and foreign markets. Among these medicinal rosella plants (*Hibiscus sabdariffa* L.) which is belonging to the family Malvaceae and has a common name in Egypt as Karkadeh. Roselle plants are cultivated mainly for the important commercial part of the plant which is the fleshy sepals (calyx) surrounding the fruit (capsules). This plant can grow on a wide range of soil conditions, but for economic with production, soil should be well supplied essential minerals, which can improve sepals yield and quality. Nitrogen and potassium are two major limiting nutrients for plant growth and yield (Adanlawo and Ajibade, 2006). So, great attention to cultive such plants and exporting the calyx can be an important economic issue.

At Siwa oasis, large quantities of pressed olive cake are resulted as a waste of olive oil extraction. Moreover, increasing the organic matter content of soil (especially in newly reclaimed soils) has the additional benefits of mitigating the problems associated with the use of brackish or saline waters which are frequently used in these areas for crop irrigation, Tomar *et al.*,(2003).

Many authors documented the favorable effects of pressed olive cake compost on sandy soils such as increasing nutrient availability, cation exchange capacity, organic matter content and enzymes activity which consequently stimulates plant growth and plant productivity, Cucci *et al.*(2008). In addition, Giovanna *et al.* (2008) showed that supplying wet olive pomace improved soil structure, increased organic matter and nutrient content without altering pH and salinity. Moreover, it improved nutrient content in sunflower and wheat in comparison with the control. Furthermore, Montemurro *et al.*, (2004) showed that addition of olive pomace compost increased growth, yield and macronutrients (NPK) uptake as well as dry matter content of rye-grass.

In Egypt ,El-Tantawy and Mohamed (2009) under Sinai conditions found that, addition of pressed olive cake composting with chicken manure and phosphate solubilizing bacteria enhanced tomato plant growth, number and weight of fruits and increased phosphorus content in leaves. In connection, Ben-Jenana *et al.* (2009) found that addition of olive husks compost with pozidonia and chicken manure significantly improved growth characters and yield of tomato plants. Sellami *et al.* (2007) and *Hachicha et al.* (2006) reported that addition the compost of olive husks with chicken manure and irrigated with olive mill wastewater improved soil properties, did not have any negative impact on soil phenols, pH and EC at different soil depths and enhanced a better growth and yield of potato.

Unfortunately, the literatures interesting the response of Roselle plants to olive cake compost addition are not available. However, tremendous literatures concerning the effect of other types of organic compost wastes on Roselle growth are cited such as Abou-El-Seoud *et al.* (1997); El-Keltawi *et al.* (2003); El-Sherif and Sarwat (2007) and Yasser *et al.* (2011) who reported that application of organic manure to Roselle increased vegetative growth parameters, number of branches and fruits, sepal yield and a slight increase in the protein and phosphorus content of sepals of Roselle.

It is well known that potassium regulates many metabolic processes in plants. It is involved in cell division and enlargement, increases stress tolerance, regulates the opening and closing of the stomata and it is required for osmotic regulation. In addition, K promotes photosynthesis and activates enzymes and co-enzymes to metabolize carbohydrates for the manufacture of starch and protein. Furthermore, potassium improves oil content in oil crops and is essential for the development of the root system Bidari and Hebsur (2011). In connection, Shalan *et al.*(2001) investigated the effect of nitrobein (biofertilizer), nitrogen fertilizer; (40 or 60 kg N/fed) combined with potassin as foliage spray or potassium sulfate; (50 or 100 kg/fed.) on Roselle plants and reported that N and K at different levels increased plant height, number of branches, number of fruit/plant, sepal weight (fresh & dry), anthocyanin, sugars and protein contents of sepals. The author added that Potassin (foliar P K fertilizer) as a source of potassium resulted in a high significant increases in most parameters; branch number, fruit number/plant, acidity, as well as anthocyanin, sugars and protein contents.

The main objective of this study is to find out whether sufficient and high quality of roselle yield can be produced using pressed olive cake compost, pressed olive cake + chicken manure compost and potassium fertilization under the soil and climate conditions of Siwa Oasis.

MATERIALS AND METHODS

A field experiment was conducted in a newly reclaimed soil at the experimental farm at Siwa Oasis located at 29.11° N latitude and 25.33° E longitude, Matrouh Agricultural Research Station, Agricultural Research Center (ARC), Egypt, during 2013 and 2014 growing seasons. aiming to evaluate compost type e.g. pressed olive cake (POC) and pressed olive cake (POC)+Chicken Manure (CM) in 1:1 ratio, both at rate of 2 $tonfed^{-1}$under potassium fertilization rates of 0, 24 and 48 kg K_2O fed^{-1} on growth, sepals yield and its components and chemical constitutes of Roselle (*Hibiscus Sabdariffa L.)* as well.

Particle size distribution and some chemical characteristics of the experimental soil as determined according to Ryan *et al.* (1996) are shown in Table 1.

The POC accumulates, in huge quantities, as a waste from olive oil mills at Siwa Oasis. The POC used in the present study was obtained from the olive oil extraction mill belongs to Desert Research Center (DRC) at Siwa Oasis, whereas CM was collected from the local peoples. On preparing the compost piles of POC and POC+CM (2 m^3 in volume) were prepared and insulated for 3- month period. During the composting process both windrows were homogenized by mixing every two weeks and moistened to keep the moisture in the range of 40 to 60%. The piles were periodically sampled at zero, 30, 60 and 120 days for chemical analyses to determine percentages of N, P, K and organic carbon, and data are represented in Table 2.

Table 1: Soil particle size distribution and some chemical characteristics of the experimental site, 2013 and 2014 seasons.

properties		2013 season	2014 season
Particle size distribution (%)	Coarse sand	7.40	8.70
	Fine sand	61.20	64.80
	Silt	26.60	22.40
	Clay	4.80	4.10
Textural class		Sandy loam	Sandy loam
EC dSm^{-1} (soil paste extract)		2.41	2.23
pH (1:2.5, soil: water suspension)		7.42	7.28
$CaCO_3$ (%)		6.20	5.80
Soluble cations ($meqL^{-1)}$	Ca^{+2}	5.14	4.92
	Mg^{+2}	4.32	4.24
	Na^+	13.74	12.42
	K^+	1.58	1.42
Soluble anions ($meqL^{-1}$)	HCo_3^-	5.34	4.87
	Cl^-	9.00	8.75
	SO_4^{--}	10.44	9.38
Available nutrients (ppm)	N	11.22	11.72
	P	3.42	3.86
	K	22.85	24.15

Experimental design and execution

The experiment was laid out in a split-plot design with three replicates. The main plots were assigned for compost types e.g. control (without compost addition), POC and POC+CM both at 2 ton fed^{-1} rate, whereas the subplots were devoted to potassium fertilization rates e.g. control (without K fertilization), 24 and 48 kg K_2O fed^{-1}in potassium sulphate form.The experimental unit area was 14 m^2 (3.5 mx4.00 m) contained five ridges 70 cm apart and 50cm between plants i.e. 40 plants per plot. Seeds of Roselle (*Hibiscus sabdariffa* L., cv. Sabaheia 17) were obtained from Medicinal and Aromatic Plants Research Department, Horticulture Research Institute, Agricultural Research Center, Giza. Four seeds per hill were sown on 6th and 2nd April in the 1st and 2nd seasons, respectively. After one month, the seedlings were thinned to leave one seedling per hill. The tested composts, potassium fertilizer levels, and calcium superphosphate (15% P_2O_5 at rate of 30 kg P_2O_5 fed^{-1}) as well were applied during seedbed preparation. Nitrogen fertilizer as ammonium nitrate (33.5%) was added at 40 kg $Nfed^{-1}$ rate divided into three equal portions at 35, 50 and 70 days after planting. Surface drip irrigation was adopted in the experimental field, and chemical analyses of the irrigation water are shown in Table 3.

Table 2: Chemical analyses for POC and POC + CM piles at different periods during composting process in 2013 and 2014 seasons.

Treatments	Pressed olive cake				Pressed olive cake + chicken manure			
	Initial time	30 days	60 days	120 days	Initial time	30 days	60 days	120 days
2013 season								
Total N (%)	1.19	1.11	1.21	1.29	1.28	1.19	1.31	1.39
Total P (%)	0.15	0.11	0.17	0.18	0.17	0.14	0.17	0.19
Total K (%)	1.18	1.14	1.18	1.21	1.22	1.17	1.23	1.24
Organic matter %	57.98	60.31	53.78	52.92	55.63	60.02	50.17	43.63
Organic carbon %	33.63	34.98	31.19	30.70	32.27	34.86	29.10	25.31
C/N Ratio	28.26	31.51	25.78	23.80	25.21	29.29	22.21	18.21
2014 season								
Total N (%)	1.22	1.12	1.25	1.32	1.31	1.23	1.36	1.41
Total P (%)	0.17	0.15	0.20	0.25	0.20	0.18	0.19	0.23
(Total K (%	1.22	1.19	1.23	1.26	1.25	1.21	1.27	1.29
Organic matter %	58.33	61.05	55.22	53.57	56.12	58.15	51.55	41.78
Organic carbon %	33.83	35.41	32.03	31.07	32.55	34.86	29.90	24.23
C/N ratio	27.73	31.61	25.62	23.54	24.84	28.34	21.98	17.18

Table 3: Chemical analyses of the irrigation water.

Season	EC		pH	Parameters: Soluble cations (mqL^{-1})				Soluble anions (mqL^{-1})		
	(dSm^{-1})	ppm		Na^+	Mg^{++}	Ca^{++}	K^+	Cl^-	HCO_3^-	$SO_4^=$
2013	3.13	2003	7.6	10.8	2.9	3.4	0.2	9.2	3.2	4.9
2014	2.35	1504	7.1	10.5	2.3	3.2	0.2	8.8	3.0	4.4

Data Recorded:

At harvest time (200 days after sowing), the plants were sampled at random from the middle ridges of the experimental unit to estimate the following data:

Plant height (cm), number of branches $plant^{-1}$, number of fruits $plant^{-1}$, fresh weigh of fruits $plant^{-1}$, dry weigh of sepal $plant^{-1}$ (g), seed yield $plant^{-1}$ (g), seed yield ($kgfed^{-1}$) and sepal yield ($kgfed^{-1}$), Concerning dry sepals chemical constituents, nitrogen content was determined by wet oxidation using Kjeldahl digestion and distillation procedures, Parkinson and Allen (1975), while phosphorous was determined calorimetrically according to the procedure outlined by (Ryan *et al.*1996). Potassium content was determined using flame photometer according to (Black, 1982).Total carbohydrate and ascorbic acid were determined according to Nielsen (2010), anthocyanin content was determined as described by Byamukama et al. (2014). Acidity of sepal was determined according to AOAC (1975). Data were subjected to the statistical analysis according to Snedecor and Cochran (1980). Mean values of the treatments were compared against each other using the least significant differences (LSD) at 5% level of significance.

RESULTS AND DISCUSSION

1- Plant height, branches No. $plant^{-1}$, seed yield(g $plant^{-1}$) and seed yield (kg fed^{-1})

(a) Effect of compost types

Data presented in Table 4 show that the tested parameters were significantly affected due to the adopted compost types and K fertilization rates and interactions and POC+CM compost exhibited the highest figures in the 1st and 2nd seasons.

The increases in plant height, number of branches $plant^{-1}$, seed yield (g $plant^{-1}$) and seed yield (kg fed^{-1}),due to POC+CM compost application, amounted to (48.21 and 57.88%), (25.44 and 71.67%),(82.34 and 25.86 %) and(84.26 and 24.18%) in the 1st season and by (51.52 and 57.12%), (23.77and 62.88 %),(81.47 and 24.14 %)and (82.72 and 24.95%) in the 2nd one, respectively, compared to POC and the control. The beneficial effect of POC+CM compost is attributed to providing the necessary the soil macro and micronutrients, in available forms, which are necessary for healthy plant growth. Such results are in accordance with those reported by Tomati *et al.*, 1996; Cucci *et al.*, 2008 and Medjahdi *et al.*, 2014.

(b) Effect of potassium fertilization rates

Respecting the effect of potassium fertilization on studied parameters of roselle plants, data in Table 4 reveal that increasing potassium rate from zero to 24 or 48 K_2O kgfed^{-1}gradually increased all investigated parameters. The increase values, under 48 K_2O Kgfed^{-1} rate, in plant height, number of branches plant^{-1}, seed yield (gplant^{-1}) and seed yield (kgfed^{-1}) in 1st season, amounted to (5.64 and 17.45%), (19.54 and 71.59 %),(10.89 and 29.25 %) and (2.37 and 29.61 %) higher than those with 24 K_2O kgfed^{-1}rate and the control, respectively. In 2nd season, the corresponding increases for the abovementioned parameters reached to (15.49 and 25.58%), (18.63 and 60.09%), (13.25 and 30.15 %) and (13.83 and 32.50 %) in the same order of the treatments. Such increases are attributable to favorable effect of the highest K- fertilization rate in regulating many metabolic processes in Roselle plants. These results are in accordance with those reported by Abo-El-Seoud *et al.* (1994), Abbas and Ali (2011) and Sakr *et al.*, (2014) on Roselle plants.

(c) Effect of the interaction

Regarding the effect of interacted factors under study on Plant height, Branches No. plant^{-}1, Seed yield (g plant^{-1}) and Seed yield (kg fed^{-1}) of Roselle plants, data illustrated that the combination of POC+CM compost and the highest potassium fertilization rate resulted in the highest figures of the investigated parameters, Table 4.

Table 4: Plant height, branches No. plant^{-1}, seed yield (g plant^{-1}) and seed yield (kg fed^{-1}) of roselle plants as affected by compost types and potassium fertilization rates and interaction 2013 and 2014 seasons

Treatments		Plant height (cm)	Branches No. plant^{-1}	Seed yield (g plant^{-1})	Seed yield (kg fed^{-1})
			2013 Season		
Control, zero compost		89.26	8.33	17.16	223.36
POC*		95.09	11.40	24.86	331.41
POC+CM**		140.93	14.30	31.29	411.56
L.S.D at 0.05		2.39	0.27	1.21	5.96
Control		98.98	8.20	21.20	277.71
24 kg K_2O		110.04	11.77	24.71	368.69
48 kg K_2O		116.25	14.07	27.40	359.94
L.S.D at 0.05		2.07	0.18	1.07	12.01
Control, zero compost addition	Zero K_2O	82.70	5.80	14.81	192.54
	24 kg K_2O	90.85	8.60	17.27	224.68
	48 kg K_2O	94.23	10.60	19.39	252.87
POC	Zero K_2O	87.55	7.60	21.14	279.48
	24 kg K_2O	96.42	11.80	25.33	343.56
	48 kg K_2O	101.30	14.80	28.12	371.18
POC+CM	Zero K_2O	126.70	11.20	27.65	361.10
	24 kg K_2O	142.85	14.90	31.52	417.82
	48 kg K_2O	153.23	16.80	34.69	455.77
L.S.D at 0.05		3.11	0.43	1.64	8.88
			2014 Season		
		Compost types effect			
Control, zero compost		97.91	9.08	18.24	239.59
POC*		101.53	22.95	26.64	350.37
POC+CM**		153.84	14.79	33.07	437.78
L.S.D at 0.05		4.74	0.18	1.07	12.01
		K- fertilization rates effect			
Control		105.67	9.07	22.59	294.57
24 kg K_2O		114.90	12.24	25.96	342.88
48 kg K_2O		132.70	14.52	29.40	390.31
L.S.D at 0.05		4.74	0.18	1.07	12.01
		Interaction effect			
Control, zero compost addition	Zero K_2O	91.55	6.92	15.74	204.15
	24 kg K_2O	97.85	9.10	17.98	237.85
	48 kg K_2O	104.32	11.22	21.00	276.76
POC	Zero K_2O	94.60	8.43	23.05	302.42
	24 kg K_2O	101.88	12.28	26.76	352.14
	48 kg K_2O	108.12	15.15	30.11	396.55
POC+CM	Zero K_2O	130.87	11.86	28.97	377.13
	24 kg K_2O	144.98	15.33	33.15	438.58
	48 kg K_2O	185.66	17.18	37.08	497.62
L.S.D at 0.05		8.21	0.51	1.84	20.18

***POC= pressed olive cake compost **POC+CM= pressed olive cake + chicken manure**

2- Dry sepals yield and its components:

(a) Effect of compost types

Results in Table 5 show that the adopted compost types and K fertilization rates and interaction as well significantly affected sepals yield and its components of Roselle plants. Supplying POC+CM compost resulted in the highest figures of sepal yield per feddan which were higher by (63.04 and 17.96%) and (59.04 and 14.01 %) than those under without compost addition and POC compost addition in 1stand 2ndseasons, respectively. Similar trends were noticed with dry weigh of sepals (gplant^{-1}), number of fruits plant^{-1} and fresh weigh of fruits (gplant^{-1}). The increase percentages, due to POC+CM compost addition, were (74, 00 and 13.88), (68.90 and 13.21) and (70.97 and 14.26) higher than those under without compost addition and POC compost addition, respectively, in 1st season. The corresponding increase percentages in 2nd season were (59.04 and 14.20), (67.83 and 14.03), (67.54 and 15.93) and (65.95 and 13.98) in the same order of treatments and parameters. Similar results have been obtained due to supplying compost from different organic wastes on Roselle plants, Abo-El-Seoud *et al.* (1997)، El-Sheriff and Sarwat (2007) and Yasser *et al.*(2011).

(b) Effect of potassium fertilization rates

The highest figures of the investigated parameters were recorded with 48 kg K_2Ofed^{-1} rate and such trend was true in the 1st and 2nd seasons, Table 5. In the 1st season, reducing the k fertilization rate to be without k addition and 24 kg K_2O fed^{-1} rate resulted in values of the studied parameters e.g. sepals yield per feddan, dry weigh of sepals (gplant^{-1}), number of fruits plant^{-1} and fresh weigh of fruits (gplant^{-1}) amounted to (33.82 and 19.51%), (39.03 and 21.21%), (38.41 and 21.08%) and (38.35 and 22.39%), respectively, lower than that with 48 kg K_2Ofed^{-1} rate. The corresponding reduction values in 2nd season were (34.53 and 22.58%), (37.78 and 22.72%), (37.80 and 22.42%) and (37.76 and 21.93%) in the same order of the treatments. The obtained results were in accordance with those reported by Abo-El-Seoud *et al.*(1994), Abdou *et al.*(2004), Abbas and Ali (2011) and Sakr *et al.*(2014) .

Table 5: Sepals yield and its components of roselle plants as affected compost types and potassium fertilization rates and interaction in 2013 and 2014 seasons.

Treatments		2013 season: Dry sepals yield (kg fed^{-1})	2013: Dry weigh of sepals (g plant^{-1})	2013: Number of fruits plant^{-1}	2013: Fresh weigh of fruits plant^{-1}	2014 season: Dry sepals yield (kg fed^{-1})	2014: Dry weigh of sepals (gplant^{-1})	2014: Number of fruits plant^{-1}	2014: Fresh weigh of fruits plant^{-1}
Compost types effect									
Zero compost addition		214.78	15.23	21.67	62.34	251.76	18.06	23.20	71.34
POC*		296.90	23.27	32.33	93.28	350.59	26.58	33.53	103.86
POC+CM**		350.18	26.50	36.60	106.58	400.39	30.31	38.87	118.40
L.S.D at 0.05		1.06	0.13	1.97	4.61	3.44	2.27	1.03	12.43
Potassium fertilization rates effect									
Zero K addition		231.76	16.53	23.20	67.56	270.27	19.47	24.80	76.04
24 kg K_2O		281.85	21.36	29.73	85.05	319.63	24.18	30.93	95.38
48 kg K_2O		348.24	27.11	37.67	109.59	412.83	31.29	39.87	122.18
L.S.D at 0.05		0.08	0.73	1.11	3.54	3.22	2.12	0.07	2.11
Interaction effect									
Zero Compost addition	Zero K addition	180.21	10.58	15.20	43.68	199.51	43.68	16.40	49.83
	24 kg K_2O	197.25	14.91	20.80	58.44	228.64	58.44	22.00	68.08
	48 kg K_2O	266.87	20.21	29.00	84.91	327.12	84.91	31.20	96.12
POC	Zero K addition	222.43	16.84	24.20	70.74	270.55	70.74	25.40	79.02
	24 kg K_2O	306.98	23.33	32.80	93.74	353.84	93.74	34.00	105.32
	48 kg K_2O	361.28	29.64	40.00	115.36	427.38	115.36	41.20	127.24
POC+CM	Zero K addition	292.65	22.17	30.20	88.25	340.76	88.25	32.60	99.28
	24 kg K_2O	341.31	25.83	35.60	102.98	376.42	102.98	36.80	112.75
	48 kg K_2O	416.58	31.49	44.00	128.51	483.98	128.51	47.20	143.18
L.S.D at 0.05		3.49	1.12	2.60	7.32	6.62	3.04	1.21	6.53

POC= pressed olive cake compost POC+CM= pressed olive cake + chicken manure compost

(c) Effect of the interaction

The interaction data indicated that POC+CM compost as interacted with K fertilizer rate of 48 kg K_2O exhibited the highest figures of the investigated parameters in 1st and 2nd season, Table 5.

3- Macronutrients (N, P and K) contents:

(a) Effect of compost types

Data in Table 6 reveal that the adopted compost types significantly affected N, P and K% of roselle petals, and the highest values were recorded with POC+MC compost in 1st and 2nd seasons. The increases in N, P and K contents, due to POC+CM application, comprised (11.17 and 19.67%), (29.55 and 54.05 %) and (13.97 and 22.95%) in 1st season and (9.39 and 18.97%), (38.00 and 72.50%) and (16.07 and 23.81%) in 2nd season, respectively, compared with POC and zero compost addition. Similar results were reported by Nabila and Aly (2002), El-Sheriff and Sarwat (2007), Gad (2011) and Abbas and Ali (2011) who stated that organic waste composts addition significantly increased N, P and K contents of Roselle dry matter.

(b) Effect of potassium fertilization rates

Data obtained in Table 6 show that the adopted potassium fertilization rates significantly influenced N, P and K % in sepals of Roselle plants in 1st and 2nd seasons, and the highest figures were reported with48 kg K_2Ofed^{-1} rate and reached to (2.07 and 2.26%), (0.51and 0.61%) and (3.39 and 3.69 %) in 1st and 2nd seasons, respectively. With zero K addition and 24 kg K_2Ofed^{-1} rate, N, P and K contents tended to reduction by (8.70 and 3.38 %),(27.45 and 7.84%) and(18.66 and 12.26 %) in 1st season and in 2nd seasons by (10.62 and 4.87%),(26.23 and 13.11%) and(12.20 and 5.69%), respectively, comparable with 24 kg K_2Ofed^{-1} rate. The beneficial effects of potassium fertilizer on N, P and K% content were previously observed by Sakr *et al.* (2014) and Ghasemi *et al.* (2015) on Roselle plants.

Table 6: N, P and K contents in sepal of Roselle plants as affected by compost types and Potassium fertilization rates and interaction in 2013 and 2014 seasons

Treatments		2013 season			2014 season		
		N%	P%	K%	N%	P%	K%
Compost types effect							
Zero compost addition		1.83	0.37	2.92	1.97	0.40	3.15
POC*		1.97	0.44	3.15	2.13	0.50	3.36
POC+MC**		2.19	0.57	3.59	2.33	0.69	3.90
L.S.D at 0.05		0.15	0.60	0.21	0.11	0.04	0.13
Potassium fertilization rates effect							
Zero K addition		1.89	0.40	3.05	2.02	0.45	3.24
24 kg K_2O		2.00	0.47	3.23	2.15	0.53	3.48
48 kg K_2O		2.07	0.51	3.39	2.26	0.61	3.69
L.S.D at 0.05		0.10	0.05	0.11	0.09	0.04	0.09
Interaction							
Zero Compost addition	Zero K addition	1.74	0.30	2.74	1.89	0.32	2.91
	24 kg K_2O	1.83	0.38	2.92	1.94	0.41	3.18
	48 kg K_2O	1.91	0.42	3.11	2.08	0.46	3.37
POC	Zero K addition	1.86	0.38	2.97	2.00	0.42	3.21
	24 kg K_2O	1.97	0.44	3.16	2.15	0.49	3.29
	48 kg K_2O	2.09	0.49	3.33	2.23	0.58	3.57
POC+MC	Zero K addition	2.07	0.51	3.44	2.18	0.60	3.59
	24 kg K_2O	2.21	0.58	3.61	2.35	0.69	3.97
	48 kg K_2O	2.29	0.63	3.73	2.46	0.78	4.13
L.S.D at 0.05		NS	NS	NS	NS	NS	NS

***POC= pressed olive cake compost **POC+CM= pressed olive cake + chicken manure compost**

(c) Effect of the interaction

Combination of compost types and K fertilization rates on N, P and K percentages in sepal Roselle plants exhibited insignificant effects in 1st and 2nd seasons. However, the highest values were recorded with application of POC+MC as interacted with the highest rates of K_2O (48 kg fed^{-1}). Meanwhile, the lowest values were recorded with compost and K fertilization - untreated plants in 1st and 2ndseasons. The obtained results are coincided with those reported by Montemurro *et al.* (2004) on rye-grass and Medjahdi *et al.* (2014) on durum wheat plants.

4- Chemical constituents:

(a) Effect of compost types

Data in Table 7 show that the studied chemical constituents of Roselle sepals, except P^H, significantly affected due to the tested compost types in 1st and 2nd seasons, and the highest figures were recorded with POC+MC compost addition. Values of chemical constituents e.g. total carbohydrates, anthocyanin content, ascorbic acid and P^H seemed to reduce, under both without compost addition and POC, by (10.75 and 9.62%), (12.05 and 5.13%), (11.68 and 5.98%) and (5.80 and 3.04%) in 1stseason, respectively, comparable with POC+MC. Whereas the corresponding reduction values in 2nd season were (17.64 and 10.39%), (12.14 and 5.23%), (12.39 and 6.94%) and (5.15 and 2.44%) in the same order of the treatments. These results are in good agreement with those found by Nabila and Aly (2002), El-Keltawi *et al.* (2003) and Postma *et al.* (2003) who indicated that organic waste composts significantly increased anthocyanin, total and soluble carbohydrates and ascorbic acid in Roselle sepals.

(b) Effect of potassium fertilization rates

The investigated chemical constituents of roselle sepals were significantly altered due to the adopted K fertilization rates, and the highest values of total carbohydrates, anthocyanin, ascorbic acid and pH were noticed with 48 kg K_2Ofed^{-1} in 1st and 2nd seasons. Reducing K fertilization to be without K fertilization or 24 kg K_2Ofed^{-1}rate resulted in reductions in the abovementioned chemical constituents reached to (6.43 and 4.57%), (9.12 and 4.31%), (5.19 and 2.15%) and (3.91 and 1.68%) in 1st season, respectively, lower than those with48 kg K_2Ofed^{-1}rate.The corresponding reduction values in 2nd season were (10.26 and 5.66%), (10.96 and 6.24%), (5.19 and 2.30%) and (3.55 and 1.37%) in the same order of the treatments. These results come in agreement with Shalan *et al.* (2001) who found that applying potassium fertilizer at different rates increased anthocyanin and sugar contents of roselle sepals. Similar results obtained by Abbas and Ali (2011), Sakr *et al.* (2014) and Ghasemi *et al.* (2015) on Roselle.

(c) Effect of the interaction

Data in Table 7 prove that interaction of the adopted compost types and K fertilization rates insignificantly affected the studied chemical constituents of Roselle sepals. However, the highest values of total carbohydrate, anthocyanin, ascorbic acid and pH of Roselle sepals were recorded as POC + MC interacted with the highest rate of K fertilization (48 kgK_2Ofed^{-1}) in 1^{st} and 2^{nd} seasons.

Table 7: Total carbohydrates, anthocyanin, ascorbic acid contents and pH of Roselle sepals as affected by compost types and K fertilization rates and interaction in 2012/2013 and 2013/2014 seasons

Treatments		2012/2013 season				2013/2014 season			
		Total carbohydrates (%)	Anthocyanin content (mg $gdry^{-1}$)	Ascorbic acid (mg g dry^{-1})	pH	Total carbohydrates (%)	Anthocyanin content (mg $gdry^{-1}$)	Ascorbic acid (mg $gdry^{-1}$)	pH
Compost types effect									
Zero compost addition		14.19	18.18	34.55	3.41	14.43	18.97	34.94	3.50
POC*		14.37	19.61	36.78	3.51	15.70	20.46	37.23	3.60
POC+CM**		15.90	20.67	39.12	3.62	17.52	21.59	39.88	3.69
L.S.D at 0.05		0.11	0.27	0.80	NS	0.47	0.36	0.92	NS
Potassium fertilization rates effect									
Zero K fertilizer addition		14.55	18.54	35.78	3.44	15.05	19.41	36.32	3.53
24 kg K_2O		14.84	19.52	36.93	3.52	15.82	20.44	37.43	3.61
48 kg K_2O		15.55	20.40	37.74	3.58	16.77	21.80	38.31	3.66
L.S.D at 0.05		0.22	0.71	0.41	0.21	0.61	0.83	0.45	0.06
Interaction									
Zero compost addition	Zero K addition	13..21	17.33	33.62	3.33	13.89	18.12	33.97	3.42
	24 kg K_2O	13.87	18.15	34.78	3.42	14.27	18.87	35.12	3.51
	48 kg K_2O	14.51	19.05	35.25	3.48	15.12	19.91	35.74	3.58
POC	Zero K addition	14.07	18.80	35.58	3.44	14.76	19.62	36.21	3.55
	24 kg K_2O	14.68	19.76	36.92	3.51	15.62	20.68	37.34	3.61
	48 kg K_2O	15.43	20.26	37.84	3.57	16.72	21.07	38.15	3.65
POC+MC	Zero K addition	15.02	19.48	38.15	3.55	16.51	20.48	38.77	3.63
	24 kg K_2O	15.96	20.65	39.08	3.64	17.58	21.77	39.83	3.70
	48 kg K_2O	16.71	21.88	40.13	3.68	18.47	22.53	41.05	3.75
L.S.D at 0.05		NS	NS	NS	NS	NS	NS	NS	NS

***POC= pressed olive cake compost **POC+CM= pressed olive cake + chicken manure compost**

CONCLUSION

Under the conditions of the present study, it is advisable to apply pressed olive cake compost due to its beneficial effect in improving Roselle sepals production and quality. In addition, applying compost of pressed olive cake + chicken manure combined with K fertilization at48 kg K_2O fed^{-1} rate was superior to achieve the highest figures in this concern.

REFERENCES

Abbas, M.K. and A.S. Ali (2011). Effect of foliar application of NPK on some growth characters of two cultivars of roselle (Hibiscus sabdariffa). American J. Plant Physiol., 6 (4): 220-227.

Abdou, M.A.H.; M.A. El-Sayed; F.S. Badran R.S. and El-Deen (2004). Effect of planting density and chemical and biofertilization on vegetative growth, yield and chemical composition of fennel (*Foeniculum vulgare*, Miller): II-Effect of NPK chemical fertilization and biofertilization treatments. Annals of Agricultural Science, 42 (4): 1923-1937.

Abo-EI-Seoud M.A., M.F. Hashim and F.A. Mohamed (1994). Combined effect of gamma radiation and potassium fertilization on growth and coloring matter contents of Roselle (Hibiscus Sabdariffa L.). Second Arab Conference on the Peaceful Uses of Atomic Energy, Cairo, p.p: 863-874.

Abo-El-Seoud, M.A.A.; M.F. abdel-Sabour and E.A. Omar (1997). Productivity of roselle (Hibiscus sabdariffa L.) plant as affected by organic waste composts addition to sandy soil. Bull. Natl. Res. Center, Cairo, 22: 495-505.

Adanlawo I.G. and V. A. Ajibade (2006). Nutritive value of the two varieties of roselle (*Hibiscus sabdariffa*) calyces soaked with wood ash. Pak. J. Nutr. 5, 555- 557.

Ahmed, S.K.; E.O. El-Ghawas and A.F. Aly (1998). Effect of dry yeast and organic manure on roselle plant. Egypt. J. Agric. Research, 76: 1115-1142.

Ammar E. and B. Ben Rouina (1999). Potential horticultural utilization of olive oil processing wastewater. Acta Horto. 4 (74):741–744.

AOAC (1975). Association of Agricultural Chemist, Washington, D.C., 200. Official Method of Analysis 12th. Ed., 44: 94-117.

Ben-Jenana R.K.; M.A. Triki; R. Haoula; C. Hanachi; M. Ben Khedher and A.B. Henchi (2009). Composted posidonia, chicken manure and olive mill residues an alternative to peat as seed germination and seedling growing media in Tunisian Nursy. Pakistan J. Bot. 41(6): 3139-3147.

Bidari, B.I.and N.S. Hebsur (2011) Potassium in relation to yield and quality of selected vegetable crops. Karnataka J. Agric. Sci., 24 (1): 55-59.

Black, C.A. (1982) Methods of Soil Analysis." Amer. Sec. Agron. Inc. Publisher. Madison, Wisconsin, U S A.

Byamukama R.; M.Andima; A. Mbabazi and B.T. Kiremire (2014). Anthocyanins from mulberry (*Morusrubra)* fruits as potential natural colour additives in yoghurt. African Journal of Pure and Applied Chemistry. 8 (12): 182-190.

Cucci, G.; G. Lacolla and L. Caranfa (2008). Improvement of soil properties by application of olive oil waste. Agron. Sustain. Dev. 28:521–526.

El-Keltawi, N.E.; A.A. Tawfik and A.M. Ahmed (2003). Roselle (Hibiscus sabdariffa L.) production as affected by two natural alternatives to farmyard manure: Π- chemical assessment of sepal quality. Assuit. J. of Agric. Sci., 34 (6): 307-321.

El-Sheriff, M.H. and M.E. Sarwat (2007). Physiological and chemical variations in producing roselle plant (Hibiscus Sabdariffa. L.) by using organic farmyard manure. World J. Agric., Sci., 3 (5): 609-616.

El-Tantawy, M.E. and M.A.N. Mohamed (2009). Effect of inoculation with phosphate solubilizing bacteria on the tomato rhizosphere colonization process, plant growth and yield under organic and inorganic fertilization. Journal of Applied Sciences Research, 5(9): 1117-1131.

Faraji, M.H. and A. H. Tarkhni (1999).The effect of sour tea (Hibiscus sabdariffa) on essential hypertension. J. of Ethnopharmacology, 7: 231-236.

Gad, N. (2011). Productivity of roselle (*Hibiscus sabdariffa* L.) plant as affected by cobalt and organic Fertilizers. J. Appl. Sci. Res., 7(12): 1785-1792

Ghasemi, S.; K. Abbaszadeh; M. Ghasemi; M. Salari; F. Zarei (2015). Effect of application of nitrogen and potassium fertilizers on some vegetative and reproductive traits in Roselle (Hibiscus sabdariffa). International Journal of Agronomy and Agricultural Research, 7(2): 75-79.

Giovanna, C.;L. Giovanni and C. Leonardo (2008) Improvement of soil properties by application of olive oil waste. Agron. Sustain. Dev. 28: 521–526.

Hachicha, S.; M. Chtourou; K. Medhioub and E. Ammar (2006). Compost of poultry manure and olive mill wastes as an alternative fertilizer. Agron. Sustain. Dev. 26:135–142.

Medjahdi, N.; A.D. Djbeura and M. Kaid-Harache (2014). Effect of three types of composts of olive by products on growth and yield of hard wheat 'Triticum durum Desf'. Afr. J. Biotchnol. 13(52): 4685-4693.

Montemurro, F.; G. Convertini and D. Ferri (2004). Mill wastewater and olive pomace compost as amendments for rye-grass. Agronomie, Sciences, 24 (8):481-486.

Nabila, Y.N. and M.S. Aly (2002). Variations in productivity of (Hibiscus sabdariffa L.) in response to some agricultural supplementation. Annals of Agric. Sci. (Cairo), Faculty of Agric. Ain Shams Univ. Cairo, Egypt, 47 (3): 875-892.

Nielsen, S.S. (2010). Food Analysis and Laboratory Manual. *Second Edition.* Purdue University West Lafayette, IN, USA.

Parkinson, J. A. and S. E. Allen (1975). A wet oxidation procedure suitable for the determination of nitrogen and mineral nutrients in biological material. Communications in Soil Science and Plant Analysis, 6 (1): 1-11.

Parr, J.F., and S.B. Hornick. (1992). Agricultural use of organic amendments: A historical perspective. Am. J. Alternative Agric. 7:181–189.

Postoma , J.; M. Montanari; P.Vanden and H.J.F. Boogert (2003). Microbial enrichment to enhance the disease suppressive activity of compst. Euro. J. Soil Biol., 39: 157-163.

Riad, A. (1982). Potential sources of organic matter in Egypt. FAO soil Bull., 45: 22-25.

Ryan, J.; S. Garabet; K. Harmsen and A. Rashid (1996). Soil and Plant Analysis. Manual Adapted for the west Asia and North Africa Region. ICARDA, Aleppo, Syria. 140 pp.

Sakr, W.R.A; H.M. Elbagoury;M.A. Sidky; S.A. Ali (2014). Production of organic roselle by natural minerals and biofertilizers. American-Eurasian J. Agric. & Environ. Sci. 14(10), 985-995.

Sellami, F.; R. Hachicha; K. Meddich and E. ammer (2007). Composting of oil exhausted olive-cake, poultry manure and industrial residues of agro-food activity for soil amendment. Bioresour. Tecnol. 99:1177-1188.

Shalan, M.N.; T.A. Abd El-Latif; S.G. Soliman and E.O. El-Gawwas (2001). Effect of some chemical and biofertilizer treatments on roselle plants (Hibiscus sabdariffa L.). Egyptian Journal of Agricultural Research, 79 (2): 587- 606.

Snedecor, G.W. and W.G. Cochran (1980). One way classification-Analysis of Variance – The random effect model- Two way Classification (Eds) In Statistical Methods. The Iowa State Univ. Press, Amer. Iowa, USA, 215-273.

Tomar, O.S.; P.S.Minhas; V.K.Sharma; Y.P. Singh and R.K. Gupta (2003). Performance of 31 tree species and soil conditions in a plantation established with saline irrigation. Forest Ecology and Management, 177 (2003) 333-346.

Tomati, U., E. Galli, F. Fiorelli and L. Pasetti (1996). Fertilizers from composting of olive-mill wastewaters. International Biodeterioration and Biodegradation, 38:155-162.

Yasser, M.A.; E. A. Shalaby and N.T. Shanan (2011). The use of organic and inorganic cultures in improving vegetative growth, yield characters and antioxidant activity of roselle plants (*Hibiscus sabdariffa* L.). African Journal of Biotechnology 10 (11): 1988-1996.

استجابة نباتات الكركدية لإضافة نوعين من كمبوست المتبقي من استخلاص زيت الزيتون ومستويات مختلفة من التسميد البوتاسي في الاراضي المستصلحة حديثا بواحة سيوة – مصر

خطاب عبد الباقي خطاب
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية

اقيم هذا البحث بواحة سيوة -محطة البحوث الزراعية بمطروح – مصر لدراسة استجابة الكركدية لنوعين من الكمبوست المصنع من بقايا استخلاص زيت الزيتون (كمبوست مخلف استخلاص زيت الزيتون) و(كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن) اضيفا بمعدل 2 طن للفدان مقارنة بعدم الاضافة ومستويات مختلفة من التسميد البوتاسي (24 و48 كجم بو$_2$ا فدان$^{-1}$ مقارنة بعدم الاضافة) والتفاعلات على محصول البتلات ومكوناته، بعض المكونات الكيميائية وامتصاص العناصر الغذائية الكبرى (ن، فو، بو) ذلك خلال 2013 و2014. يمكن تلخيص أهم النتائج في الآتي:1- كان تأثير معاملات كلا من الكميوست والتسميد البوتاسي معنويا على ارتفاع النبات، عدد الفروع بالنبات ومحصولي البذور بالنبات وبالفدان. أعطي كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن وكذا معدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ أعلى القيم من الصفات السابقة في الموسمين. التفاعل بين المعاملات تحت الدراسة كان معنويا على الصفات تحت الدراسة وأعلي القيم من تفاعل كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن ومعدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ في كلا الموسمين.2- محصول البتلات ومكوناته تأثرا معنويا بمعاملات الكمبوست وكذا مستويات التسميد البوتاسي تحت الدراسة. أعلي القيم لمحصول البتلات ومكوناته سجلت بإضافة كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن وكذا معدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ في موسمي الزراعة. التفاعل بين كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن ومعدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ أظهر أعلي القيم لمحصول البتلات ومكوناته في كلا الموسمين.3- محتوي البتلات من ال ن، فو، بو% تأثرا معنويا بمعاملات الكمبوست وكذا مستويات التسميد البوتاسي تحت الدراسة. أعلي القيم سجلت بإضافة كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن وكذا معدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ في موسمي الزراعة. التفاعل بين كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن ومعدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ أظهر أعلي القيم لمحتوي البتلات من ن، فو، بو% في كلا الموسمين. 4 - محتوي الكربوهيدرات، الأنثوسيانين وحمض الاسكوربيك في بتلات الكركدية تأثروا معنويا بمعاملات الكمبوست وكذا مستويات التسميد البوتاسي تحت الدراسة في كلا الموسمين. أعلي القيم للمكونات السابقة سجلت بإضافة كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن وكذا معدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ في موسمي الزراعة. التفاعل بين كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن ومعدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ أظهر أعلي القيم للمكونات السابقة وان لم تكن الفروق معنوبة في كلا الموسمين. اضافة كمبوست مخلف استخلاص زيت الزيتون + معدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ أعطي قيم عالية لمحصول البتلات ومكوناته من المركبات الكيميائية والعناصر الغذائية الكبرى (ن، قو، بو) خلال 2013 و2014. بالرغم من ذلك ينصح بإضافة كمبوست مخلف استخلاص زيت الزيتون + سماد الدواجن ومعدل التسميد البوتاسي 48 كجم بو$_2$ا فدان$^{-1}$ للحصول على القيم الأعلى من الصفات السابقة الذكر تحت ظروف التجربة الحالية.