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Response of Jerusalem Artichoke Plants Grown under Saline Calcareous Soil to Application of Different Combined Organic Manures

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TWO FIELD experiments were successfully carried out to evaluate the potential influencesof three organic manure (farmyard, FYM, poultry, PLM, and pigeon PGM) applied in different combinations on growth and tuber yield, and biochemical constituents of deJerusalem artichoke plants. The results indicated that organic treatments improved all test parameters, with different degrees, compared to the control. In the first season (2016/2017), the combined PLM + PGM treatment (T_2) produced the highest values of No. of leaves, leaf and stem fresh and dry weights, tuber fresh and dry weights, and tuber nitrogen content. The combined PGM + ½ FYM + ½ PLM) treatment (T_6) produced the highest values of plant height, No. of lateral shoots, tuber phosphorus, cadmium and nickel content. While combined FYM + PLM treatment (T_1), produced the highest values of leaf nitrogen content and total yield. While, the combined FYM + ½ PLM + ½ PGM treatment (T_4) showed the best number of lateral shoots, leaf fresh and dry weights, tuber fresh weight and total tuber yield,leaf phosphorus and tuber nitrogen contents in the second season (2017/2018). However, the combined FYM + PGM treatment (T_3) produced the highest values of total phenolic compounds, leaf phosphorus and tuber potassium contents, and the combined PGM + ½FYM + ½PLM treatment (T_6) was the best for inulin percentage in both seasons. The results of this study recommend using organic fertilizers, especially the combined T_1 or T_4 for Jerusalem artichoke.

Keywords: Jerusalem artichoke, Loamy clay sand soil, Organic manures, Heavy metals .Macronutrients uptake

Introduction

The use of mineral fertilizers to increase yield has been found to be effective only within few years, demanding consistent use on long term basis (Ojeniyi et al., 2009). The hazardous environmental consequences and high cost of mineral fertilizers make itundesirable but also uneconomical and out of reach of the poor farmers who still dominate in the Egyptian agriculture sector (Shiyam and Binang, 2011). This are led to increase use of organic manure, a readily available alternative, to be more environmentally friend. Over-use of chemical fertilizer can be harmful to environment by polluting water and whichbe hazardous to human health. In organic farming, the soil becomes rich in nutrients; therefore, crops grow healthy and can be resistant to pests and diseases, making the quality of the products more nutritious, testy and contain substances that are good for health (Wakui, 2009).

In recent year, attention has been directed toward organic manure because of the rising cost of mineral fertilizers coupled with their inability to give the soil the desired sound health. Poultry manure, sometimes called chicken manure, is an excellent soil amendments that provides nutrients for growing crops when use wisely, because it has high organic matter content combined with

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available nutrients for plant growth (Van Ryssen et al.,1993).

Jerusalem artichoke (*Helianthus tuberosus* L.) is a non-traditional tuberous crop, which is recently introduced to Egypt for its high nutritional and medicinal values. The plant can grow in almost all soils with the exception of clay soil. It contains an important homo-polysaccharide (Inulin) which plays very important roles for nutrition and treatment of diabetic patients and obesity. Recently, Jerusalem artichoke has attracted attention by the bioethanol industry sector because of its high productivity as well as high content of inulin (Puangbut, et al., 2012). The inulin is present as a reserve carbohydrate in its tubers and can be easily hydrolyzed for ethanol production (Maria et al.2006). In order to improve the yield of Jerusalem artichoke, the soil content of nutrients should be increased to increase the fertility which can be achieved by either using organic fertilizer such as cattle manure, poultry manure, pigeon manure and use of compost (Dauda et al., 2008) or by using chemical fertilizers mainly potassium and nitrogen compounds.

Therefore, the objective of the present work was to study the influence of some different organic manure combinations for good vegetative growth, some chemical constituents and high tuber yield and quality characters of Jerusalem artichoke.

Materials and Methods

Experimental site

This experiment was carried out at the Experimental farm of the Faculty of Agriculture, Fayoum University, Demo farm station during two successive summer seasons of 2016/2017 and 2017/2018, to investigate the effect of combination of some different fermented organic manures;farmyard manure(FYM); poultry manure (PLM)andpigeon manure(PGM) on Jerusalem artichoke (*Helianthus tuberosus* L. Baladi cv.) plants grown in sandy clay loam soil.

Manures and intercultural operations

Well-decomposed FYM, PLM and PGM were applied before sowing at the rate of 12 tons $ha^{-1}$to the all plots except control treatment. Only 480 kg of ammonium sulfate (20.6% N); 480 kg of triple superphosphate (15.5% P_2O_5) and 240 kg $ha^{-1}$of potassium sulfate wereadded as a source for nitrogen; phosphorus and potassium, respectively. The total amount of triple superphosphate and 50% of total dose of ammonium and potassium sulfate were applied during soil preparation. The rest amounts of ammonium and potassium sulfate were applied after 35 days from sowing. Intercultural operations like thinning, sowing, irrigation, insects and pest management were done to facilitate optimum crop growth. Moreover, Organic fertilizers samples were analyzed to determine theNitrogen, Phosphorus, Potassium and organic matter content as shown in Table 1.

Experimental design

The single factor randomized complete block design (RCBD) was used with three replications. The plot area was 10.5 m^2 (3.5 m × 3.0 m). The experiment consisted of three organic manures levels as shown in Table 2.

TABLE 1. Analysis of organic manure used in this study for two seasons

Organic manure	FYM	PLM	PGM	FYM	PLM	PGM
	2016/2017			2017/2018		
Nitrogen (%)	0.112	0.393	0.403	0.128	0.430	0.440
Phosphorus (%)	0.180	0.188	0.053	0.168	0.199	0.059
Potassium (%)	0.082	0.456	0.350	0.086	0.490	0.398
Organic matter (%)	24.2	21.2	42.7	25.8	21.6	48.7

FYM Farm yard manure PLM Poultry manure PGM Pigeon manure

TABLE 2. The experimental treatments of organic manure

Treatment	Rates	Quantity of Organic fertilizers
T_0	Control	480 kg of ammonium sulfate, 480 kg of triple super phosphate, 240 kg of potassium sulfate and no organic manure add
T_1	50% FYM+50% PLM	21 kg of Farm Yard Manure + 21 kg of Poultry Manure
T_2	50% PLM+50% PGM	21 kg of Poultry Manure + 21 kg of Pigeon Manure
T_3	50% FYM+50% PGM	21 kg of Farm Yard Manure + 21 kg of Pigeon Manure
T_4	50% FYM+25% PLM+25% PGM	21 kg of Farm Yard Manure + 10.5 Kg Poultry Manure + 10.5 kg Pigeon Manure
T_5	50% PLM+25% FYM+25% PGM	21 kg of Poultry Manure + 10.5 Kg Farm Yard Manure + 10.5 kg Pigeon Manure
T_6	50% PGM+25% FYM+25% PLM	21 kg of Pigeon Manure + 10.5 Kg Farm Yard Manure + 10.5 kg Poultry Manure

FYM Farm yard manure PLM Poultry manure PGM Pigeon manure

TABLE 3. Mean physical and chemical characters for the two experimental seasons

Soil property	2016/2017 season	2017/2018 season
Particle size distribution		
Sand (%)	65.9	63.8
Silt (%)	6.9	7.4
Clay (%)	27.2	28.8
Soil texture	Sandy clay loam	Sandy clay loam
pH (in soil paste)	7.85	7.69
ECe (dSm^{-1})	13.80	11.3
Organic matter (%)	0.62	0.77
$CaCO_3$ (%)	10.30	9.90
Soluble ions mmeq/L		
CO_3^{--}	----	----
HCO_3^-	5.13	4.05
Cl^-	110.00	67.00
SO_4^{--}	26.60	42.20
Mg^{++}	22.00	15.00
Na^+	79.30	73.60
K^+	2.02	2.19
SO_4^{--}	26.60	48.20
Total N (%)	23.5	24.6
Extractable P $NaHCO_3$ pH=8.5 (mg kg^{-1})	13.10	12.10
Extractable K NH_4OAC at pH=7.0 (mg kg^{-1})	301.00	311.00
DTPA Extractable micronutrients (mg kg^{-1})		
Fe	0.4314	0.3388
Mn	0.9466	1.5600
Zn	0.2660	0.3350
Cu	0.2766	0.2868

Collection and analysis of Soil sample

Soil samples of each experiment were collected from 25 cm depth and analyzed for some physical and chemical properties according to the methods described by Page et al. (1982) as shown in Table 3.

Statistical analysis

A random sample of five plants from each experimental plot was taken at flowering initiation stage (after 120 days from planting) to calculate plant height (cm), lateral shoots plant^{-1}, leaves and stem fresh and dry weights plant^{-1} (g). All of these characters were analyzed according to Official Methods of the Association Chemists (AOAC, 1975).

Yield and its components

At harvest time, 290 days after planting, average tuber fresh and dry weight plant^{-1} (g), total tuber yield (Mg ha^{-1}) were assessed.

Chemical constituents

Leaves

Random samples from the upper fourth leaf were collected; washed with distilled water to estimate chlorophyll index using SPAD 502 plus chlorophyll meterandthen, oven dried at 70º C to determine the nitrogen, phosphorus and potassium contents according to the methods described in AOAC (1992).

One g portions fromoven dried leaves of Jerusalem artichoke were digested with H_2SO_4-H_2O_2 method according to Parkinson, Allen (1975) and analyzed,for total nitrogen using the Orange Gmethod according to Hafez and Mikkelsen (1981); phosphorus content was determined using a colorimetric method according to Chen et al. (1956) and potassium content was estimated using a flame photometer, Jenway- PFP7 with acetylene burner as described by Page et al. (1982).

Tubers

Total nitrogen, phosphorus and potassium were determined by Hafez and Mikkelson (1981), Chenet al.(1956) andPage et al. (1982), respectively, Inulin content was determined in tubers according to the methods of Winton and Winton (1985), some heavy metals; cadmium, lead and nickel were determined by the inductively coupled plasma– optical emission spectrometry (ICP-OES, Perkin- Elmer OPTIMA-2100 DV, Norwalk, CT)and total Phenolic compounds (TPCs) were extracted from dry sample (1.0 g) by the method described by Taga et al. (1984).

Results and Discussion

Vegetative growth

The results in Table 4 indicate that all organic treatments improved all growth parameters, with differentdegrees, compared to the control which received inorganic fertilizers only (T_0). The application of 50% pigeon manure+50% poultry manure (T_2) and 25% farmyard manure + 25% Poultry manure + 50% pigeon manure (T_6) recorded the highest values in 2016/2017 for all parameters studied. Asthe lowest valueswere obtained by applying 50% farmyard manure + 50% pigeon manure (T_3) and inorganic NPK (T_0), respectively in the first season.On the second season, the highest values of all growth parameters were recorded by using (T_3) and 50% farmyard manure + 25% poultry manure + 25% pigeon manure (T_4).The lowest values of all growth parameters were recorded by applying the inorganic fertilizers (T_0).Given the steady increase in population and the urgent need for a food free from contaminants, new sources of food had to be sought with environmentally friend fertilizers. Analysis of variance indicated that all organic combination treatments had significant effects on all growth parameters (plant height, No. of lateral shoots, No. of leaves, leaf area, leaves fresh and dry weights), positively reflecting in yield and its components at $P \leq 0.01$ in Table (4). These results are in agreement with those obtained by Ahmed and El-Zaawely(2010) for plant height and number of lateral shoots which may be attributed to the high levels of organic nutrients in the manures that could encourage growth.Ndukwe et al. (2011) indicated that organic manures are a valuable source of crop nutrients and organic matter, which can improve the soil physical, chemical and biological properties. Obtained results are coinciding with those reported by Ng'Etich et al. (2012). These results may be attributed to that soil with high organic content and adequate nutrients are required to favor the growth Chweya and Mnzava (1997). In addition, plants that received little or no nutrients were stunted in growth compared to healthy plants. Results had highly significant effects for leaves fresh weight ,dry matter , stem fresh weight and dry matter in both seasons. These results appeared to be in a close agreement with the findings recorded by Abd El-Hak (2005). The results might be due to the efficient absorption and assimilation of nitrogen from manures by the plants which serve as a

TABLE 4. Influence of organic manure combination on some growth characters of Jerusalem artichoke plants in two seasons.

Growth season	Treatment	Plant height cm	No. of lateral shoots plant^{-1}	No. of leaves plant^{-1}	Leaves plant^{-1}(g) FW	Leaves DW	(Stem plant^{-1}(g FW	(Stem plant^{-1}(g DW	Leaf area (plant^{-1}(cm^2
2016/2017	T_0	76.55d	11.22d	113.00f	129.63e	54.12f	106.47f	64.28e	5524.05f
	T_1	100.22b	21.11c	221.44c	258.57d	89.05c	285.27d	98.96d	9177.40c
	T_2	99.78b	26.33a	332.11a	506.77a	184.12a	480.40a	168.79a	17030.42a
	T_3	75.00d	9.67e	103.67g	134.55e	50.91f	149.70e	59.85f	4621.17g
	T_4	91.89c	20.78c	187.78d	307.50c	77.08d	356.40c	100.43d	8397.02d
	T_5	97.89b	12.22d	154.78e	241.87d	62.27e	393.97b	113.94c	6592.55e
	T_6	105.22a	22.67b	297.78b	371.37b	115.74b	354.60c	132.99b	12295.72b
$LSD_{0.05}$		****2.37**	****1.35**	****3.79**	****41.56**	****3.50**	****4.76**	****3.34**	****609.94**
2017/2018	T_0	92.33c	9.89f	108.00e	164.93f	102.29c	234.17f	111.32e	16681.35f
	T_1	104.78b	14.67e	236.67c	234.07e	155.26abc	262.00e	150.03d	27470.62d
	T_2	105.56b	16.00d	226.33d	259.53d	178.99abc	349.03c	201.21b	31388.62c
	T_3	117.67a	18.78c	293.89b	400.20b	230.55a	472.70a	263.46a	36958.44a
	T_4	109.33b	23.00a	327.33a	434.33a	224.79ab	447.90b	258.67a	32748.15b
	T_5	103.89b	20.89b	237.11c	252.47d	151.45bc	292.97d	180.59c	25931.42e
	T_6	110.11b	19.56c	237.22c	280.37c	162.08abc	265.47e	148.08d	26172.12de
$LSD_{0.05}$		****6.48**	****1.11**	****5.46**	****7.86**	***70.12**	****22.40**	****13.59**	****1300.80**

constituent of chlorophyll which has been reported to be directly proportional to photosynthetic process (Ng'etich et al., 2009). The results are agree with those of Sumeet et al. (2009), who reported that chlorophyll is strongly related to nitrogen content in the soil and is constituents of chlorophyll. In addition, the release of nutrients with the decomposition of this organic manures (Wang et al., 2014).

Chemical constituents

Leaves

Chlorophyll index

The effect of mixturesof organic manures on the chlorophyll index of leaves is shown in Fig.1. The highest value of chlorophyll index (37.82) were recorded by $T_0$when inorganic fertilizers added followed by $T_5$with value of 37.13 while, the lowest value was recorded by T_6 (34.36) in 2016/2017.On the other hand, the highest values were recorded by T_2 (33.39) followed by T_0(33.13), the lowest value was recorded by T_6(29.87) in 2017/2018.

From the obtained data, the rates of increase between the highest and lowest values were 9.14% and 10.54% in 2016/2017 and 2017/2018, respectively.Chlorophyll index of leaves of Jerusalem artichoke plants, significantly and highly significant improved in both seasons, respectively. The results of both seasons reflected the effect of organic compound and the organic nitrogen, which was in the following order $T_0 > T_2 > T_6 \approx T_5 > T_3 \approx T_4 \approx T_1$with values of about 0.254, 0.182, 0.151, 0.150, 0.119, 0.118 and 0.117 kg N/plot in the same order. However, T_0 applied more nitrogen per plot than any organic treatments, but the presence of organic acids produced by organic matter decomposition was more effective than inorganic nitrogen.

Nitrogen, phosphorus and potassium content inleaves

The results in Table 5 indicate that T_3 (50%FYM + 50%PGM) treatment recorded the values (1.5 and 215%, respectively) for phosphorus and potassium, while value for nitrogen (4.49%) was recorded by applying T_1 (100% FYM) treatment in the first season.On the other hand, the highest values (5.56 and 2.11%) were showed by using T_3 for nitrogen and potassium, respectively, and (1.57%) by T_4 treatment for phosphorus in the second season.

The results in Table 5 showed that in the first season, nitrogen in leaves was significantly higher with $T_1 = T_3 = T_2 = T_6$ than T_5 which was higher the $T_4 \approx T_0$, while in the second season all organic mixtures produced higher N-content in leaves than the inorganic (T_0) treatment.

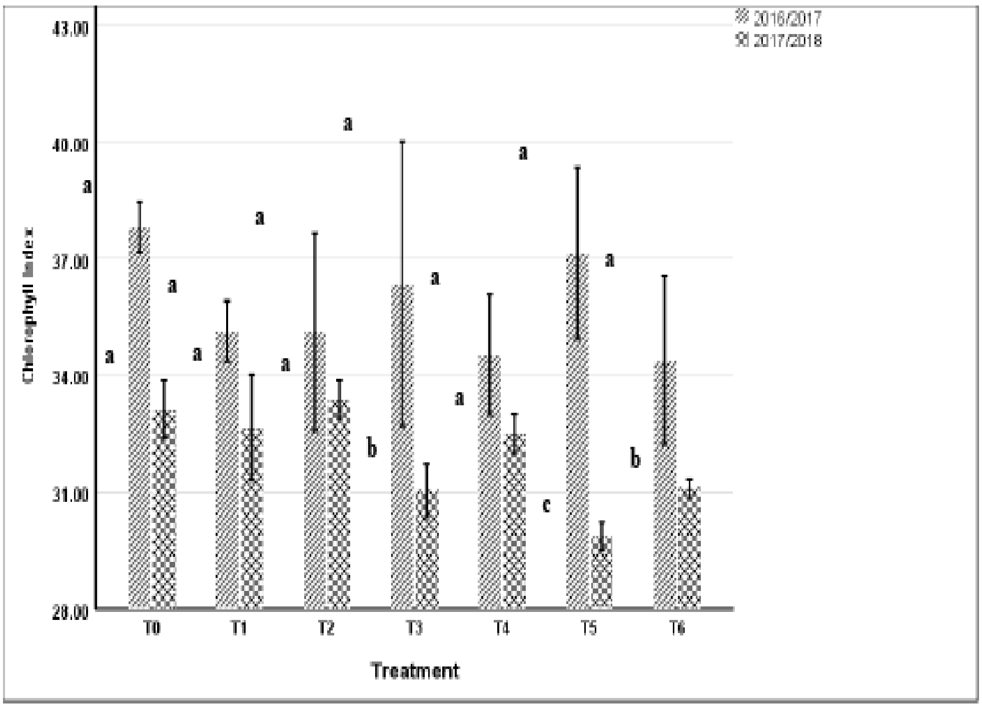

Fig. 1. Influence of organic manure combination on chlorophyll index of Jerusalem artichoke leaves in 2016/17 and 2017/18

TABLE 5. Influence of organic manure combination on leaf and tuber contents of mineral nutrients of Jerusalem artichoke plants in the two seasons

Growth season	Treatment	Leaves (%)			Tubers (%)		
		N	P	K	N	P	K
2016/2017	T_0	4.03d	1.13b	1.74b	1.95a	0.29g	1.12de
	T_1	4.49a	1.39ab	1.92ab	1.66b	0.51f	1.19bc
	T_2	4.43a-c	1.43ab	1.92ab	2.00a	0.51e	1.08e
	T_3	4.48ab	1.53a	2.15a	1.65b	0.68a	1.44a
	T_4	3.99d	1.40ab	1.81b	1.88ab	0.70c	1.13de
	T_5	4.25ac	1.51a	1.74b	1.84ab	0.68d	1.15cd
	T_6	4.34abc	1.41ab	1.75b	1.75ab	0.70b	1.21b
LSD $_{0.05}$		**0.21**	**0.31**	**0.30**	**0.23**	**0.13**	**0.05**
2017/2018	T_0	4.71b	1.11d	1.75d	1.72ab	0.25f	1.08c
	T_1	5.21a	1.41c	1.79cd	1.61b	0.41e	1.16bc
	T_2	5.38a	1.47bc	1.79d	1.84a	0.45d	1.05c
	T_3	5.56a	1.61a	2.11a	1.82ab	0.70a	1.35a
	T_4	5.50a	1.57a	1.99b	1.89a	0.61c	1.05c
	T_5	5.44a	1.44c	1.84c	1.70ab	0.59c	1.08c
	T_6	5.49a	1.54ab	2.00b	1.68ab	0.67b	1.23ab
LSD $_{0.05}$		**0.38**	**0.08**	**0.08**	**0.20**	**0.02**	**0.14**

According to P-leave content, it was also significantly higher with all organic mixtures than (T_0) inorganic treatment in both seasons. Also, K leaves content increased significantly with T_3, T_1 and T_2 than control treatment. T_3 (50%PLM + 50% PGM) usually showed the highesttrend of NPK in leaves.

The results in Table 5 showed that in the first season, nitrogen in leaves was significantly higher with T_1=T_3=T_2=T_6 than T_5 and T_5 which were higher than the T_4 and T_0, while in the second season all organic mixtures produced higher N-content in leaves than the inorganic (T_0) treatment. According to leaves P content it was also significantly higher with all organic mixtures than (T_0) inorganic treatment in both seasons.

Also, leaves Kcontent increased significantly with T_3, T_1 and T_2, than T_0. Treatment 3 (50% FYM + 50% PGM) usually showed the best trend of NPK in leaves.

With regard to the lowest values, the results were similar, however T_0 (control) treatment recorded (1.13 and 1.74%) for phosphorus and potassium, and (3.99%) for nitrogen in the first season.In the second season, the lowest values (4.71; 1.11 and 1.75%, respectively) were recorded without any organic manure T_0 (control) treatment for nitrogen; phosphorus and potassium, respectively. Such data reveal that there are highly significant differences between treatments for the three studied elements for both growing seasons. Regarding,N, P and K content in Jerusalem artichoke leaves, organic manures not only a source of nutrients available for plants but also as the most important constituent of the soil humus, which provides good substrate to plant growth. This could be attributed to the fact that nutrients in the organic manures were released gradually through the process of mineralization (Mehedi et al. 2012), maintain optimum soil levels over prolonged periods of time. Some of the organic substances released during the mineralization may act as chelates, which help to uptake of essential ions (Lobo et al., 2012), they added that organic materials could formed complex, preventing the fixationof P, reduced the P sorption capacity of the soil, enhanced P availability, improved P recovery or resulted in better utilization by plants. In addition, organic manures added carbon to the soil provides substrate for microbial growth and decomposition of organic materials improves C and N mineralization rate and enzyme activities that affect nutrient cycling and availability to the plants. This effect may be due to the high phosphorus and potassium contents of pigeon and poultry manures as shown in Table 3 in addition to the role of PLM for enhancement of decomposition of the organic materials and mineralization of nutrients especially, N and P in presence of mineral fertilizers (Okunlola et al., 2011).

Tubers

Nitrogen, phosphorus and potassium content intubers

As regard to the influence of organic manure mixtures on nitrogen (N); phosphorus (P) and potassium (K) contents in Jerusalem artichoke tuber,Table 5 indicated that the three nutrients content were highly significant enhanced with the application of organic manure mixtures as compared with control. The highest values of 2.00; 0.70 and 1.44%, for N, P and K, respectively were obtained by applying T_2 (50% PLM + 50% PGM) for N; T_4 (50% FYM + 25% PLM + 25% PGM) and T_6 (50% PGM + 25% FYM + 25% PLM) for P and T_3 (50% FYM + 50% PGM) for K in 2016/2017 growingseason, but in 2017/2018, the highest value (1.89; 0.70 and 1.35, respectively) were recorded by applying T_4; T_3 and T_3, for N; P and K, respectively.

Cadmium, lead and nickel content of tubers

Cadmium (Cd); Lead (Pb) and nickel (Ni) concentrations in Jerusalem artichoke tuber are shown in figures (4; 5 & 6). The obtained results indicated that the lowest values were recorded with applying T_7(50% PGM+ 25% FYM + 25 PLM)(0.05 and 0.07 for Cd and 2.71 and 2.69 mgkg^{-1} for Ni),whilethe lowest values of Pb (1.67 and 1.64) were recordedwith applying T_6(50% PGM + 25% FYM + 25% PLM) and T_3(50% FYM + 50% PGM) in 2016/2017 and 2017/2018 growth seasons, respectively. On the other side, the highest values of 0.51and 0.52 for Cd; 3.67 and 4.23 for Pb and 6.36 and 6.29 for Ni mgkg^{-1}, in 2016/2017 and 2017/2018, were recorded with applying T_1 or chemical fertilizers T_0respectively. The ANOVA results showed that the Cd; Pb and Ni concentrations were significantly affected by all combinations of organic manures as compared with control treatment at 1% probability level.

In arid and semi-arid regions including Egypt, irrigation water and soil are characterized by high levels of salinity that may aggravate the problem of heavy metals pollutions (Rady et al. 2016). These results may be due to that soil application of organic manures has been shown to improve soil fertility to reduce salt stress and the bioavailability of heavy metals to plant roots (Ok et al., 2012). In addition, the application of organic manures improved the soil physical, chemical and biological properties and decreased the heavy metals bioactivity to plant roots. Moreover, the application of organic manures reduced the metals toxicity and consequently increased soil microbial activity (Usman et al., 2013). On the other hand, (T_0) recorded the highest values for Cd; Pb and Ni due to the frequent use of chemical fertilizers such as ammonium sulfate, calcium super phosphate and potassium sulfate as shown in Table 2 which cause an increase in the concentration of heavy metals in soil and irrigation water, consequently, in plants (Hadi et al., 2014). Indeed, the soil heavy metals availability can be decreased by applying the organic manures that causing heavy metals transformation from more readily available forms to less available forms such as fractions, associated with organic materials, carbonates or heavy metals oxides causing reduction in heavy metals uptake by plants (Ok et al., 2011).

Total phenolic compounds and inulin content of tubers

Presented data in (Fig. 2 and 3) indicate the influence of some organic manure combinations on total phenolic compounds (TPC) and inulin content (IC) of Jerusalem artichoke tubers. The highest values (16.93 and 17.81%, respectively) were showed by T_3 (50% FYM + 50% PGM) and T_2 (50% PLM + 50% PGM) treatments for TPCs, and (13.13 and 12.86%, respectively) by T_6 (50% PGM + 25% FYM + 25% PLM) for IC in 2016/2017 and 2017/2018 growth season, respectively. On the other side, the lowest values (6.20 and 8.05%, respectively for TPCs) were recorded by T_6 and T_5 (50% PLM + 25% FYM + 25% PGM) treatments and (10.38 and 10.9% for IC) by T_0 (control) in both of seasons, respectively. Obtained results are coincided with those reported by Ragab et al. (2008) on Jerusalem artichoke.

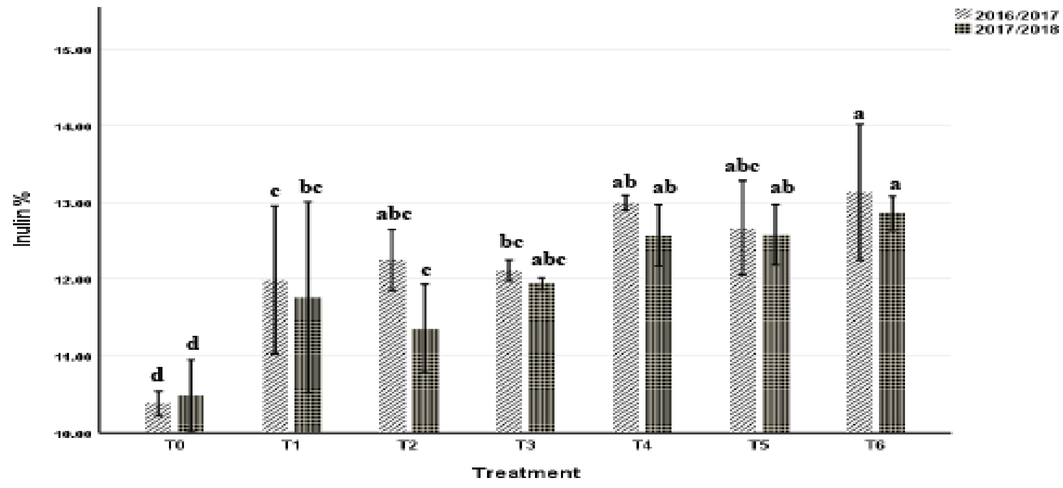

Fig. 2. Influence of organic manure combination on inulin content % of Jerusalem artichoke tubers in 2016/17 and 2017/18

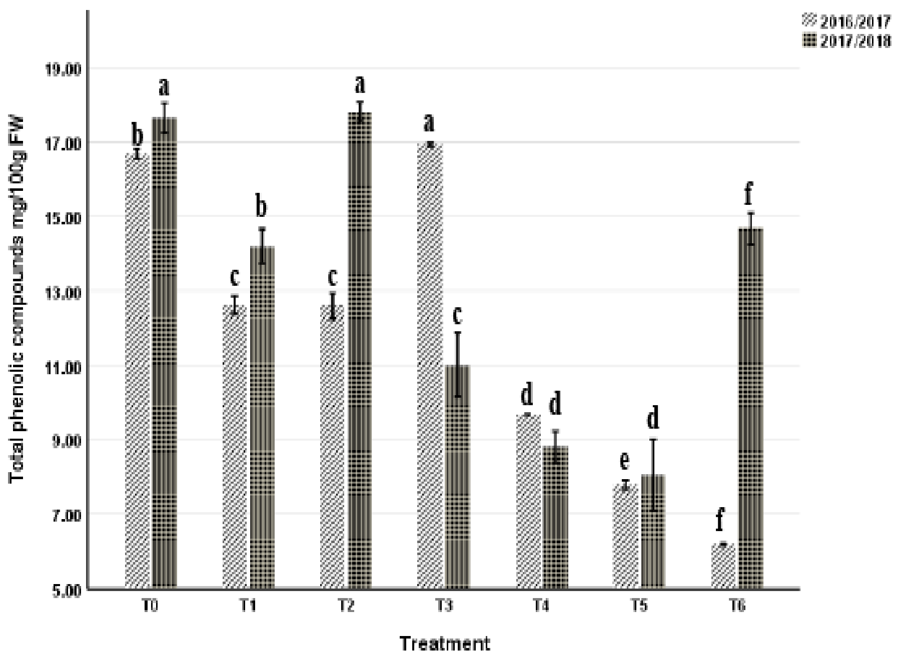

Fig. 3. Influence of organic manure combination on total phenolic compounds of Jerusalem artichoke tubers in 2016/17 and 2017/18

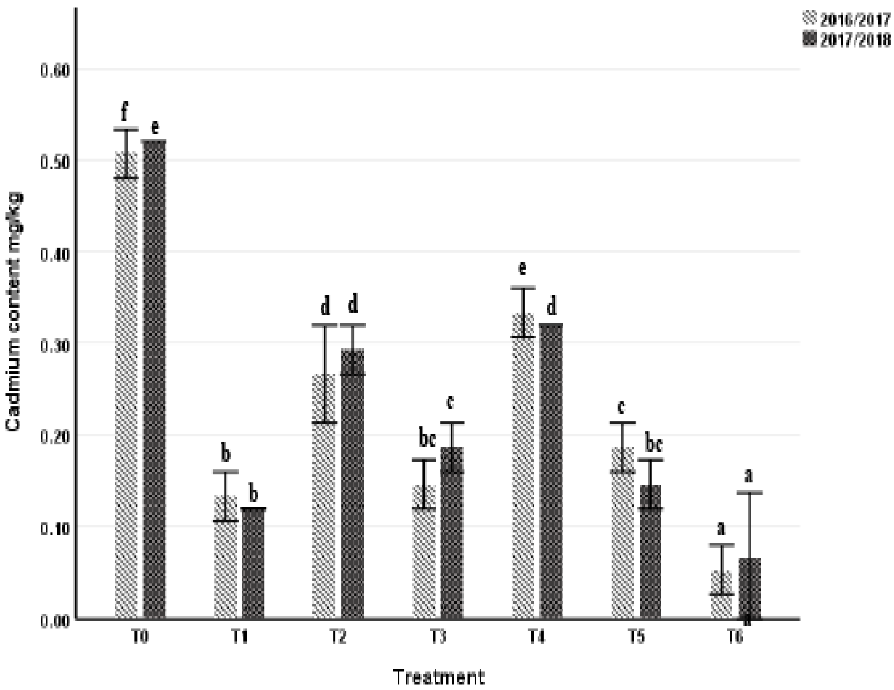

Fig. 4. Influence of organic manure combination on cadmium content of Jerusalem artichoke tubers in 2016/17 and 2017/18

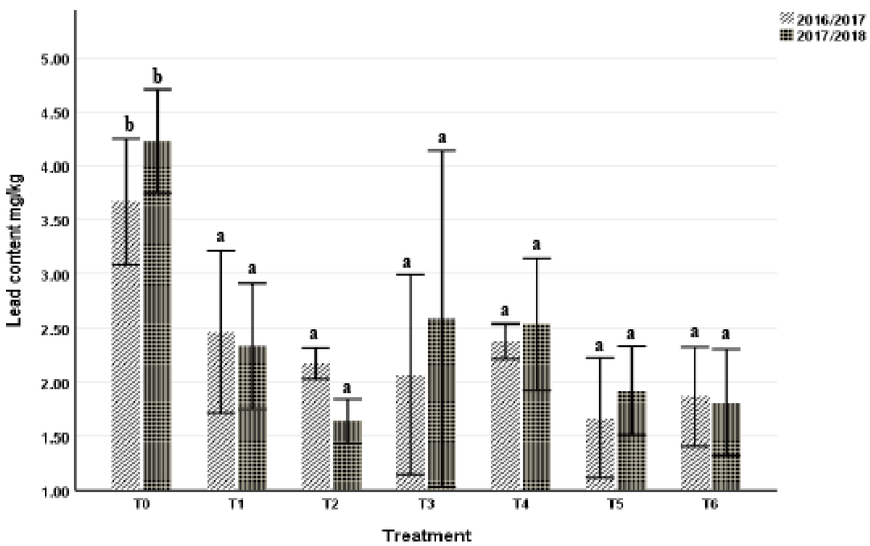

Fig. 5. Influence of organic manure combination on lead content of Jerusalem artichoke tubers in 2016/17 and 2017/18

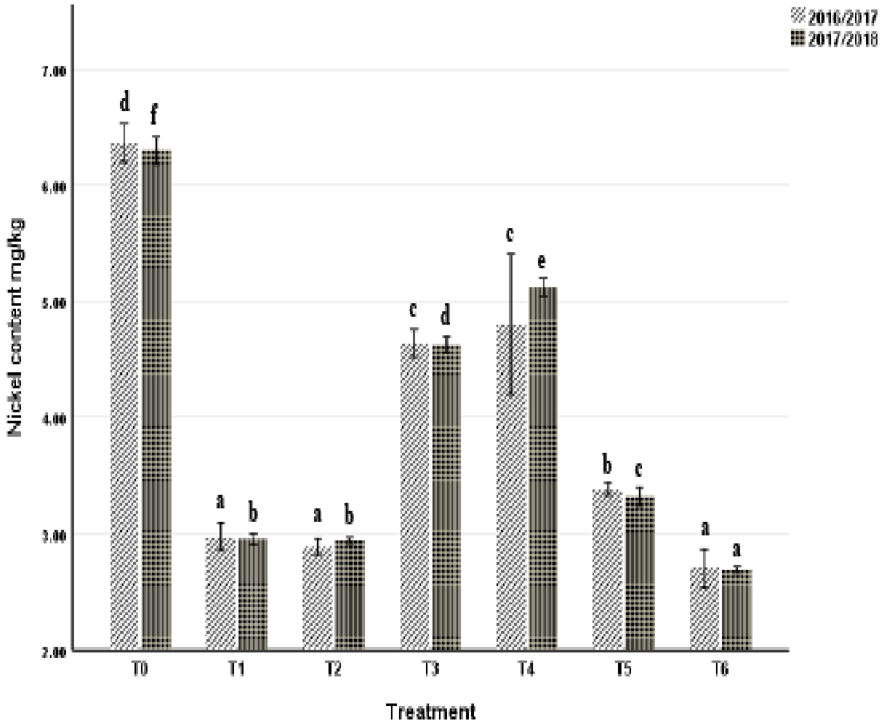

Fig. 6. Influence of organic manure combination on nickel content of Jerusalem artichoke tubers in 2016/17 and 2017/18

TABLE 6. Influence of organic manure combination on tuber yields of Jerusalem artichoke plants in the two seasons

Growth season	Treatment	Tuber (g plant^{-1})		%	Total Yield
		Fresh weight	Dry matter	dry matter	(tons ha^{-1})
2016/2017	T_0	236.11	118.40	50.16	27410.00
	T_1	243.83	188.01	34.57	50560.00
	T_2	987.17	352.92	35.84	40206.67
	T_3	284.25	110.76	38.96	42250.00
	T_4	663.90	177.51	26.74	35726.67
	T_5	635.83	176.21	27.71	35726.67
	T_6	725.97	248.73	34.26	35726.67
$LSD_{0.05}$		43.23**	4.69**	34.26**	8064.15**
2017/2018	T_0	399.10	213.61	53.68	18800.00
	T_1	496.07	305.29	61.55	15843.20
	T_2	608.57	380.20	62.48	14432.00
	T_3	872.90	494.01	56.53	24377.60
	T_4	882.23	483.45	54.82	20009.60
	T_5	545.43	332.04	60.88	17388.80
	T_6	545.83	310.16	56.83	17523.20
$LSD_{0.05}$		22.68**	74.27**	ns	ns

These results could be explained due to that high content of these nutrients of leaves positively reflected in the nutritional status of tubers. It is evident from the results that TPCs and IC were highly significant affected by applying organic manure combinations. As shown from results, might be due to applying organic manures improved the mineral status of JA plants Kolota and Osinska (2006), in addition, total phenolic compounds are synthesized through a secondary metabolism cycle and it could produce some plant hormones Franco et al. (2002).

Yield and its components

Tuber fresh and dry weights

Data illustrated in Table 6 show the influence of organic manure combinations on yield components expressed as fresh and dry weights of tubers. The highest values (987.17 and 352.92 g plant^{-1}, respectively) were showed by applying T_2 (50% PLM + 50% PGM) treatment, although the highest value (50.16%) of dry weight percent was recorded by using T_0 (control) in 2016/2017, as, the highest values (882.23 and 494.01) were showed by applying T_4 (50% FYM + 50% PLM) and T_3 (50% FYM + 50% PGM). On the other side, the lowest values were showed by applying T_0 (control) for fresh and dry weights in both seasons. The rates of increasing were (76.08 and 66.45%) and (54.76 and 56.76%) for fresh and dry weights in both seasons.

Total tuber yield

The indicated data in Table 6 indicated that the highest values (50.56 and 42.25 t ha^{-1}) were recorded by applying T_1 (50% FYM + 50% PLM) followed by T_3(50% FYM + 50% PGM) treatments in 2016/2017 growingseason, and (24.38 and 20.01 t ha^{-1}) by applying T_3 followed by T_4 treatments in 2017/2018 growingseason. The lowest values (27.41 and 14.43 t ha^{-1}) were recorded by T_0 (Control) and T_2 (100% PLM) treatments, the rates of increasing were 45.79 and 22.87 % in both seasons respectively.This increase in yield components may be attributed to the high levels of nutrients in the manures that could encourage the vegetative growth and accelerate the photosynthetic rate (Ahmed andElzaawely2010). In addition, poultry manures contained essential nutrients associated with high photosynthetic activities and thus promotes roots and vegetative growth (Daoula et al. 2008). The increase could be attributed to the ability of poultry manure to promote vigorous growth, increase meristematic and physiological activities in the plants due to supply of plant nutrient and improve in the soil properties. In this respect, similar findings were also found by Osman (2004).

The results of statistical analysis of these data indicated that treatments were highly significant increase in 2016/2017 season and no significant in 2017/2018 growth season as compared with control. These results were in line with the results obtained by Dauda et al. (2005b), however poultry manure is good source of nitrogen for sustainable crop production.

The increase in the total yield may due to the effect of organic manures on soil aggregation, soil aeration ,increase water holding capacity and offers good environmental conditions for the root system(Ng'etich et al. 2012). In addition, farmyard manures are slow release nutrients all over the growing seasons.

Conclusion

On the basic of the obtained results it was concluded thatthe highest total yield were recorded by T_1(50% FYM + 50% PLM) and T_4 (50% FYM + 25% PLM + 25% PGM) treatments in 2016/2017 and 2017/2018 growth seasons, respectively. T_3 treatment was the highest treatment for total phenolic compounds and T_6 (50% PGM + 25% FYM + 25% PLM) treatment for inulin.

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إستجابة نباتات الطرطوفة النامية تحت ظروف الاراضى الجيرية الملحية إلى معدلات الاضافة المختلفة من الاسمدة العضوية

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أجريت تجربة علي نباتات الطرطوفة المنزرعة بأرض جيرية عالية الملوحة حديثة الاستصلاح خلال الموسم الصيفي ٢٠١٧/٢٠١٦ و ٢٠١٨/٢٠١٧ لتقييم تأثير خلط ثلاثة أنواع مختلفة من الأسمدة العضوية (مخلفات الماشية و مخلفات الدواجن وذبل الحمام) علي بعض صفات النمو الخضري وامتصاص بعض العناصر الكبرى (النيتروجين – الفوسفور – البوتاسيوم) وانعكاس ذلك علي محتوي الدرنات من هذه العناصر كأحد صفات الجودة، اضافة الي مدي تأثير نتائج خلط هذه الاسمدة علي محتوي الدرنات من بعض العناصر الثقيلة مثل الكادميوم والنيكل والرصاص.

وقد أشارت النتائج المتحصل عليها بأن خلط هذه الاسمدة قد أدي الي تحسين في كل الصفات المدروسة ولكن بدرجات متفاوتة وذلك عند مقارنتها بنتائج التسميد المعدني الموصي به من قبل وزارة الزراعة المصرية. ففي خلال موسم النمو الأول ٢٠١٧/٢٠١٦ سجلت المعاملة T2 (٢١ كجم مخلفات الدواجن + ٢١ كجم ذبل حمام) أعلي القيم لصفة عدد الأوراق والوزن الطازج والجاف لكل من الاوراق والسيقان والدرنات إضافة الي محتوي النيتروجين الكلي بالدرنات، بينماأعطت المعاملة T6(٢١ كجم ذبل الحمام + ١٠,٥ كجم مخلفات الماشية + ١٠,٥ كجم مخلفات دواجن) أعلي النتائج لكل من طول النبات وعدد الأفرع الجانبية ومحتوي الفوسفور بالدرنات علاوة علي أقل تركيز من الكادميوم والنيكل بالدرنات، وكانت المعاملة T1(٢١ كجم مخلفات الماشية + ٢١ كجم مخلفات الدواجن) هي الأفضل علي الإطلاق بالنسبة لمحتوي النيتروجين الأوراق ومحصول الدرنات الكلي.

في موسم النمو الثاني ٢٠١٨/٢٠١٧، علي الجانب الاخر،كانت المعاملة T4(٢١ كجممخلفات ماشية + ١٠,٥ كجم مخلفات دواجن + ١٠,٥ كجمذبل حمام) هي الأعلى في تسجيل قيم الصفات التالية: عدد الافرع الجانبية ووزن الطازج والجاف للأوراق وايضا الوزن الطازج للدرنات ومحتوي الدرنات من عنصري النيتروجين والفوسفور.

في المقابل سجلت المعاملة T3(٢١ كجم مخلفات ماشية + ٢١ كجم ذبل حمام) أعلي النتائج لمحتوي الدرنات من المركبات الفينولية الكلية وايضا محتوي الأوراق من الفوسفور والبوتاسيوم، بينما سجلت المعاملة T6 اعلي القيم لمحتوي الدرنات من سكر الانيولين وذلك خلال موسمي الدراسة، توصي نتائج البحث استخدام الاسمدة العضوية وتحديدا كلا من المعاملتين T1 و T4 للحصول علي أعلي انتاج وجودة لمحصول نبات الطرطوفة في الاراضي الجيرية حديثة الاستصلاح العالية الملوحة.