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Impact of Organic Manure Combinations on Performance and Rot Infection of Stressed-Jerusalem Artichoke Plants

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THIS investigation was carried out for two summer seasonsof 2016/2017 and 2017/2018 to investigate the influence of three types of organic manures;farmyard (FYM),poultry (PLM) and pigeon manures(PGM) and their combinationson southern blight disease incidence (caused by *Sclerotiumrolfsii*), some vegetative growth characters, chemical constituents, yield and its components of Jerusalem artichoke **(***Helianthus tuberosus* L.**)**plants grown under saline and calcareous soils. The results indicated that T_8 (75% PGM + 25% FYM) treatment recorded the highest values for plant height, number of lateral shoots, number of leaves, leaf fresh and dry weights, stem fresh dry weights and leaf area plant^{-1} in 2016/2017 growth season.However, T_2 (100% PLM) treatment showed the highest values for the previous characters except the number of leaves and leaf areaplant^{-1}. Superior values were obtained by T_4 (75% FYM + 25% PLM) followed by T_3 (100% PGM) treatments regardingrelative chlorophyll content in both seasons.Treatments T_9(75% PGM+25% PLM) for cadmium and T_7(75% PGM+25% PLM) for nickel showed the lowest values of tuber Jerusalem artichoke in both seasons, in addition T_3(100% PGM) and T_4 (75% FYM + 25% PLM)treatments for lead content in 2016/2017 and 2017/2018, respectively. The treatment T_2 had the highest significant reduction of the disease incidence(DI) percentage.While, the best treatment conferred highest leaf contents ofNPK, as well astuber fresh and dry weights, dry matter, and total yieldand lowest tuber content of nickel were T_7 (75% PLM + 25% PGM) and tuber cadmium content was T_9 (75% PGM + 25% PLM). The same treatment T_7 had the highest significant reduction rate of DI and area under disease progress curves (AUDPC).

Keywords: Jerusalem artichoke,Organicmanure,Heavy metals,*Sclerotiumrolfsii*, Saline and calcareous Soil.

Introduction

Southern blight disease has a wide host range of agricultural and horticultural crops, forest trees and weeds, which is caused by the soilborne fungus; Sclerotiumrolfsii (Flores-Moctezumaet al., 2006). The fungus is distributed around the world in tropical and subtropical regions, as Africa, Asia,Australia and parts of Europe (Flores-Moctezuma et al., 2006). Southern blight is a limiting disease for Jerusalem artichoke production(Sennoi et al.,2010). Primarily, the disease was caused in warm climates, especially under high temperature with a humid condition (Kwon et al., 2008 and Sennoi et al., 2010). Whereas, Okabe et al. (2000) has grouped the S. rolfsii isolates according to ORF-ITSinto three groups; two of them were detected in warm temperature regions and one in a cool temperate region.

Certain publication concerning on sources of genetic resistance against S. rolfsii. Where, the main pathogen management is depending on crop rotation (reducing sclerotia numbers in the soil) and subsequent disease incidence in susceptible crops (as the rotation of carrot with sweet potato or buckwheat (Jenkins and Averre, 1986), and peanut with bahiagrass or cotton (Johnson et al., 1999). Adding organic amendments such as oat straw (Gautum and Kolte, 1979) or cruciferous plants (Stapleton and Duncan, 1998) limits disease incidence and might be useful in controlling S. rolfsii in small-scale agricultural systems. Whereas, Flores-Moctezuma et al. (2006) have found that

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by application of the three plant amendment (finely ground dried compost of *Ficusmicrocarpa* L., *Coffeaarabica* L. beans, and plant residues *Partheniumhy sterophorus*) individually was associated with increased damage and high sclerotial populations.

Due to continuous cropping and negligence of soil organic fertilizers, soil nutrient status may be improved by the use of organic fertilizerssuch as farmyard, poultry and pigeon manures with or without inorganic fertilizers (Dauda et al. 2008). In this respect, poultry manure is known as nutrient-richest (Enujeke et al. 2013), helping establish and optimize soil physical and chemical for plant growth.It is also essential for establishing and maintaining the optimum soil physical condition for plant growth.Scientists have been studied the beneficial effects of organic materials for plants, soils and environment. Modern farming system is heavily dependent on chemical fertilizers, creating. A wide range of problems is including depletion of fertilityand reducing crop yieldwhich reduces the yield year after year. Whereas,organic fertilizerscan improve the texture of different soil types (Mahmoud et al., 2009). However, excessive use ofchemical fertilizers maycontaminatethe environment, negatively affectingcrop plants and human health. In organic farming, the soil becomes rich in nutrients, resulting in healthy and pathogen-resistantcrop plants (Wakui, 2009). An integral use of organic and inorganic fertilizers may use for supplying of adequate nutrient quantities to improve crop productionand minimize environmental hazard impact John et al. (2004).

Soil salinization is proved to occur due to several reasons such as poor irrigation water with its poor management, over-irrigation that accumulates salts in the soil top layer, proximity to the sea, the capillarity riseof salts from underground water into the root zone due to excessive evaporation, low rainfall,high evaporation rate, and excessive use of chemical fertilizers (Rady et al., 2013).Salinization is spreading more rapidly in irrigated lands because of improper management of irrigation and drainage (FAO 2008). Salinity is one of the environmental problems,limiting soil productivity. It affects plants through osmotic effects making so-called “Physiological drought; Rady et al., 2013”, ion specific effects and oxidative stress (Mansour et al., 2005). High salinity levels are known to affect many physiological and metabolic processes, leading to plant growthrestriction (Sadeghi, 2010). Calcareous soils containing various levels of calcium carbonate cover a considerable portion of Agricultural lands in Egypt (about 0.65 million feddan = 0.27 million hectare), particularly in the northwestern coastal zone and Sinai. They characterize by undesirable properties negatively affecting plant growth(Hassan, 2012). Therefore, this type of soil needs untraditional mean such as organic manure mixtures to overcome the undesirable soil properties(El-Hadyet al., 2010, 2012 a,b).

Jerusalem artichoke (JA; *Helianthus tuberosus* L.) is a native of North America.It has been grown in Europe since the 17th century (Žaldarienė et al., 2012). JA is considered one of the important non-traditional vegetable crops that are newly introduced to Egypt for its high nutritional and medical values. However, growing of this crop is still limited in small areas. The aim of this study was to assess the influence of three different organicmanures(farmyard, poultry, and pigeon)on some growth characteristics, chemical constituents,yieldand disease severity of southern blight of Jerusalem artichokegrown under saline and calcareous conditions, and compared those impacts with the effect of chemical fertilizers.

Material and Methods

Experimental site and plant material

This study was conducted at ‘Demo’ Experimental Station Farm (29° 17’N; 30° 53’E), Faculty of Agriculture, Fayoum University, Egypt, during the two growingseasons of 2016/2017 (29.297672, 30.922477) and 2017/2018 (29.297826, 30.922404). The experimental locations had history ofSclerotiumrolfsii infection (the experimental plot was planted with carrot for the two previous years). Soil samples were collected from the upper 30 cm layer and analyzed for some physical and chemical properties according to the methods described by Page et al.,(1982) as shown in Table 1. Another soil samples were collected before and after plowing the field to assess pathogen incidence as described by Punja et al., (1986).Tuber seeds of Jerusalem artichoke (Helianthus tuberosus L., cv. Baladi) were purchased from Agricultural Research Center, Qanater Station, Egypt

TABLE 1. Some physical and chemical soil characters of the experimental farm

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	11.30
Organic matter (%)	0.62	0.77
$CaCO_3$ (%)	10.30	9.90
Soluble ions ($meqL^{-1}$)		
CO_3^{--}	----	----
HCO_3^-	5.13	4.05
Cl^-	110.0	67.00
SO_4^{--}	26.60	42.20
Ca^{++}	38.50	24.50
Mg^{++}	22.00	15.00
Na^+	79.30	73.60
K^+	2.02	2.19
Total N (%)	23.5	24.6
Extractable P $NaHCO_3$ pH=8.5 (mg kg^{-1})	13.10	12.10
Extractable K NH_4OAC pH=7.0 (mg kg^{-1})	301.00	311.00
DTPA Extractiblemicronutriments(mg kg^{-1})		
Fe	0.4314	0.3388
Mn	0.9466	1.5600
Zn	0.2660	0.3350
Cu	0.2766	0.2868

Experimental design

Complete randomized block design (CRBD) was used with three replicates. Three different types of fermented organic fertilizers (FOM); farmyard (FYM), poultry (PLM) and pigeon (PGM) manure. Samples of organic fertilizers were collected from Animal and Poultry Production Unit of the 'Demo' Experimental Station during both seasons. Nitrogen, phosphorus, potassium and organic matter (%) were determined (Table 2) according to the procedures of Page et al. (1982). The FOM treatments at different rates (Table 3) were added each for 3 plots (each plot = 3.5 length × 3.0 width = 10.5 m^2) containing 3 rows.

Control treatment plots were fertilized by chemical fertilizers only; $Ca(H_2PO_4)_2$ 15.5% P_2O_5, $(NH_4)_2SO_4$ 20.6% N, and (K_2SO_4) 48% K_2O, at the rates of 150, 300, and 150 $kgfed^{-1}$, respectively, as NPK sources. Phosphorus fertilizer was added with soil preparation for sowing and the amounts of nitrogen and potassium fertilizerswere equally divided and side dressed at 30 and 60 days after planting,while different organic manures treatments were applied to all plots except control treatment.All other recommended agricultural practices for Jerusalem artichoke production were adopted throughout growth seasons of 2016/2017 and 2017/2018 according to the bulletin of Egyptian Ministry of Agriculture (1020/2006).

Isolation of southern blight disease causal agent

The fungal pathogen was isolated from soil samples using dilution method on PDA medium with penicillin. Petri dishes were incubated at 25 °C for 7 d. All of the cultures were purified using the same isolation medium. Morphological identification was performed using colony characteristics, sclerotia under light microscopy at Plant Pathology labs, Faculty of Agriculture, Fayoum University, Egypt. Before and after plowing and fertilizing the soil, the inoculum density of the fungal pathogen was assessed by counting the sclerotia number per soil sample using wet-sieving procedure (Punja et al., 1986)

TABLE 2. Analysis of the different organic fertilizers

Organic manure	2016/2017			2017/2018		
	FYM	PLM	PGM	FYM	PLM	PGM
N (%)	0.112	0.393	0.403	0.128	0.430	0.440
P_2O_5 (%)	0.180	0.188	0.053	0.168	0.199	0.059
K_2O (%)	0.082	0.456	0.350	0.086	0.490	0.398
O.M (%)	24.2	21.2	42.7	25.8	21.6	48.7

TABLE 3.The applied fertilizer organic fertilizers treatments

Treatment	Rates	Quantity of Organic fertilizers
T_0	Control	No any of FOM was added
T_1	%100 FYM	42 kg of farmyard manure only
T_2	%100 PLM	42 kg of poultry manure only
T_3	%100 PGM	42 kg of pigeon manure only
T_4	75% FYM+25% PLM	31.5 kg of farmyard manure + 10.5 kg poultry manure
T_5	75% FYM+25% PGM	31.5 kg of farmyard manure + 10.5 kg pigeon manure
T_6	75% PLM+25% FYM	31.5 kg of poultry manure + 10.5 kg farmyard manure
T_7	75% PLM+25% PGM	31.5 kg of poultry manure + 10.5 kg pigeon manure
T_8	75% PGM+25% FYM	31.5 kg of pigeon manure + 10.5 kg farmyard manure
T_9	75% PGM+25% PLM	31.5 kg of pigeon manure + 10.5 kg poultry manure

Disease assessment

Twenty random plants/plot were assessed for disease incidence each 10 −30 days after post emergence of seedlings(14 days after sowing; DAS) (Junsopa et al., 2016 with modifications). Southern stem rot disease incidence was calculated using the following formula according to Cooke (2006).

Whereas disease severity was scored using the scale 0−5 scale/plant(Sennoiet al. 2010), where; 0 = healthy plants, 1 = lesions without wilting, 2 = 1–2 wilted leaves, 3 = more than 2 wilted leaves, 4 = damped off plant, and 5 = dead plant. These disease score dates were converted to severity index as described by Junsopaet al.(2016)

Data of disease incidence were transformed to the area under disease progress curve (AUDPC) as follows (Davis et al., 1996)

$$AUDPC = \sum_{i=1}^{n} \left[\frac{X_i + X_{i-1}}{2}\right] \frac{\square}{t_i - t_{i-1}}$$

Where: i is the number of days in which the observations were made, n is the last days in which observations were done, X_i is the disease incidence in days i, and $t_i$is the time assessing the disease incidence.

Vegetative growth characters

A random sample of three plants from each experimental plot was taken at flowering initiation stage (120 DAS) to record plant height (cm), number of lateral branches plant^{-1}, leaffresh and dry weights,stem fresh and dry weights (g) and leaf area plant^{-1}. All of these characters were carried out according to procedures of A.O.A.C. (1992).

Leaves chemical constituents

Random samples from the upper fourth leaf were collected and washedby distilled water to estimatethe chlorophyll index using SPAD 502 plus chlorophyll meter.Thereafter, samples wereoven dried at 70º C to determine the contents of nitrogen, phosphorus and potassium according to the methods described in A.O.A.C. (1992).

Tuber quality

Inulin content was determined in tubers according to the methods of Winton and Winton (1985).Total phenolic compounds (TPCs) were extracted from a fresh sample (1.0 g) using the method of Taga et al.(1984).Total nitrogen, phosphorus and potassium were determined by Pageet al. (1982). Total metal concentrations were determined by the inductively coupled plasma– optical emission spectrometry (ICP-OES, Perkin-Elmer OPTIMA-2100 DV, Norwalk, CT).

Yield and its components

At harvest time (270 DAS), the average tuber fresh and dry weights (g), total yield (kgfed^{-1}), and percentage of tuber dry weight (calculated by drying 100 g of fresh tubers in an electricoven at 70° C till a constant weight).

Statistical analysis

The analysis of variance (ANOVA) and LSD were calculated by using GENSTAT statistical package, version 9.2 (GENSTAT, 2007).

Results and Discussion

Vegetative growth characters

Plant height and number of lateral shoots

The highest values of plant height (101.33 and 95.22 cm) were recorded for T_8 (75% PGM + 25% FYM) treatment followed by T_6 (75% PLM + 25% FYM) treatment.However the lowest value (73.00 cm) was recorded with T_1 (100% FYM) treatment. The magnitudes of increasing in plant height were24.46 and 19.61% in 2016/2017 season as compared with the control treatment.On the other side, in 2017/2018 season, the highest values (118.56 and 114.78 cm) were recorded withT_2 (100% PLM) treatment followed by T_5(75% FYM + 25% PGM)treatment as the lowest value was obtained with T_0 (the control), with the increasing rates of 22.12 and 19.56%, respectively.

With respect to thenumber of lateral shoots, the highest values (22.00 and 18.89) were recorded with T_8treatment followed by T_6treatment (Table 4). On the other hand, the lowest value (6.33) was showed with T_9 (75% PGM + 25% PLM) treatment. The amountsof increase were 71.23 and 57.09%, respectively compared to the lowest value of the first season.In the second season, the highest number of lateral shoots wasfound with T_2 followed by T_5treatment, but the lowest one was obtained with the control (T_0), the increasing rate was 54.13 and 50.28%, respectively, as compared to control.These resultsare inline with the findings of Nelson et al. (1970), as organic manures play a significant role in plant nutrition.

Organic manures especially farmyard manure could raise the concentrations of many nutrients and the soil enhance the nutritional value and nutrient balance of plants Graham et al., (2000). Organic acids such as citric, malic, oxalic and phenol that form Fe complexes are released when organic matter of organic manures decomposes Dauda et al. (2008). Poultry manure is relatively resistant to microbial degradation, establishing and maintaining optimum soil physical conditions that are important for plant growth. It is good source of nitrogen for sustainable crop production Massriand Labban (2014).

Number of leaves and leaf area

It is clear that T_8(75% PGM + 25% FYM) followed by T_6(75% PLM + 25% FYM) treatments showed the highest values for no. of leaves and leaf area of Jerusalem artichokeduring 2016/2017 season (Table 4).On the other hand, in 2017/2018 season, the highest values were recorded with T_5 (75% FYM + 25% PGM) followed by T_7 (75% PLM + 25% PGM) treatments for no. of leaves and with T_7 (75% PLM + 25% PGM) followed by T_2 (100% PLM) treatments for leaf area. Increase of 69.22 and 66.72% for no. of leaves and 56.34% and 56.15% for leaf area were obtained from these respective treatments.

These results are in harmony with those obtained by Ragab et al. (2008). These findings may be attributed to the main role of organic fertilizers which they are a source of slow release macro-nutrients and improved the physical, chemical and biological properties of the soil (Anwar et al., 2011).

Poultry manure is essential for establishing and maintaining the optimum physical condition for plant growth (Enujeke et al., 2013). It is the effective source of nitrogen for sustainable crop production (Ewulo et al., 2008).

Leaf and stem fresh and dry weight

Plants that received 75% PGM + 25% FYM (T8) had the highest values during the first season, and 100% PLM (T2) in the second season showed also the highest values of leaf and stem fresh and dry weights (Table 4). Similar results were obtained by El-Sharkawy (2007) on taro and Eifediyi et al., (2010) on cucumber. The application of pigeon manure and farm yard manure increased the fresh weigh and dry matter of leaves and stem. This increase could be attributed to the increase in the nutrient availability and their uptake by plants (Eifediyiet al., 2010; Hoseini et al., 2013).

TABLE 4. Effect of different organic manures on some vegetative growth characters of Jerusalem artichoke plants grown on sandy clay loam soil during 2016/2017 and 2017/2018 growth seasons

Growth Season	Treatment	Plant height cm	No. of lateral shoots plant^{-1}	No. of leaves plant^{-1}	Leaves plant^{-1}		Stem plant^{-1}		Leaf area plant^{-1} cm^2
					Freshweight	Dry matter	Fresh weight	Dry matter	
2016-2017	T_0	76.55de	11.22ab	113.00f	129.63h	54.12f	106.47j	64.28g	5524.05f
	T_1	73.00e	7.67b	79.67h	107.63j	37.67h	115.80i	42.30i	3635.42h
	T_2	85.89c	11.33ab	133.78e	166.33g	58.52e	193.23g	66.19g	6284.00e
	T_3	93.33b	16.67ab	234.56c	316.30b	107.01b	335.80b	115.91b	11037.12c
	T_4	75.56de	10.89ab	96.56g	114.83i	45.52g	140.97h	51.86h	4207.86g
	T_5	88.56c	13.89ab	210.33d	251.20e	88.68d	260.67e	91.70e	7604.76d
	T_6	95.22b	18.89ab	286.22b	292.03c	105.31b	327.63c	106.13c	12157.23b
	T_7	84.33c	12.67ab	214.00d	271.27d	100.95c	287.50d	99.53d	10623.94c
	T_8	101.33a	22.00a	375.00a	532.30a	149.74a	634.07a	181.53a	19128.21a
	T_9	79.78d	6.33b	115.89f	171.70f	61.53e	201.90f	73.62f	5601.90f
LSD		4.22**	11.86*	5.43**	5.03**	3.70**	3.52**	2.18**	474.10**
2017-2018	T_0	92.33e	9.89f	108.00h	164.93g	102.29g	234.17g	111.32g	16681.35h
	T_1	109.56bc	20.33ab	240.78d	319.57c	191.01c	396.83c	223.71c	30416.17d
	T_2	118.56a	21.56a	324.33b	434.07a	252.40a	488.60a	259.86a	38039.35a
	T_3	110.67bc	16.22d	185.67g	204.37f	109.40f	369.07d	206.76d	19568.26g
	T_4	105.78cd	16.22d	211.89e	256.63e	124.44e	330.43ef	186.23ef	23330.50f
	T_5	114.78ab	19.89ab	350.89a	426.90a	251.74a	428.27b	250.39b	36843.84b
	T_6	98.56de	18.67bc	269.00c	318.47c	195.15c	350.80de	201.60d	34855.53c
	T_7	112.00a-c	19.44b	324.56b	394.40b	240.95b	418.17b	230.43c	38210.39a
	T_8	100.67d	14.22e	205.67f	281.73d	163.22d	335.63ef	189.29e	30494.97d
	T_9	105.22cd	17.33cd	205.00f	248.60e	160.86d	327.87f	179.54f	26902.50e
LSD		7.05**	1.66**	3.49**	13.44**	6.75**	21.14**	7.68**	1105.45**

Chemical constituents

Leaves

Relative chlorophyll content

The application of T4(75% FYM + 25% PGM) followed by T3 treatments (75% FYM + 25% PLM) recorded the highest chlorophyll values (39.16 and 38.60, respectively) of Jerusalem artichoke in 2016/2017, while 75% FYM + 25% PLM (T3) followed by T4 treatments (75% FYM + 25% PGM)showed the highest chlorophyll values (34.80 and 34.16, respectively) in 2017/2018. However, the lowest chlorophyll values (35.01 and 31.88) were obtained with applying 75% PGM + 25% PLM (T9) in 2016/2017 and 2017/2018growth seasons, respectively (Figure 1).

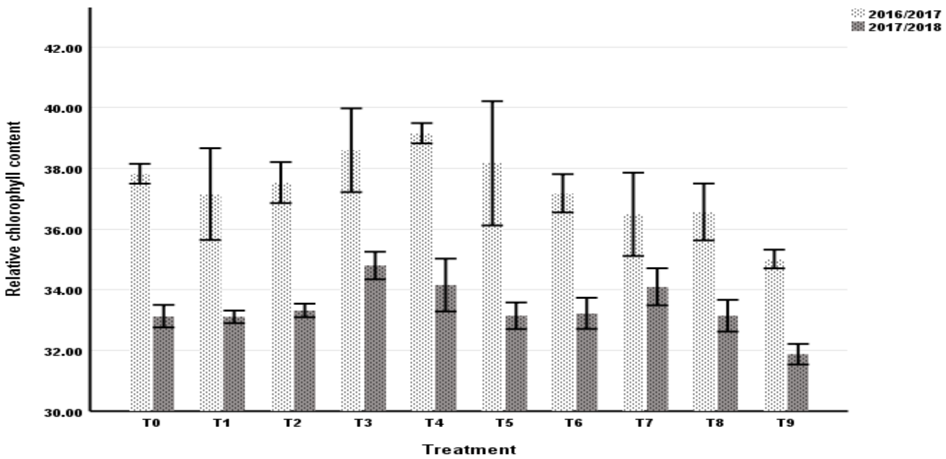

Fig.1. Effect of some different organic manures and their combinations on leaves chlorophyll index.

The present results coincide with those reported by Karanatsidis and Berova (2009). They may be attributed to the increased photosynthesis and the stabilizing effect of the organic fertilizer upon the chlorophyll-protein complex. In addition to pigeon manure had the highest N content. Regarding the role of N in the vegetative growth,the high N content in pigeon manure would probably increase the no of leaves and leaf weight (Hoseiniet al., 2013).

Nitrogen, phosphorus and potassiumcontent of leaves

The chemical composition of Jerusalem artichoke leaves, *i.e.* nitrogen; phosphorus and potassium were influenced with applying the different organic manures and their combinations (Table 5). It is of great interest to notice that the highest values were found with T7 (75%PLM + 25%PGM) treatment for the three studied nutrients (NPK)in both of seasons.There were no significant differences between the control and different organic manurecombination treatments (P=0.05) for N and highly significant differences for P in both season,respectively. While no significant and high significant differences for K in 2016/2017 and 2017/2018 growth seasons respectively. These results agree with those the laboratory analysis results of the studied applied organic manureswhich showed that PLM had the highest P and K, but PGM had the highest N content as it is shown in (Table 5).

The effect of the different organic manures and their applied levels might be due to their decomposition of micro-organisms through one or more mechanisms such as nitrogen fixation, production of organic acids, enhancing nutrients uptake, synthesis of vitamins, amino acids, auxins and gibberellins which stimulate the plant growth Haggag, et al. (2015).

Tubers

Total phenolic compounds and Inulin of tuber

The total phenolic compounds (TPCs) were significantly different ($p \leq 0.05$) due to the effect organic manures and its combinations (Figure 2). The effect of different organic manures and its combinations on total phenolic compounds (TPCs) of tubers is presented in Fig 2.The highest values of those compounds were found with T2treatment and were 19.60 and 20.86 in both seasons respectively, followed by T4 (17.06) in the first season and by T5 (18.42) in the second season. In contrary the lowest values (12.60 and 13.50) were recorded with T9 treatment in both of seasons, respectively.

TABLE 5. Effect of different organic manures on nitrogen, phosphorus and potassium contents of Jerusalem artichoke leaves and tubers during 2016/2017 and 2017/2018 seasons.

Growth season	2016/2017						2017/2018					
	Leaves content (%)			Tubers content (%)			Leaves content (%)			Tubers content(%)		
	N	P	K	N	P	K	N	P	K	N	P	K
T_0	4.03a	1.13bc	1.74a	1.95ab	0.29f	1.12b-d	4.71a	1.10e	1.75e	1.72cd	0.25g	1.08f
T_1	4.25a	1.15bc	1.82a	1.82b	0.38d	1.20b	5.11a	1.11e	1.84de	1.89b-d	0.37e	1.20c
T_2	4.19a	1.12bc	1.88a	2.00ab	0.34e	1.10cd	5.45a	1.77a	2.10ab	1.89b-d	0.32f	1.09ef
T_3	4.19a	1.08c	1.73a	1.88ab	0.39d	1.07d	5.03a	1.11e	1.77e	1.93a-c	0.33f	1.03g
T_4	4.33a	1.70a	2.05a	1.86ab	0.43c	1.41a	5.07a	1.35d	1.90cd	1.77b-d	0.43d	1.31a
T_5	4.22a	1.44abc	1.88a	2.01ab	0.43c	1.19bc	5.34a	1.65b	2.07b	1.99ab	0.42d	1.15de
T_6	4.28a	1.50ab	2.05a	1.96ab	0.45c	1.15b-d	5.11a	1.17e	1.95c	1.68d	0.42d	1.12ef
T_7	4.37a	1.71a	2.10a	2.09ab	0.50b	1.17bc	5.65a	1.79a	2.16a	2.13a	0.48c	1.19cd
T_8	3.92a	1.50ab	1.95a	2.11a	0.55b	1.18bc	5.09a	1.55c	2.05b	1.99ab	0.52b	1.13ef
T_9	4.28a	1.28bc	2.08a	1.97ab	0.57a	1.38a	5.29a	1.58bc	1.90cd	1.91a-c	0.56a	1.26b

These results are in harmony with those reported by Franco et al.(2002).The total phenolic compounds(TPCs)are synthesized through a secondary metabolism cycle and it could produce some plant hormones.

The effect of different organic manures and their combinations on inulin percent of Jerusalem artichoke tubers was found in (Figure 3). The highest values (12.39 and 11.67%, respectively) followed by (12.21 and 11.52%, respectively) were presented with T_6 and T_7 treatments in the first season and T_4 and T_9 treatments in the second season. On the other hand, the lowest values (10.38 and 10.49%) were showed with T_0 treatment (control) in both of seasons.These results are agreed with those reported El-Sirafyet al. (2008), and these results might be due to organic manures applying improved the mineral status of JA plants Kolota and Osinska (2006).

Nitrogen, potassium and phosphorus contents of tubers

The chemical composition of Jerusalem artichoke tubers, *i.e.* nitrogen, phosphorus and potassium were affected by using organic manures and their combinations as shown in Table 5. The highest values (2.11 and 2.09%) for nitrogen, (0.57 and 0.55%) for phosphorus and (1.41 and 1.38%) for potassium were found with T_8 and T_7treatments for nitrogen, T_9 and T_8treatments for phosphorus and $T_4$and T_9treatments for potassium in 2016/2017 growth season.On the other hand the highest values (2.13 and 1.99%) for nitrogen, (0.56 and 0.52) for phosphorus and (1.31 and 1.26) for potassium was found with T_7 and T_5 for nitrogen, T_9 and T_8 for phosphorus and T_4 and T_9treatments for potassium in 2017/2018 growth season.These results agreed with those reported by Haggag et al. (2015), however the effect of the different organic manures and their combinations might be due to their decomposition micro-organisms through one or more mechanisms such as nitrogen fixation, production of organic acids, enhancing nutrients uptake, synthesis of vitamins, amino acids, auxins and gibberellins which stimulate the plant growth Haggag et al. (2015).

Cadmium, lead and nickel content of tubers

The influence of fertilizers organic manure combinations on some heavy metals *i. e.* cadmium (Cd); lead (Pb) and nickel (Ni) in tuber Jerusalem artichoke showed in Figures (7; 8 & 9), the lowest values (0.05 and 0.09 for Cd) were recorded with applying 75% PLM + 25% PGM (T_7); (1.40 and 1.27 for Pb) with 100% PGM (T_3) and 75% FYM + 25% PLM (T_4) and (2.59 and 2.57 for Ni) with applying 75% FYM + 25% PLM (T_9) in 2016/2017 and 2017/2018, respectively.

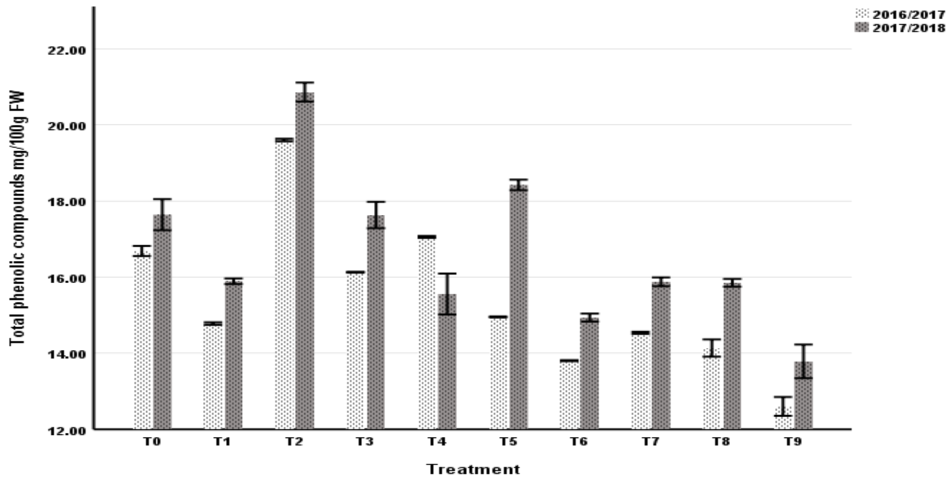

Fig. 2. Effect of some different organic manures and their combinations on total phenolic compounds of Jerusalem artichoke tubers.

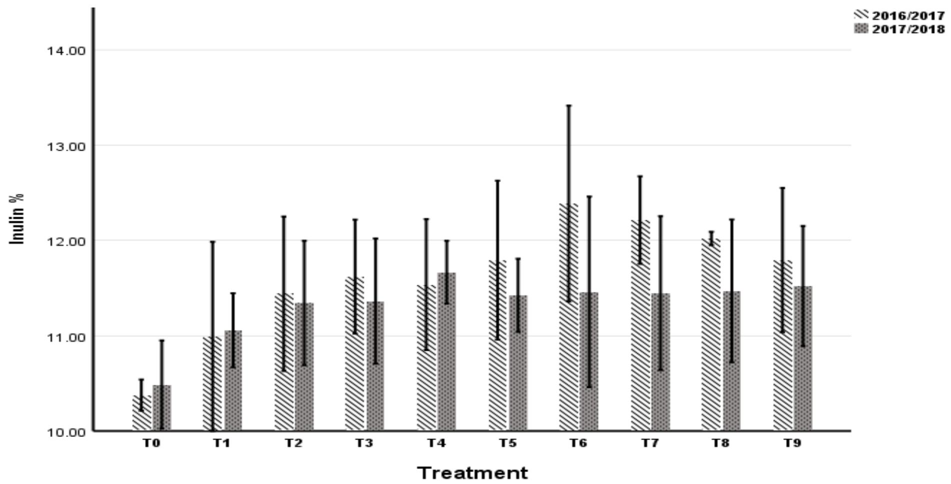

Fig. 3. Effect of some different organic manures and their combinations on inulin % of Jerusalem artichoke tubers.

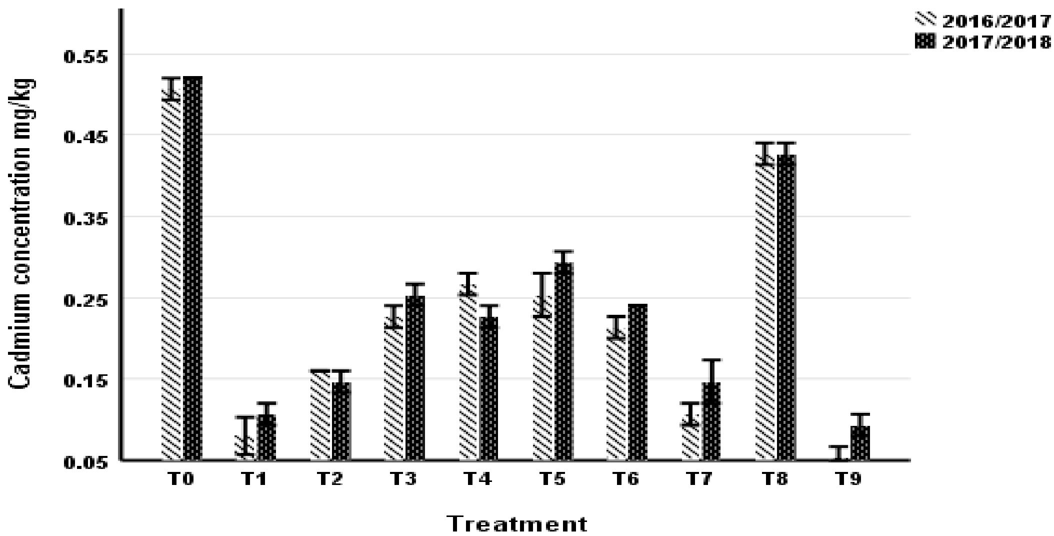

Fig.4. Effect of some different organic manures and their combinations on cadmium content of Jerusalem artichoke tubers

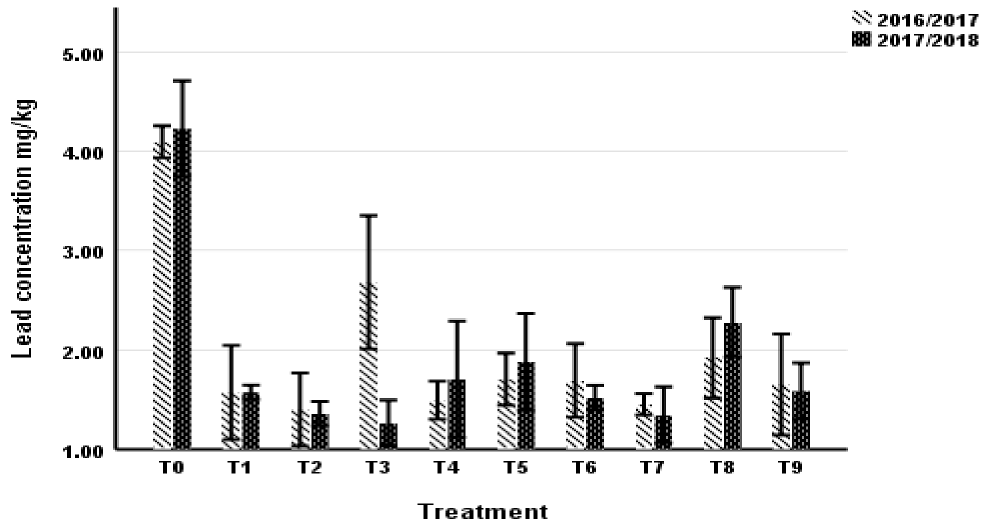

Fig. 5. Effect of some different organic manures and their combinations on lead content of Jerusalem artichoke tubers

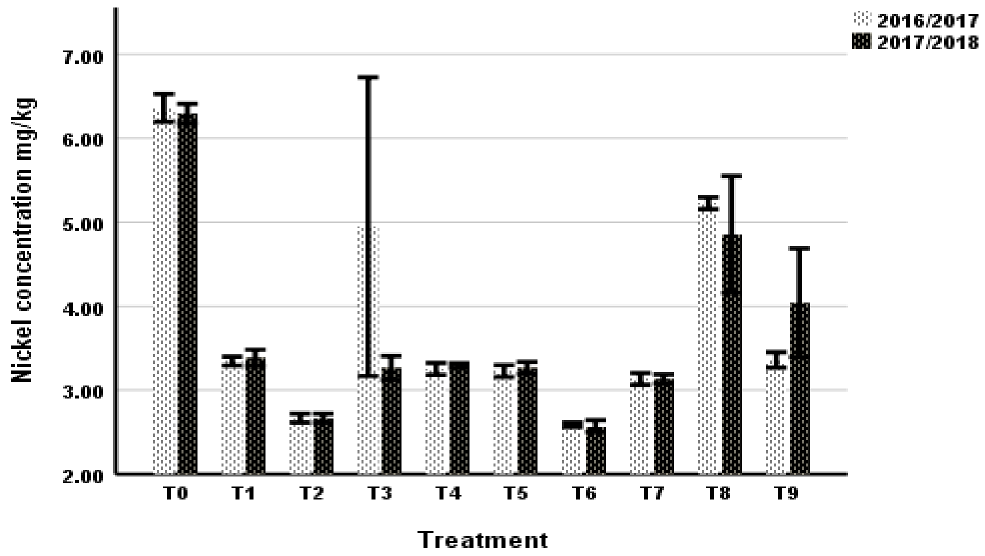

Fig. 6. Effect of some different organic manures and their combinations on nickel content of Jerusalem artichoke tuber

The ANOVA results indicated showed that the Cd; Pb and Ni were significantly affected by applying all organic manures combinations treatments as a comparing with control at 1% probability level.

Yield and its components

Tuber fresh and dry weight

Table 6 shows the effect of different organic manures and its combinations on tuber fresh and dry weights and % of dry matter. The highest values were recorded with T_2 followed by T_4treatments for tuber fresh weight (1395.33 and 1328.23 g, respectively), dry weight (347.13 and 338.40 g, respectively) and tuber dry matter % (26.32 and 24.31%, respectively) in 2016/2017 growth season.However, data in 2017/2018 season the respective highest values (1050.00 and 1026.00g, respectively) were showed with plants applied with 100% PGM (T_3) followed by 75% PLM + 25% PGM (T_7) for tuber fresh weigh, while for tuber dry weight, T_7 treatment had the highest value (314.43 g) followed by T_3 (310.86 g).For dry matter percentage, the respective highest values (33.27 and 31.89%, respectively) wererecorded with T_6 followed by T_8. The treatments had not significantly affect the tuber fresh weight in both seasons, therewere significantlydifferences from the control at (P≤ 0.01) for tuber dry weight.The dry matter percentage significantly differed at the first season but did not differ at the second season.

The obtained results are in an agreement with those reported by Raramurthy and Shivashankar (1996), who stated that organic manure improved the plant height, dry matter production at different stages of crop growth and yield attributing characters of corn. In addition, the application of FYM increased the dry weight and yield due to the nutrient availability and its uptake by the plants (Eifediyiet al., 2010).

Total yield and its components

The plants that were fertilized with 75% PLM + 25% PGM (T_7) recorded the highest total yield values of (20423.20 and 9730.56 kg fed^{-1}) in 2016/2017 and 2017/2018, respectively, followed by T_4 (75% FYM + 25% PLM) in the first season and T_2 (100% PLM) in the second season (Table 6).The lowest total yield values were obtained with T_5 (75% FYM + 25% PGM) in both seasons; thereby, the increasing rates were 69.90 and 49.60% in 2016/2017 and 2017/2018 growth seasons, respectively. The application of T_7 treatment in both growth seasons significantly increased the total yield (P≤ 0.001) over those of the control (T_0).

In this respect, similar findings were also found by Ahmed and Elzaawely (2010) and Ahmed et al. (2013). The increase in total yield may be attributed to the high contents of N; P and K in poultry and pigeon manures that encourage the adsorption of these nutrients by Jerusalem artichoke plants to go forward and accelerate the photosynthetic rate Ahmed and Elzaawely, (2010).

Disease assessment

Pathogen determination and its inoculum density

The pathogen isolated was identified as Sclerotiumrolfsii with typical morphological characteristics as described by Cúndomet al. (2013). The inoculum density of Sclerotiumrolfsii was expressed as number of sclerotia/300cm^3 of soil samples (Figure 7). The inoculum density average was about 16.5 and 17.5 sclerotia in soil sample before plowing soil which decreased by 22.7and 22.1% to be about 13 and 13.5sclerotia/ soil samples in 2016/2017 and 2017/2018 respectively

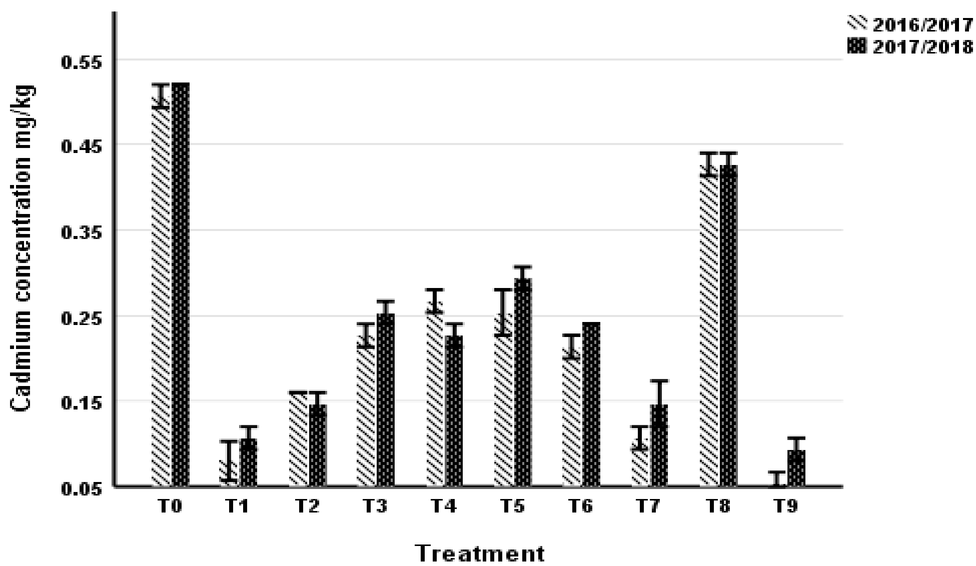

Fig. 7. The inoculum density of Sclerotiumrolfsii was expressed as number of sclerotia/300cm^3 of soil samples before and after plowing &adding fertilization regime

TABLE 6. Effect of different organic manures and its combinations on tuber fresh and dry weights, % of dry matter and total yield of Jerusalem artichoke plants during 2016/2017 and 2017/2018 growth seasons.

Growth season	Treatment	Tuber (g/plant)		%	Total Yield (kg fed^{-1})
		Fresh weight	Dry weight	Dry matter	
2016/2017	T_0	1319.07a	288.03a-c	21.79bc	11512.20f
	T_1	1187.87ab	257.53a-d	21.95bc	16464.00c
	T_2	1395.33a	347.13a	26.32a	13171.20de
	T_3	1301.13a	275.87a-c	21.25c	13906.20d
	T_4	1328.23a	338.40ab	24.31ab	20403.60a
	T_5	744.83b	160.30d	21.34bc	6090.00h
	T_6	1110.03ab	230.43cd	21.03c	18551.40b
	T_7	1152.53ab	241.30b-d	20.94c	20423.20a
	T_8	1097.83ab	261.13a-d	22.38bc	12463.50e
	T_9	990.63ab	212.73cd	22.10bc	9299.64g
LSD		ns	92.39**	2.71**	2.001**
2017/2018	T_0	833.33a	193.17ab	22.79b	7896.00ab
	T_1	756.67a	189.46ab	25.48ab	7578.14ab
	T_2	820.00a	238.49ab	28.25ab	9527.35a
	T_3	1050.00a	310.86a	29.92ab	7783.10ab
	T_4	480.00a	102.69b	22.46b	4904.26b
	T_5	1013.33a	266.88ab	26.51ab	9420.10a
	T_6	486.67a	134.43b	33.27a	6599.38ab
	T_7	1026.00a	314.43a	30.34ab	9730.56a
	T_8	880.00a	269.46ab	31.89ab	8291.14ab
	T_9	796.67a	215.53ab	27.24ab	7585.54ab
LSD		ns	ns	ns	7.377**

Disease assessment

All the studied fertilization regime of FOM had significantly reduced the percent of southern blight disease incidence as shown in (Figure 8) with reference to control treatment (T_0) with exception to T_6, T_3, and T_4. The treatments T_2 followed by T_1 andT_5had the highest high DI reduction; 45.3, 38.5, and 38.5% respectively. All the treatments had significantly decreased the SI with reference to the control one. Meanwhile, the severity index was positively decreased in T_7during the two years of study (Figure 9). Generally, negativetrendbetween number lateral shoots per plant and its severity index was observed, where the increase number of lateral shoots the decrement of disease severity by escaping from infection or producing new shoots to compensate the infected ones, which is combined with the plant height as; $T_7$and T_9corresponding the tothe type of FOM and their percentages used. The highest significant decrement of the treatment T_7 might be to the heist % of potassium in leaves (as indicator to vegetative growth) which decreasing the fungal ability penetration or disease progress into the plant tissues.

T_7 had the lowest significantly area under disease progress curve which might be an evidence on its efficacy in suppressing the disease progress (Figure 10). T_2 (100%FYM) had the highest significant reduction of the DI percentage only.While, The best treatment of nitrogen, phosphorus and potassium contents of leaves, tuber fresh and dry weights, dry matter and total yield was obtained from using T_7 (75% PLM + 25% PGM) treatment. The same treatment T_7 had the highest significant decreasing rate of DI and AUDPC.

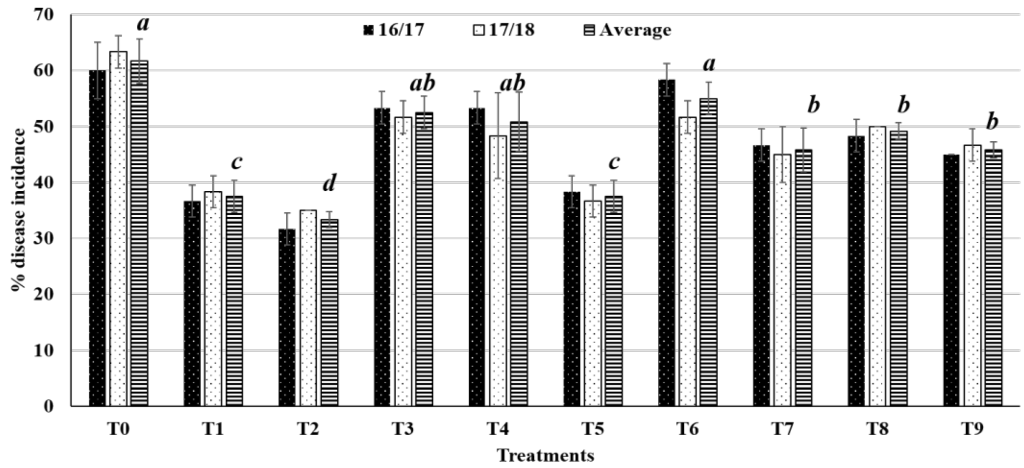

Fig.8. Percentage of southern blight disease incidence in Jerusalem artichoke with three different fermented organic manures fertilizationsand their combinations during the twoseasons.

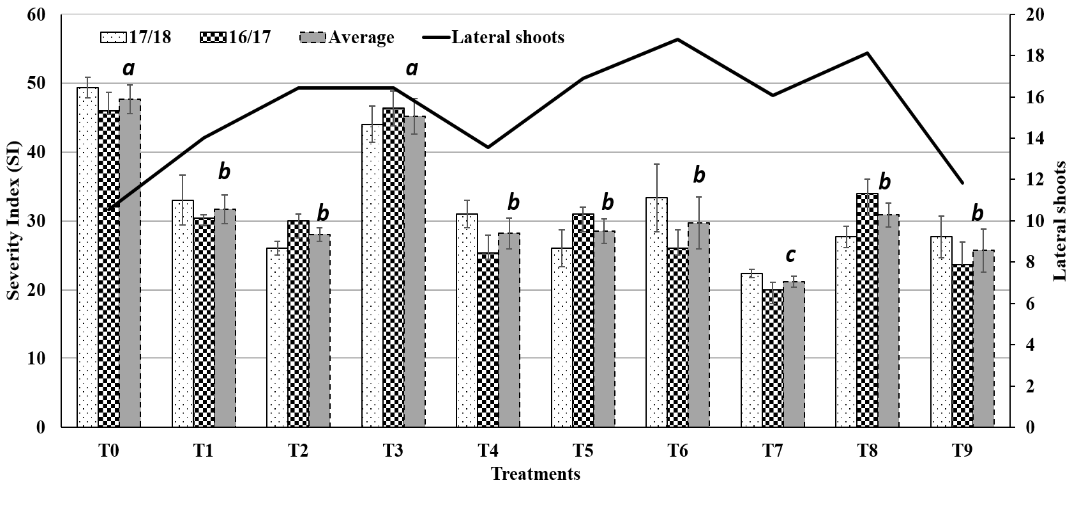

Fig. 9. Southern blight disease severity index (SI) in Jerusalem artichoke and number of plant lateral shoots with three different fermented organic manures fertilizations and their combinations during the two seasons

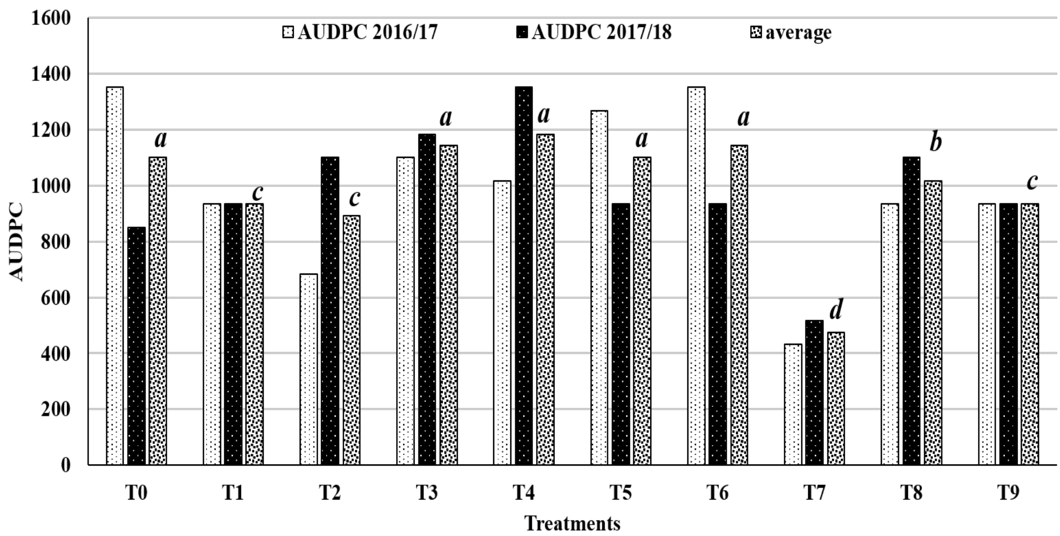

Fig. 10. AUDPC means for Southern blight disease incidence in Jerusalem with three different fermented organic manures fertilizations and their combinations during the two seasons

Conclusion

From the previous results of this investigation, it could be concluded that all different organic fertilizers and their combinations affected the studied characters. With regard to the highest values for plant height, number of lateral shoots, leaves and stem fresh and dry weights plant^{-1} were recorded with applying T_8(75% PGM+25% FYM)and T_2(100% PLM) in 2016/2017 and 2017/2018, respectively. On the other hand, T_7(75% PLM+25% PGM) was the best treatment for nitrogen, phosphorus, potassium, nickel content of leaves and total yield, while T_9(75% PGM+25% PLM) was the better for phosphorus, T_4(75% FYM+25% PLM)for potassium content of tubers and T_2 was the better for total phenolic compounds of tubers in the first and second seasons.But, the results were not similar for other some characters; however the greatest values were showed with using T_8 and T_5(75% FYM+25% PGM)for number of leaves plant^{-1}; T_6(75% PLM+25% FYM)and T_4(75% FYM+25% PLM)for inulin content; T_4 and T_3(100% PGM) for SPAD reading; T_8 and $T_7$for nitrogen content of tubers;T_3 and T_4 for the lowest level of lead content of tubers in 2016/2017 and 2017/2018, respectively.

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تأثير مخاليط الاسمدة العضوية علي أداء ومرض عفن الساق في نباتات الطرطوفة تحت ظروف الإجهاد

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**قسم النبات الزراعي (أمراض النبات) – كلية الزراعة –جامعة الفيوم

أجريت التجربة خلال الموسم الصيفي ٢٠١٧/٢٠١٦ و ٢٠١٨/٢٠١٧ علي نباتات الطرطوفة المنزرعة تحت ظروف الملوحة والقلوية لدراسة تأثير ثلاثة أنواع مختلفة من الأسمدة العضوية وهما سماد الماشية وسماد الدواجن وسماد الحمام و بعض تركيباتهما علي بعض صفات النمو الخضري والتركيب الكيماوي للدرنات والمحصول ومكوناته ومقارنة تلك المعاملات بالتسميد المعدني الموصي به لنباتات الطرطوفة.

وقد أشارت النتائج المتحصل عليها الي ان المعاملة الثامنة (٣١,٥كجم سماد الحمام + ١٠,٥كجم سماد الماشية) سجلت أعلي القيم بالنسبة لصفات طول النبات وعدد الافرع الجانبية وعدد الاوراق والوزن الطازج والجاف للاوراق والسيقان ومساحة سطح الورقة لكل نبات خلال موسم الزراعة الاول (٢٠١٧/٢٠١٦)،بينما المعاملة الثانية (٤٢كجم سماد الماشية) كانت الأعلي لكل الصفات السابقة الذكر عدا صفة مساحة سطح الورقة لكل نبات، اما بالنسبة لصفة محتوي الكلوروفيل النسبي للأوراق فأعلي القيم سجلت من المعاملة الرابعة (٣١,٥ كجم سماد الماشية + ١٠,٥ كجم سماد الدواجن) تليها المعاملة الثالثة (٤٢ كجم سماد الحمام) في كلا الموسمين.

اما بالنسبة لتركيزات بعض العناصر الثقيلة في الدرنات، فوجد أن أقل محتوي من عنصري الكادميوم والنيكل سجلت من خلال المعاملة التاسعة (٣١,٥ كجم سماد حمام + ١٠,٥ كجم سماد الدواجن) والمعاملة السابعة (٣١,٥ كجم سماد دواجن + ١٠,٥ كجم سماد حمام) علي الترتيب، بينما أقل محتوي لعنصر الرصاص سجل من خلال المعاملة الثالثة و المعاملة الرابعة خلال موسمي النمو علي الترتيب. بينما المعاملة الثانية كانت الاقل في النسبة المئوية لحدوث الأصابة

أفضل المعاملات بالنسبة لمحتوي الأوراق من عناصر النيتروجين والفوسفور والبوتاسيوم والوزن الطازج والجاف والنسبة المئوية للمادة الجافة والمحصول الكلي سجلت من خلال المعاملة السابعة (31.5 كجم سماد دواجن + 10.5 كجم سماد الحمام) خلال موسمي الزراعة.