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RESPONSE OF GROWTH AND YIELD OF JERUSALEM ARTICHOKE TO DIFFERENT NITROGEN SOURCES AND ORGANIC MANURE (FYM).

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ABSTRACT

The study was carried out at the Horticultural Research station of Barrage region during summer seasons of 2000 and 2001 on Jerusalem artichoke Local and Fuseau cultivars on plant growth, tuber yield and tuber chemical constituents. Three organic manure levels, i.e 10,20 and 40m^3 FYM/Fed and nitrogen sources. i.e $(NH_4)_2 SO_4$ and $NH_4 No_3$. The Local cultivar showed higher fresh weight of foliage, No. of branches, No. of main stems in contrast to plant height. Tuber yield of Fuseau cultivar was 14.78 and 15.48% higher than that of the Local one during 2000 and 2001 respectively, Fuseau and Local cultivars growth parameters responded positively with the increased levels of organic manure application up to 40m^3 FYM/Fed; during 2000 and 2001. Results also indicated that Fuseau cultivar tuber yield and inulin content increased as FYM level elevated from 10, 20, 40 m^3 FYM/Fed as compared to Local cultivar, during 2000 and 2001. Application the form of $(NH_4)_2 SO_4$ increased fresh weight of foliage and greater number of branches, number of main stems. and tuber yield by 6.63 and 22.80% more than that $NH_4 NO_3$ during 2000 and 2001, respectively. Local cultivar tubers showed greater total carbohydrate and total sugar, total protein, total nitrogen and total potassium, compared with Fuseau cultivar Fertilization with 40m^3 FYM/Fed Also, $(NH_4)_2 SO_4$ increased inulin concentration, carbohydrate, total sugar, total protein and NPK content application with 40m^3 FYM/Fed and 40 Kg N/Fed $(NH_4)_2 SO_4$ were the optimum rates to maxmize tuber yield and quality of the local and Fuseau Jerusalem artichoke cultivars.

INTRODUCTION

Jerusalem artichoke is an agricultural crop with a great potential for high sugar yields per hectare 9-13 t/ha (Klaushofer, 1986). The main storage carbohydrate is fructan that contributes about 70-80% of the tuber dry matter (Chubey and Dorreli, 1974; Pilnik and Vervelde, 1976 and Kosaric *et al.*, 1984). Although the above-ground parts of the plant can be used for biogas production or in animal nutrition (Gunnarson *et al.* 1985; Malmberg and Theander, 1986; Seiler,1988). The main interrest in Jerusalem artichoke is due to biotechnological utilization of the tubers. Fermentation of the tubers may yield ethanol or other bulk chemicals (Guiraud, *et al.*1981; Williams and Ziobro 1982; Marchal *et al.*1985; Fages *et al.*, 1986; Rosa, *et al.*1987). Hydrolyzed fructan is an important raw material for the production of fructose sweetener (Byun and Nafim, 1978).

Growth conditions, e.g. soil and fertilization, play an important role on yield production. The effect of nutrition has been investigated mainly by application of the main nutrients (NPK), N being the main factor.

The major inorganic forms of N absorbed by plants are NO_3^- and NH_4^+. Both forms of N can present naturally in the soil solution. NH_4 is released from decay of organic matter whereas NH_3^+ is released from nitrification of

NH_4^+ (Haynes, 1986). Both forms of N also can be applied. NH_4^+ is less costly and therefore, it is often be applied.

Today there is a trend of producing nitrogen fertilizer having high nitrogen concentration, with eleminating some industrial processes to reduce the cost of nitrogen unit. A great number of nitrogen fertilizer sources such as calcium nitrate, ammonium nitrate, ammonium sulphate and urea are used in Egypt. Thus, evaluation of these fertilizers to choose the best of them with regard to their effect on plant productivity as well as their economic is of paramount importance.

Organic matter in the organic manure is very important for structure of soil, water properties and retention, and release of the nutrient elements. (Cheng 1976 and Lapshina 1984) reported that application of 40 t FYM/ha increased the growth, leaf area and yields of fresh fodder and crude protein by 28.7-1.8% and 1.5-1.7 times, respectively (El-Nagar, 1996) on potato mentioned that application of FYM contribute to plant growth through its effect on physical, chemical and biological properties of the soil as well as through its effect as a source of essential nutrients. Moreover, organic fertilizers application led to higher tuber yields and higher dry matter of potato compared with mineral fertilization (Kolbe *et al.*, 1995).

Organic fertilizers such as FYM had a considerable effect on increasing yield and dry matter of potato tubers (Sharma and Arora, 1990. Also, Arisha and Bardisi, 1999) found that plant height, NPK Contents in foliage and tuber, number and weight of tubers potato/plant and total tubers yield/Fed, as well as the tuber dry matter content were significantly increased with increasing FYM. (Zvara and Hergep, 1983; Leible, 1986 and Starck 1989) stressed the remarkable productivity improvements at high nutrient levels of nitrogen sources with organic manure (FYM) the increase in biological activities caused by organic manure might be due to available carbon sources on which microorganins live besides conserving soil moisture and maintaining favourable soil temperature (Lou and Sum, 1994). This study aimed to investigate the effect of organic manure at different rates in the form of FYM and choose the best source of mineral fertilizers in the form of ammonium sulphate or ammonium nitrate as well as their combinations with FYM on growth, yield ability and N,P,K contents in Jerusalem artichoke tubers.

MATERIALS AND METHODES

Two field experiments were conducted during the Summer seasons of 2000 and 2001 at the experimental farm of the Barrage Horticultural Research Station farm., characteristics of both organic manure (FYM) and soil employed in this experiment are presented in Tables 1 and 2.

To the treatments of the N source were as follows : ammonium nitrate ($NH_4 No_3$ 33%N) and ammonuim sulphate $(NH_4)_2 So_4$ (20.5%N) were applied at the rates of 40 kgN/Fed. In two equal parts, started one month after planting and the second half was added one month later and control without applying nitrogen sources fertilizer organic manure i.e. farm yard manure (FYM) was applied before planting during soil preparation at rates of 10,20 and $40m^3$/Feddan.

Table (1): Soil analysis.

Season	Clay	Silt	Fine sand %	Coarce sand %	Texture	PH	EC	Water Hd ding capicaty%	Organic matter %
2000	16.50	8.5	32.09	415	Sandy clay	8.6	2.45	32.5	1.5
2001	16.30	8.3	32.15	41.41	Sandy clay	8.7	2.64	32.4	1.9

Table (2): FYM analysis:

Season	Mineral nutrients (mg/100g)			Anions		
	N	P	K	Hco_3-	$C1^-$	$So_4$2-
2000	0.2	12.54	4.5	1.08	30.41	17.25
2001	0.17	12.43	4.4	1.09	31.22	17.30

Plots were arranged in a split-split plot design with three replications. Cultivars; Fuseau and local consisted main plots, organic manure (FYM) rates were assigned randomly to sub-plots while N sources were assigned randomly to sub-sub-plots.Each experimental unit was of 3 rows 5m long and 1m apart. Within row spacing was about 50cm. The two experiments were planted on April 19th , 2000 and 23th,2001 during the two growing seasons. Plant growth and yield measurements. A random of representative sample of 5 plants were taken from each treatment after 120 days from planting when plants were reached green tops, where vegetative measurements and yield data were recorded. These measurements were, plant height, No. of stems, No. of branches. Fresh weight of branches/plant, plant fresh weight from eash sub-plot and then converted into kg/plot.

Chemical analysis

Carbohydrates, total sugar content was determined according to (Somogyi, 1952 and Nelson, 1974). Inulin concentration was determined according to (Winton and Winton, 1958), Nitrogen (Koch and Mc Meckin, 1924), protein content was determined as nitrogen content and converted to its equivalent protein content by multiplying with 6.25 as described by (Pregl, 1945), phosphorus (Troug and Meyer, (1939), potassium, (Brown and Lilleland, 1946), were determined following oven-dry at 65-70°c for 48h in an air-forced ventilated oven. Data were statistically analysed using a General linear Model procedure of SAS Institute, (1989). Fishers protected least significant (LSD) at P =0.05 was employed to separate the treatment means.

RUSULTS AND DISCUSSION

I- Vegetative growth characters :

1) Plant height :

Data presented in Table 3. Showed that Fuseau cultivar produced longer plants comparing with local cultivar. The increment in the plant height was estimated by 15.3 and 10.3% for the two growing seasons, respectively.

A wide range of variation was reported by many authors,(Khereba 1979; Kiehin *et al.*1993; and El-Sharkawy 1998), concerning the effect of organic manure levels; Data also presented in Table 3.

Table (3) : Interactive effect of cultivars, organic manure (FYM) and nitrogen sources and their interactions on plant height (m) of Jerusa lem artichoke at 120 days during 2000 and 2001 seasons.

Seasons	Cultivar	FYM ($10m^3$) Control	FYM ($10m^3$) $(NH_4)_2So_4$	FYM ($10m^3$) NH_4No_3	FYM ($10m^3$) M	FYM ($20m^3$) Control	FYM ($20m^3$) $(NH_4)_2So_4$	FYM ($20m^3$) NH_4No_3	FYM ($20m^3$) M	FYM ($40m^3$) Control	FYM ($40m^3$) $(NH_4)_2So_4$	FYM ($40m^3$) NH_4No_3	FYM ($40m^3$) M	Average Control	Average $(NH_4)_2So_4$	Average NH_4No_3	Average M
2000	Fuseau	2.203	2.787	2.593	2.528	2.410	2.827	3.033	2.757	2.623	2.987	3.250	2.947	2.412	2.860	2.95	2.74
	Local	1.800	2.260	2.33	2.132	2.027	2.410	2.603	2.347	2.192	2.553	2.73	2.491	2.006	2.408	2.55	2.32
	M	2.002	2.523	2.465	2.330	2.218	2.618	2.818	2.552	2.407	2.760	2.990	2.719	2.209	2.634	2.75	
2001	Fuseau	1.897	2.113	2.347	2.119	2.280	2.383	2.610	2.424	2.42	2.527	8.717	2.571	2.210	2.341	2.55	2.30
	Local	1.563	1.860	2.087	1.837	1.750	1.983	2.267	2.00	2.363	2.612	2.647	2.541	1.892	2.152	2.33	2.12
	M	1.730	1.987	2.217	1.978	2.015	2.183	2.438	2.212	2.438	2.57	2.682	2.556	2.054	2.247	2.44	

LSD 0.05	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
2000	0.243	0.0972	0.092	0.138	0.131	0.160	0.726
2001	0.052	0.042	0.031	0.060	0.044	0.053	0.075

Indicated that 40m^3 FYM/Fed produced (6.14 and 14.31%) and (13.46 and 22.6%) higher significant plant height than 20, 10m^3/Fed in the two seasons, respectively, these results were in accordance with (Arisha and Bardisi, 1999). Moreover, the results in Table 3. Indicated that nitrogen fertilizer in the form of ammonium nitrate significantly increased plant hight by (4.50, 19.91) and(8.14, 16.03)compared with ammonium sulphate and control in the two seasons, respectively.

The interaction between cultivar and organic manure (FYM) affected plant height, it could be noticed that in 2000, 2001 Fuseau cultivar produced the longest stem compared to the local cultivar when using the higest organic manure (40m^3) but these differences were not significant during the first season. As for the effect between cultivar and nitrogen sources on average plant height, data indicated that the tallest Jerusalem artichoke plants were obtained with Fuseau cultivar when applying ammonium nitrate in the second season only. However, the interaction between cultivar by organic manure (FYM) and nitrogen sources was significant in the second season only, indicating that the two produced the highest plants with high levels organic manure (40m^3 FYM) when given combined with ammonia as compared with other treatments.

2) Number of branches :

The local cultivar produced the higher number of branches/plant compared with Fuseau cultivar in the two growing season (Table-4). As similar trend previously reported by (El-SharKawy, 1998 and Hamad, 2001) Regard to FYM, the same table indicated that application of 40 m^3/Fed resulted in 16.3, 20.38 and 11.33, 23.72 higher branches/stem than 10m^3 during the two growing seasons, respectively. Moreover, the results also indicated that ammonium sulphate significantly increased Number of branches in both seasons by 12.80, 12.68 as compared with ammonium nitrate. The interaction effect indicated that the greates No. of branches was achieved by both cultivars when subjected to 40 m^3 FYM/Fed and also by applying ammonium sulphate in both years. It was also, clear that cultivar, organic manure and nitrogen sources on were only significant in first season where combination of ammonium sulphate with
40 m^3 FYM consistently obtained the higher No. of branches produced by the two cultivars.

3- Number of main stems :

Table (5) showed that the local cultivar surpassed Fuseau cultivar on number of main stems but these difference were only significant during the first season 19.80% ratio. These results were in hormony with (Khereba 1979) who found that significant difference in number of stems of some Jerusalem artichoke clones. Also, (El-Baz *et al.*1980, and Ibrahim *et al.*1990) on potato plants showed that there were significant differences among cultivars in this character.

It is also evident from data in Table (5) that number of main stems tend to increase when the higher FYM (40m^3) rate 10.37-61.81%, and 12.77-43.3% compared with 20-10m^3 FYM during 2000 and 2001 seasons, respectively.

Table (4) : Interactive effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on number of branches / stem of Jerusalem artichoke at 120 days during 2000 and 2001 seasons.

Seasons	Cultivar	FYM ($10m^3$)				FYM ($20m^3$)				FYM ($40m^3$)				Average			
		Control	$(NH_4)_2So_4$	NH_4No_3	M	Control	$(NH_4)_2So_4$	NH_4No_3	M	Control	$(NH_4)_2So_4$	NH_4No_3	M	Control	$(NH_4)_2So_4$	NH_4No_3	M
2000	Fuseau	35.30	38.73	32.27	35.43	40.63	42.74	34.71	39.56	44.06	48.36	42.60	45.10	39.99	43.37	36.53	39.96
	Local	51.86	52.95	45.84	50.22	51.98	52.61	47.35	50.65	54.93	55.40	51.02	53.79	52.92	53.35	48.07	51.55
	M	43.58	45.84	39.06	42.82	46.30	47.67	41.03	45.00	49.49	52.02	46.81	49.44	46.46	48.51	42.30	
2001	Fuseau	28.12	30.11	27.29	28.51	35.15	33.34	31.39	32.29	35.32	42.03	35.23	37.53	31.86	35.16	31.30	32.78
	Local	30.61	32.41	28.74	30.59	36.02	39.52	33.67	36.41	40.54	43.11	36.19	39.94	35.72	38.35	32.37	35.65
	M	29.36	31.26	28.02	29.55	34.09	36.43	32.53	34.35	37.93	42.57	35.71	38.74	33.79	36.75	32.09	

LSD 0.05	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
2000	0.422	0.274	0.369	0.138	0.521	0.160	0.333
2001	0.480	0.260	0.192	0.367	0.272	0.333	0.471

Table (5) : Interactive effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on No.of stems of Jerusalem artichoke at 120 days during 2000 and 2001 seasons.

Seasons	Cultivar	FYM ($10m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($20m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($40m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	Average Control	$(NH_4)_2So_4$	NH_4No_3	M
2000	Fuseau	4.840	3.360	5.513	4.571	5.207	7.910	5.563	6.227	5.437	8.127	5.910	6.491	5.161	6.466	5.662	5.763
	Local	4.497	6.633	6.297	5.809	5.337	8.510	7.840	7.229	6.560	10.13	8.867	8.520	5.454	8.425	7.668	7.186
	M	4.668	4.997	5.905	5.190	5.272	8.210	6.702	6.728	5.998	9.130	7.858	7.506	5.313	7.440	5.749	
2001	Fuseau	2.757	4.443	3.597	3.599	5.337	7.017	6.473	6.276	5.507	7.557	7.977	7.080	4.867	6.339	5.749	5.651
	Local	3.803	5.373	4.647	4.608	5.863	6.627	6.373	6.288	6.523	7.897	7.550	7.323	5.397	6.632	6.190	6.073
	M	3.280	4.908	4.122	4.103	5.600	6.822	6.423	6.282	6.515	7.727	7.363	7.202	5.432	6.485	5.969	

LSD 0.05	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
2000	0.553	0.384	0.407	0.544	0.576	0.705	0.997
2001	N.S	0.372	0.333	0.526	0.471	0.576	0.815

Concerning the effect of nitrogen sources, data presented in table (5) indicated that the number of main stems increased significantly with ammonium sulphate 10.49, 28.65 and 7.97, 20.88% compared with ammonium nitrate and control during the two growing seasons, respectively. Concerning the interaction between cultivars and FYM, it could be noticed that in 2000 and 2001 seasons the local cultivar produced higher number of stems/plant than Fuseau cultivar, when received the higher rate of FYM, but these differences were not significant during the second season. Number of stems/plant of local cultivar was significantly enhanced with applying ammonium sulphate through the first season, while the two cultivars produced higher No. of stems/plant when applying ammonium sulphate during second season.

The maximum number of main stems of the two cultivars was abtained by applying $40m^3$ FYM and ammonium sulphate or ammonium nitrate during second season. on the other hand the firest season revealed No. of main stems of local cultivar increased significantly by $40m^3$ FYM combined with ammonium sulphate.

4- Foliage fresh weight :

Table (6) clearly indicate that, the local cultivar had the greater foliage fresh weight It showed 4.65 and 4.28 Kg during 2000 and 2001 seasons, respectively. Whereas, Fuseau cultivar produced 3.29 Kg and 2.99 Kg. Regarding to FYM; application of $40m^3$ resulted in the higher fresh weight 5.24 Kg and 4.77 Kg during the two studied seasons, respectiwely. Data presented in table (6) clearly show that the inorganic nitrogen in the form of ammonium sulphate compared with ammonium nitrate significantly affected the foliage fresh weight in both years.

Concerning the interaction effect, results in the same table showed that the foliage fresh weight was higher when the plants of the two cultivars were fertilized either with $40m^3$ FYM/Fed or by ammonium sulphate in both seasons. The interaction between organic manure (FYM) and the inorganic nitrogen sources indicated that foliage fresh weight increased when ammonium sulphate combined with $40m^3$ FYM. It caused about 19.79-4.42% foliage fresh weight comparing with using $20m^3$/Fed in both years, respectively. The intraction effect of cultivars, FYM and nitrogen sources were only significantly during first season, indicated that FYM ($40m^3$) combined with ammonium sulphate resulted in increasing foliage fresh weight. It was obvious from previous results that using $(NH_4)_2\ so_4$ as a nitrogen form had a positive effect in all parameters. This result could not only attributed to NH_4 cations but also to So_4 anion, since the two ions could participate in lowering soil pH and hence increasing the availability of the most important nutrients which in turn, increased plant growth (Riley and Barber, 1971; Russell, 1973 and Smiley, 1974). In addition, nitrogen also plays an important role in building stable soil organic matter as well as to produce optimum plant growth (Wallace, 1994).

5- Fresh weight of tubers per plant:

Data in Table (7) showed that Fuseau cultivar produced higher yield in both seasons compared with the local cultivar. The increment was estimated by 9.91 and 15.3% in the first and second seasons, respectively. However, the difference between the two cultivars did not reach to the significant level in the first season. A wide range of variation was reported by many outhers (Khereba, 1979; Soja and Liebhard, 1984; Spitters *et al.*, 1988; Klug, 1992; El-Sharkawy, 1998 and Hamad, 2001.

At harvest time in Table (7). Fresh weight of tubers/plant increased significantly with increasing FYM up to $40m^3$/Fed. It expressed 14.12 and 54.54% in the first season and 8.53 and 27.92% in the second season compared with $20m^3$ and $10m^3$ FYM, respectively. Smith *et al.*, 1989 and Staniforth and Smith, 1991) reported that the organic manure improved soil structural characteristics and increased availability of nutrients and play an important role in producing increments of yield.

Results did not reflect any significant differences between the two sources of nitrogen in respect to fresh weight of tubers/plant in the first season. However in the second season, fertilization of Jerusalem artichoke/plants with ammonium sulphate significantly increased fresh weight of tubers/plant. Findings in Table (7) cleary showed that the Fuseau cultivar was significantly affected with the higher FYM/Fed during 2001 season and it produced the larger tuber fresh weight of 6.83 Kg/plant. While the local cultivar produced the larger tuber fresh weight 5.278 Kg/plant.

Fresh weight of tubers/plant was generally enhanced by a combination cultivars with nitrogen sources in both years (Table.7). However, results were not significant in 2000. While during 2001 the Fuseau cultivar with ammonium sulphate fertilizer resulted in 10.84% higher F.W. of tuber/plant than the local cultivar.

Application of $40m^3$ FYM/Fed increased F.W. of tubers/plant when Joined with ammonium sulphate in 2001. Not with stanting, application of 40, $20m^3$/Fed FYM with ammonium nitrate was not significant in the first season. However, tubers F.W. of Fuseau CV. responded positively to application of $40m^3$/Fed FYM combined with ammonium sulphate in the second season only. During the first season Fuseau and local cultivars tubers F.W./plant was not reach to the significant level by combination of 40 and 20m3/Fed (FYM) with different inorganic nitrogen sources.

II- Total yield/plot :

Table (8) revealed that Fuseau cultivar produced the highest yield compared with local cv. in both years of studies. The total tubers yield/plot of Fuseau cv. were 209.7 and 173.1 Kg/plot. While, total tubers yield/plot produced by local cv. were 178.7 and 146.3 Kg/plot in 2000 and 2001 seasons, respectively.

Similar varietal differences were reported by many outhors. (Spitters, 1987; Spitters *et al.*, 1988; Perko, 1990; Klug, 1992 and Kiehn *et al.*, 1993). Regarding the effect of FYM, it was clear from Table (8) that there were significant and consistent increases in total yield/plot by increasing organic manure level up to $40m^3$/Fed in both years, resulted in 7.79, 54.65% and 8.89, 28.16% yield/plot increases over $20m^3$ and $10m^3$ FYM respectively.

Table (6) : Interactive effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on Foliage fresh weight of Jerusalem artichoke at 120 days during 2000 and 2001 seasons.

Seasons	Cultivar	FYM ($10m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($20m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($40m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	Average Control	$(NH_4)_2So_4$	NH_4No_3	M
	Fuseau	1.620	2.560	1.920	2.033	2.627	4.007	3.180	3.271	3.273	5.937	4.543	4.584	2.507	4.163	3.214	3.296
2000	Local	2.423	3.827	3.253	3.168	3.833	6.330	4.460	4.874	4.827	6.950	5.833	5.903	3.694	5.702	4.549	4.649
	M	2.022	3.193	2.587	2.601	3.230	5.168	3.820	4.073	4.050	6.443	5.238	5.244	3.101	4.935	3.882	
	Fuseau	1.437	2.017	1.720	1.724	2.327	3.197	2.713	2.746	3.813	5.237	4.447	4.499	2.526	3.483	2.960	2.990
2001	Local	3.113	3.803	3.330	3.416	3.337	5.623	4.123	4.361	4.560	5.883	4.720	5.054	3.670	5.103	4.058	4.277
	M	2.275	2.910	2.525	2.570	2.832	4.410	3.418	3.553	4.187	5.560	4.583	4.777	3.098	4.293	3.509	

LSD 0.05	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
2000	0.292	0.161	0.134	0.223	0.185	0.232	0.329
2001	0.098	0.122	0.113	0.172	0.160	0.196	0.276

Table (7) : Interactive effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on Fresh weigh of Tuber/plant (Kg) of Jerusalemartichoke at 180 days during 2000 and 2001 seasons.

Seasons	Cultivar	FYM ($10m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($20m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($40m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	Average Control	$(NH_4)_2So_4$	NH_4No_3	M
	Fuseau	3.300	5.290	4.437	4.342	6.917	5.663	8.090	6.890	8.383	8.900	8.517	8.600	6.200	6.618	7.014	6.611
2000	Local	2.767	3.363	3.017	3.049	6.150	7.808	7.267	7.073	7.653	7.967	7.617	7.746	5.523	6.378	5.967	5.956
	M	3.033	4.327	3.727	3.696	6.533	6.733	7.678	6.982	8.048	8.433	8.067	8.173	5.862	6.493	6.491	
	Fuseau	3.457	5.233	4.007	4.232	5.400	7.267	5.973	6.213	6.193	7.933	6.310	6.829	5.017	6.828	5.430	5.758
2001	Local	3.203	5.347	4.930	4.493	4.150	6.167	4.267	4.861	4.567	6.750	4.517	5.278	3.973	6.088	4.571	4.877
	M	3.330	5.290	4.468	4.363	4.775	6.713	5.120	5.537	5.330	7.367	5.413	6.053	4.495	6.458	5.001	

LSD 0.05	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
2000	N.S	0.620	0.837	N.S	1.183	1.444	2.049
2001	0.174	0.138	0.092	0.195	0.131	0.160	0.226

Table (8) : Interactive effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on Total yield/plot Jerusalem artichoke at 180 days during 2000 and 2001 seasons.

Seasons	Cultivar	FYM ($10m^3$)				FYM ($20m^3$)				FYM ($40m^3$)				Average			
		Control	$(NH_4)_2So_4$	NH_4No_3	M	Control	$(NH_4)_2So_4$	NH_4No_3	M	Control	$(NH_4)_2So_4$	NH_4No_3	M	Control	$(NH_4)_2So_4$	NH_4No_3	M
2000	Fuseau	99.00	160.7	133.1	130.9	227.5	249.9	242.7	240.0	251.5	267.0	255.5	258.0	192.7	225.9	210.4	209.7
	Local	83.00	100.9	90.50	91.47	184.5	234.1	218.0	212.2	229.6	239.0	228.5	232.4	165.7	191.3	179.0	178.7
	M	91.00	130.8	111.8	111.2	206.0	242.0	230.4	226.1	240.5	253.0	242.0	245.2	179.2	208.0	194.2	
2001	Fuseau	103.7	157.0	120.2	127.0	162.0	218.0	179.2	186.4	185.8	243.0	189.3	206.0	150.5	206.0	162.9	173.1
	Local	96.10	160.4	147.9	134.8	124.5	185.0	128.0	145.8	137.0	202.5	135.5	158.3	119.2	182.6	137.1	146.3
	M	99.90	158.7	134.1	130.9	143.3	201.5	153.6	166.1	161.4	222.8	162.4	182.2	134.9	194.3	150.0	

LSD 0.05	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
2000	13.13	7.69	5.044	10.87	7.133	8.736	12.35
2001	6.756	4.528	3.079	6.403	4.354	5.333	7.541

(Lapshina 1984 and Lou and sum, 1994) reported that the increase in biological activities caused by organic manure might be due to available carbon sources on which microorganisms activates besides conserving soil moisture and maintaining favourable soil temperature.

At harvesting (Table.8) showed the effect of using of the nitrogen sources. total tubers yield/plot was generally enhanced by $(NH_4)_2$ so_4 which caused increased 6.90, 14.09 and 22.95, 30.57% compared with NH_4 NO_3 and control in both seasons, respectively.

Concerning the interaction between cultivars and FYM, data presented in the same table indicated that the two cultivars responded significantly to higher levels of FYM. Also, the interaction between cultivars and nitrogen sources, data presented in Table (8) showed that the two cultivars surpassed when applying $(NH_4)_2$ SO_4 compared with NH_4 NO_3 and the control treatment in the two seasons.

It is also clear that FYM fertilizer exerted its increasing effect on the total yield/plot when combined with $(NH_4)_2$ SO_4. The interaction between cultivars, FYM and nitrogen sources, indicated that the highest values were resulted with applying nitrogen fertilizer as $(NH_4)_2$ SO_4 form and $40m^3$ FYM for both cultivars. These were true in both seasons of 2000 and 2001.

Iii- Inulin content of tubers :

Regardless treatments, the present study indicated that the Fuseau cultivar contained 3.47% higher tuber inulin concentration than those of the local one. The same trend was reported by (El-SharKawy, 1998). The positive effect of late harvest on increasing tuber inulin was reached 7.24-2.77% for $10m^3$-$20m^3$ FYM/Fed, respectively compared with $40m^3$ FYM/Fed. Concerning the nitrogen sources, it was observed that ammonium sulphate surpassed then ammonium nitrate and control by 3.41, 7.22%, respectively. Concerning the interaction effects, results in Table (9) showed that the inulin concentration ($g100g^{-1}$ DW) was higher when the plants of the two cultivar were fertilizer either with $40m^3$ and ammonium sulphate. The interaction between organic manure (FYM) and the inorganic nitrogen sources indicated inulin increment when NH_4So_3 combined with $40m^3$ FYM.while, the interaction effect of cultivars, FYM and the inorganic nitrogen sources were indicated that FYM ($40m^3$/Fed) combined with $(NH_4)_2$ So_4 increased inulin content of the tubers .

IV- Carbohydrate content of tubers :

Tubers of the local cultivar was significantly in carbohydrate than those of Fuseau cultivar. The present study indicated that $40m^3$ FYM/Fed significantly enhanced tuber carbohydrate by 3.58 and 6.54% compared with 20 and $10m^3$ FYM/Fed. In general, carbohydrate concentration with significantly higher $(NH_4)_2$ SO_4 and NH_4 No_3 compared with untreated by 2.35 and 2.24%. The effect of interaction between FYM rate and cultivars on carbohydrate percentage indicated that the local cultivar was significantly stimulated with the rate of $40m^3$ FYM/Fed. it is Also clear that the effect of interaction between cultivar and inorganic nitrogen source. Local cultivar was superior with ammonium sulphate while, Fuseau cnltivar was shown in table (9) in dictated that carbohydrate percentage increased with ammonium nitrate sources.

Table (9) : Effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on Inulin(%), Carbohydrate(%) and total sugar (%) of Jerusalem artichoke at 180 days during 2000 and 2001 seasons.

Cultivar Treatments	FYM ($10m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($20m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($40m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	Average Control	$(NH_4)_2So_4$	NH_4No_3	M
Inulin																
Fuseau	11.42	11.95	11.51	11.63	11.78	12.70	12.10	12.20	12.16	12.83	12.36	12.45	11.79	12.49	11.93	12.09
Local	10.40	11.85	11.26	11.17	10.92	12.15	12.07	11.71	11.92	12.43	12.07	12.14	11.08	12.14	11.80	11.67
M	10.41	11.90	11.39	11.40	11.35	12.42	12.09	11.95	12.04	12.63	12.22	12.29	11.43	12.32	11.90	
Carbohydrate:																
Fuseau	16.18	16.49	16.63	16.43	16.65	16.93	17.09	16.89	17.19	17.94	17.93	17.69	16.67	17.12	17.22	17.00
Local	16.80	17.04	17.18	17.00	17.40	17.88	17.56	17.62	17.90	18.29	18.06	18.08	17.37	17.74	17.60	17.57
M	16.49	16.76	16.90	16.72	17.03	17.41	17.33	17.25	17.54	18.12	18.00	17.89	17.02	17.43	17.41	
Total sugar :																
Fuseau	12.55	12.71	12.74	12.67	13.11	13.29	13.11	13.17	13.91	14.37	14.37	14.22	13.19	13.46	13.41	
Local	12.85	13.66	13.53	13.35	13.64	13.91	14.08	13.87	14.41	14.62	14.44	14.49	13.63	14.63	14.02	13.35
M	12.70	12.18	13.13	13.01	13.38	13.60	13.60	13.52	14.16	14.50	14.41	14.36	13.41	13.76	13.71	13.90

L.S.D 0.05%	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
Inulin	0.05237	0.03719	0.0370	0.05259	0.05260	0.06441	0.09109
Carbohydrate	0.2028	0.09602	0.09602	0.1358	0.1360	0.1663	0.2352
Total sugar	0.1335	0.04294	0.04299	0.06073	0.06073	0.07438	0.1052

Table (10) : Effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on Protein of Jerusalem artichoke at 180 days during 2000 and 2001 seasons..

Cultivar	FYM ($10m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($20m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($40m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	Average Control	$(NH_4)_2So_4$	NH_4No_3	M
Fuseau	8.236	8.658	8.448	8.447	8.506	9.364	9.019	8.963	8.396	9.427	9.130	8.984	8.379	9.150	8.863	8.798
Local	8.665	8.752	8.686	8.701	8.917	9.402	9.040	9.120	9.015	9.469	9.261	9.248	8.866	9.208	8.995	9.023
M	8.450	8.705	8.567	8.574	8.712	9.383	9.029	9.041	8.705	9.448	9.195	9.116	8.622	9.179	8.930	

L.S.D 0.05%	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
	0.06414	0.04801	0.0480	0.06790	0.0680	0.08316	0.1176

Concerning the interaction effects, results in the same Table, showed the carbohydrate content increased with a combination of 40m^3 FYM/Fed and ammonium sulphate or ammonium nitrate of the two cultivars.

V- Total sugar content :

In general, total sugar content of local cultivar surpassed that of the Fuseau cultivar by 3.96% (Table 9) Regardless of cultivar total sugar content was positively inflenced by rate of FYM (40m^3/Fed), significantly increased by 3.41 and 9.40% compared with 20 and 10m^3 FYM/Fed Total sugar content was correspondingly enhanced by 13.76 and 13.7,1g/100g Dry weight with $(NH_4)_2SO_4$, or NH_4 No_3 compared with control 13.4,1g/100g. The interaction between rate of FYM and Jerusalem artichoke cultivars was significant indicating that total sugar concentration of the two cultivar were increased as FYM fertilizer elevated from 10,20 and 40m^3 FYM/Fed.

Results also indicated that the interaction effect between inorganic soures and Jerusalem artichoke cultivars on total sugar content was significant when applicantion 40m^3 FYM/Fed with $(NH_4)_2$ SO_3 of the two cultivars.

VI- Total protein content :

Local cultivar produced tubers with significantly higher percentage of total protein percentage than Fuseau cultivar. Differences in tuber total protein might be due to genetic differences among Jerusalem artichoke cultivars (El-sharkawy, 1998 and Mansour *et al.*, 2001). Results indicated a significant increase of tuber total protein content as FYM level elevated to 40m^3/Fed, the increase of FYM application from 10 to 20 and 40m^3/Fed resulted in 5.95 and 0.38% higher tuber total protein concentration.

Results also indicated as significant increase of tuber protein percentage as ammonium sulphate compared with ammonium nitrate and untreated control. Concerning the interaction effect between cultivars and organic manure, it could be noticed that the local cultivar produced the higher protein concentration compared to the Fuseau cultivar when using the higher FYM (40m^3/Fed). As for the effect between cultivar and nitrogen sources on protein percentage, data indicated that tuber protein parentage increase significantly with the two cultivar by applying $(NH_4)_2$ SO_3. Concerning, the interaction between cultivar, FYM and inorganic nitrogen sources it is lear that the total protein concentration increased significantly with two cultivars (Fuseau and local) by applying 20 or 40m^3 FYM/Fed with $(NH_4)_2$ SO_3.

Nitrogen, phosphrous and potassium content in tubers :

Concerning the nitrogen and potassium content in the tubers, the data in table (11) showed that local cultivar tubers contained higher level compared with of Fuseau cultivar, wihle the phosphorus content in the tubers in same table indicated that no Sig nificant differences between the two cultivar.

Regarding the effect of FYM fertilizer levels on NPK content, were significant by increasing FYM level from 10 to 20 and 40m^3/Fed elevated tuber NPK content by 1.360, 1.406 and 1.444g/100g DW. respectively.

Table (11) : Effect of cultivar, organic manure (FYM) and nitrogen sources and their interactions on Phosphrous, Nitrogen and Potassium of Jerusalem artichoke at 180 days during 2000 and 2001 seasons..

Treatments / Cultivar	FYM ($10m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($20m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	FYM ($40m^3$) Control	$(NH_4)_2So_4$	NH_4No_3	M	Average Control	$(NH_4)_2So_4$	NH_4No_3	M
Phosphrous																
Fuseau	0.4467	0.4677	0.4507	0.455	0.4674	0.4410	0.4860	0.481	0.4967	0.5103	0.5067	0.505	0.4693	0.4897	0.4811	0.4800
Local	0.4313	0.4953	0.4800	0.469	0.4580	0.5033	0.4833	0.482	0.4710	0.5177	0.4932	0.494	0.4534	0.5054	0.4851	0.4815
M	0.4390	0.4815	0.4653	0.462	0.4113	0.4972	0.4847	0.481	0.4838	0.5140	0.5002	0.4995	0.4614	0.4976	0.4834	
Nitrogen																
Fuseau	1.318	1.385	1.352	1.353	1.361	1.498	1.443	1.434	1.343	1.508	1.461	1.437	1.341	1.464	1.418	1.408
Local	1.380	1.400	1.390	1.390	1.427	1.505	1.446	1.459	1.442	1.517	1.482	1.48	1.416	1.474	1.439	1.443
M	1.349	1.394	1.371	1.371	1.394	1.502	1.445	1.447	1.393	1.513	1.471	1.459	1.378	1.469	1.429	
Potassium																
Fuseau	1.316	1.407	1.410	1.378	1.323	1.416	1.430	1.390	1.339	1.438	1.453	1.410	1.326	1.420	1.431	1.393
Local	1.315	1.335	1.378	1.343	1.414	1.421	1.434	1.423	1.417	1.526	1.489	1.477	1.382	1.427	1.434	1.414
M	1.316	1.371	1.394	1.360	1.369	1.415	1.432	1.406	1.378	1.482	1.471	1.444	1.354	1.424	1.433	

L.S.D 0.05%	CV	Org	N	CV.Org	CV.N	N.Org	CV.Org.N
Phosphrous	0.01171	0.00680	0.00679	0.0012	0.00960	0.011076	0.01663
Nitrogen	0.0117	0.0068	0.00679	0.00970	0.00960	0.01176	0.01663
Potassium	0.01171	0.00680	0.00679	0.009602	0.00960	0.0118	0.01663

The results, also showed that N,P content increased with applying ammonium sulphate while, potassium content was increase significant applying ammonium nitrate. Results of the interaction effect between cultivars and FYM rates (Table 11) on N and K content were found in local cultivar with higher levels of FYM ($40m^3$/Fed) application on the contrary, higher levels of FYM ($40m^3$) with Fuseau cultivar produced phosphorus tubers content. Moreover, the interaction between cultivar and inorganic nitrogen sources on NPK content, the data in table (11) showed that a significant was $(NH_4)_2 SO_3$ with two cultivars However, the interaction between cultivars, FYM and nitrogen sources, the data in table (11) showed that the highest FYM ($40m^3$/Fed) with $(NH_4)_2 SO_3$ produced NPK content increases of two cultivar.

CONCLUSION

It is concluded that application of $40m^3$ FYM/Fed with ammonium sulphate at the rated 40Kg N/Fed was the best treatment for improving the vegetative growth, Also, producing the highest tuber yield and increase inulin concentration total carbohydrate, total protein, nitrogen and phosphorus concentration.

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إستجابة النمو والمحصول والمحتوى الكيميائى لمحصول الطرطوفة للمصادر النيتروجينية ومستويات الأسمدة العضوية

ظهرة عبد المولى الشرقاوى

قسم بحوث البطاطس ومحاصيل الخضر خضرية التكاثر - معهد بحوث البساتين

أجريت الدراسة بمحطة بحوث القناطر أثناء الموسم الصيفى ٢٠٠٠ و ٢٠٠١ لصنفى الطرطوفة الفيوزا والمحلى وتأثيرها على النمو الخضرى والمحصول والمحتوى الكيماوى للدرنات أستخدمت ٣ معدلات من السماد العضوى ١٠،٢٠،٤٠متر مكعب . ومصدرين من المصادر النتروجنية (سلفات نشادر ونترات الأمونيوم) (٤٠كجم نتروجين/فدان) . تفوق الوزن الطازج للمجموع الخضرى للصنف المحلى مقارنة بالصنف المستورد فيوزا أيضا عدد الفروع الجانبية والفروع الرئيسية على عكس إرتفاع النبات . المحصول الكلى للصنف فيوزا تفوق بنسبة ١٤،٧٨ و ١٥،٤٨% مقارنة بالصنف المحلى خلال الموسمين ٢٠٠٠ و ٢٠٠١ على التوالى . الصنفين المحلى والمستورد (فيوزا) أظهرت إستجابة ايجابية مع التسميد العضوى حتى ٤٠م٣/فدان أثناء الموسمين ٢٠٠٠ و ٢٠٠١ . أيضا النتائج تشير إلى محصول درنات الفيوزا ومحتوى الدرنات من الانيوين يتفوق مع الزيادة من التسميد العضوى ١٠-٢٠ إلى ٤٠م٣ مقارنة بالصنف المحلى خلال الموسمين . أضافة المصدر النتروجينى فى صورة سلفات النشادر أدى لزيادة المجموع الخضرى أيضا عدد الفروع الجانبية والفروع الرئسية على عكس إرتفاع النبات . التسميد بسلفات النشادر (٤٠ وحدة نتروجينية للفدان) أدى لزيادة محصول الدرنات بنسبة ٦،٦٣ و ٢٢،٨٠% مقارنة بنترات الأمونيوم خلال الموسمين ٢٠٠٠ ، ٢٠٠١ على التوالى . الصنف المحلى أظهر زيادة فى المحتوى من الكربوهيدرات والسكريات الكلية والبروتين والنتروجين والبوتاسيوم مقارنة بالصنف المستورد (فيوزا) التسميد ٤٠م٣ سماد عضوى وأيضا التسميد النتروجينى فى صورة سلفات نشادر (٤٠ وحده نتروجين/فدان) أدى لزيادة الانيولين والكربوهيدرات والسكريات الكلية والبروتين والنتروجين والفوسفور والبوتاسيوم لمحتوى الدرنات التسميد بالسماد العضوى (٤٠م٣/فدان) مضاف إليه سلفات النشادر (٤٠ وحدة نتروجين/فدان أعطى أفضل محصول وجودة لصنفى الطرطوفة المحلى والمستورد (فيوزا) .