

Effect of Tuber Cutting and Planting Date on Yield and Quality of Jerusalem artichoke in New Reclaimed Soil under Upper Egypt Conditions

Mohamed H.E.

Hort. Res. Inst., Agric. Res. Center, Giza, Egypt

Received: 30 Oct. 2020 / Accepted 15 Dec. 2020 / Publication date: 20 Dec. 2020

ABSTRACT

Two experiments were conducted during the summer seasons of 2018 and 2019 under new reclaimed land in Sohag governorate, with the aim of identifying the optimal planting date and the appropriate planting method using full and cutting tubers of the Jerusalem artichoke (*Helianthus tuberosus* L.) plant (the local variety), using four planting dates, which were the 15th of March, the 1st and 15th of April and the 1st of May, with two methods of planting, using whole and cutting tubers, and its effect on vegetative traits, yield and its components and the percentage of inulin in tubers. The results indicated that, the second planting date (1st of April) gave the highest values for most of the studied traits, especially plant height, average tuber weight, total yield, as well as the percentage of dry matter and the proportion of inulin in tubers compared to the other planting dates. The values obtained for most of the studied traits showed that, planting with whole tubers clearly better than planting with cutting tubers, which gave the highest values of all traits during the two seasons of the study. The interaction between planting dates and planting methods showed that, the second planting date (1st of April) with full tubers planting achieved the highest results for most of the studied traits.

Keywords: Jerusalem artichoke, *Helianthus tuberosus* L., tubers and inulin.

Introduction

Jerusalem artichoke (*Helianthus tuberosus* L.) belonging to the family Asteraceae is known as tuberous crop, with is recently introduced to Egypt for its high nutritional and medical values. It has long been a popular garden crop for its tubers, which can be eaten raw, sliced into salads, or boiled like potatoes. Farmers have used it as a livestock feed, sometimes making silage of the tops but more often feeding the harvested tubers to livestock or simply allowing hogs to root them out of the ground. The plant can easily become a weed, especially in gardens, and wild types are often called wild sunflowers. This crop is an agricultural crop with a great potential for high sugar yields/hectare (9-13 ton/ha) (Klaushofer, 1986).

Degidio *et al.*, (1988) and Paolini *et al.*, (1996) mentioned that, *H. tuberosus* is used as row material for the industrial production of inulin. *H. tuberosus* is a particularity and suitable crop for southern European countries especially in low-requirement environments. Concerning to planting dates, Planting dates play an important role for high tuber yield production (Leible 1988; Soja *et al.*, 1990 and Galindo and Guiraud 1997), also Alian and Attia (2011) significantly increase in yield and its components were noted in early date plantation comparing with late plantation.

Jerusalem artichoke tuber like potato tuber which can be plant as whole tuber or cut pieces of tuber that contain one or two eyes under optimum conditions, these cut tubers of Jerusalem artichoke may produce yield nearly equal that obtained from whole tuber. Klug-Anderson (1992) reported that, J. artichoke at different planting material sizes (25-200 gram/tubers) did not affect the tuber characters investigated. Meanwhile, Bolye and Baukwill (1955) reported that serious reduction in yield may be caused by mistakes in cutting processes that may be affected by incidence of diseases which attack the cutting surface. Two planting materials i.e. whole seed tuber and cut tuber in sandy soil were tested by El-Sharkawy *et al.*, (2008), their results indicated that Fuseau and local cultivars growth parameters responded positively with whole seed tuber.

The aime of this study was to compare the planting dates with their seeds being whole or cut on growth, yield and chemical constituents in new reclaimed soil under Upper Egypt conditions.

Corresponding Author: Mohamed H.E., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt

Materials and Methods

Two field experiments were carried out in newly cultivated sandy soil at Juhyna region, under flood irrigation Sohag Governorate, Egypt during the successive summer of 2018 and 2019 seasons to study the effect of planting dates and tuber seed (whole or cut tubers) of local cultivar of Jerusalem artichoke (*Helianthus tuberosus* L.). soil characteristics are shown in Table (1).

Table 1: Soil characterization for the experimental site.

Properties	Sand %	Silt %	Clay %	Texture	pH (1:1)	CaCO ₃	Total N%	P (ppm)	K (mg/100g)
	89.3	6.3	4.4	Sandy	8.02	11.55	0.08	3.6	0.15

Samples of the soil were obtained from 0.30 cm soil surface

The experimental design was a split plot with three replicates, the planting date were located in main plots, whereas tuber seed treatments (whole or cut tubers) were arranged randomly in the sub-plots. The experimental units size was 10.5 m². Tubers were planted on 50 cm within rows of 70 cm wide and 3 m long. The planting date was 15th March and 1st, 15th April and 1st May respectively, in both seasons.

All experimental units were fertilized with 50 kg N/fed as ammonium nitrate (33.5% N) in two doses equal after 60 and 90 days from planting date also, 50 Kg of P₂O₅/fed was applied during land preparation as well as, Potassium was applied in form of potassium sulphate with 72 kg of (48% K₂O)/fed in two equal portions at 60 and 90 days after planting date.

Five plants from each treatment were taken at random to determine stem length (m), no. of stems/plant and fresh weight of lateral stem/plant (kg) after 110 days from planting dates.

At harvest (after 180 days from planting dates), five plants were taken to determine tuber fresh weight (kg/plant), tuber fresh weight (gm.), and dry matter percentage (DM%). Total yield per/plot was recorded and converted to yield/fed. Tuber samples were selected from each treatment and washed with distilled water, weighted and dried in oven at 70 C° to constant weight to determine the dry matter percentage. Tuber inulin concentration was determined according to (Winton and Winton, 1958)

All data were statistically analyzed treatments means were compared using L.S.D. method according to Gomaz and Gomaz (1984).

Results

1. Vegetative growth parameters:

Growth parameters of Jerusalem artichoke plants were illustrated in Table (2 and 3). Data showed that, early planting dates on 15th March and 1st April recorded the highest value of stem length, number of lateral stem/plant and fresh weight of lateral stem/plant in the early planting dates and they significantly differed in both seasons. As for planting methods, whole tuber recorded the highest value for all vegetative parameters in both seasons with significant differences with compared to cut tuber method. Interaction between planting date and planting methods (whole and cut tubers), the 1st April with planting by whole tuber recorded the highest means of all treatments in both study seasons.

These results may be due to the suitable condition of early planting dates in Upper Egypt, moreover the healthy status of whole tuber compared with cutting ones. Similar conclusions were obtained by Soja *et al.*, (1990); Saengthongpinit and Sajjaanantakul (2005) and Alian and Attia (2011).

2. Tuber yield and components:

Data in Table (4 and 5) clearly mentioned that, the second planting date on 1st April in both seasons recorded the best tubers fresh weight (g.), weight per plant (kg.) and total yield (Ton/fed.), however the last planting date recorded the lowest values for the same characters. Concerning planting method, whole tuber recorded the highest value for tubers fresh weight (g.), weight per plant (kg.) and total yield (Ton/fed.) in both seasons with significant differences compared to cut

tuber method. As for interaction between planting date and planting methods (whole and cut tubers), the 1st April with planting by whole tuber was the highest values for the same characters in both study seasons. According to the weather factor in Upper Egypt, early planting is recommended for this crop to avoid high temperature. Similar results in general were recorded by Khareba (1979), El-Sharkawy *et al.*, (2008) and Alian and Attia (2011).

Table 2: Effect of planting dates and planting materials on vegetative growth of Jerusalem artichoke plants during 2018 season.

Planting date	Stem length (m)			No. lateral stems /plant			Fresh weight of lateral stem/plant (kg)		
	Whole	Cutting	Mean	Whole	Cutting	Mean	Whole	Cutting	Mean
15 th March	1.73	1.58	1.66	7.2	5.9	6.3	2.35	2.18	2.27
1 st April	1.81	1.56	1.69	7.8	5.5	6.7	2.49	2.15	2.21
15 th April	1.69	1.41	1.55	7.6	5.0	6.3	2.29	2.01	1.85
1 st May	1.52	1.36	1.44	6.7	4.8	5.8	2.10	1.81	1.76
Mean	1.64	1.48		7.3	5.3		2.31	2.04	
L.S.D. _{0.05}		0.15			0.5			0.18	
Planting dates (PD)		0.10			0.4			0.17	
Planting materials (PM)		0.27			0.9			0.23	
PD X PM									

Table 3: Effect of planting dates and planting materials on vegetative growth of Jerusalem artichoke plants during 2019 season.

Planting date	Stem length (m)			No. lateral stems /plant			Fresh weight of lateral stem/plant (kg)		
	Whole	Cutting	Mean	Whole	Cutting	Mean	Whole	Cutting	Mean
15 th March	1.69	1.49	2.43	6.8	6.1	6.5	2.13	2.03	2.08
1 st April	1.75	1.48	1.62	7.1	6.2	6.7	1.86	1.86	2.04
15 th April	1.61	1.37	1.49	6.8	4.8	5.8	1.71	1.71	1.78
1 st May	1.42	1.29	1.36	6.1	4.3	5.2	1.63	1.63	1.70
Mean	1.62	1.41		6.7	5.4		1.99	1.81	
L.S.D. _{0.05}									
Planting dates (PD)		0.12			0.4			0.13	
Planting materials (PM)		0.11			0.3			0.11	
PD X PM		0.22			0.8			0.21	

Table 4: Effect of planting dates and planting materials on tuber yield of Jerusalem artichoke plants during 2018 season.

Planting date	Tuber fresh weight (g)			Tuber fresh weight /plant (kg)			Total yield (Ton/fed)		
	Whole	Cutting	Mean	Whole	Cutting	Mean	Whole	Cutting	Mean
15 th March	41.6	41.3	41.5	1.63	1.53	1.58	10.53	9.23	9.88
1 st April	45.3	40.3	42.8	1.75	1.49	1.62	10.83	9.10	9.97
15 th April	39.9	38.7	39.3	1.51	1.43	1.47	9.73	8.63	9.18
1 st May	31.2	30.2	30.7	1.43	1.31	1.37	8.91	6.81	7.86
Mean	39.5	37.6		1.58	1.44		10.00	8.44	
L.S.D. _{0.05}									
Planting dates (PD)		2.3			0.19			0.15	
Planting materials (PM)		1.5			0.13			0.18	
PD X PM		3.4			0.33			0.36	

Table 5: Effect of planting dates and planting materials on tuber yield of Jerusalem artichoke plants during 2019 season.

Planting date	Tuber fresh weight (g)			Tuber fresh weight/plant (kg)			Total yield (Ton/fed)		
	Whole	Cutting	Mean	Whole	Cutting	Mean	Whole	Cutting	Mean
15 th March	39.7	38.8	39.3	1.51	1.38	1.45	9.89	8.39	9.14
1 st April	41.2	38.2	39.7	1.63	1.40	1.52	9.93	8.42	9.18
15 th April	33.4	32.7	33.1	1.43	1.21	1.32	7.75	6.07	6.91
1 st May	30.3	29.2	29.8	1.30	1.03	1.17	6.92	5.62	6.27
Mean	36.2	34.7		1.47	1.26		8.62	7.13	
L.S.D.0.05									
Planting dates (PD)		1.7			1.18			0.13	
Planting materials (PM)		0.9			0.15			0.17	
PD X PM		2.9			0.27			0.32	

3. Dry matter and inulin percentages:

The second planting dates on 1st April in both seasons recorded the highest dry matter and inulin percentages, meanwhile the last planting date on 1st May had the lowest percentages of dry matter and inulin. Whole tuber planting method recorded the best percentages of dry matter and inulin in both seasons with significant differences with cutting method. The interaction between planting date and planting methods, whole tuber with the second planting date on 1st April had the best percentages of dry matter and inulin in both seasons (Table 6 and 7). In earlier studies, Leible and Kahnt (1988), El-Sharkawy *et al.*, (2008) and Alian and Attia (2011) were mentioned partial similar our results for planting dates and planting methods.

It's clear that, 1st April was the best planting date in Upper Egypt; also using whole tuber for planting was more suitable.

Table 6: Effect of planting dates and planting materials on Dry matter and Inulin percentages of Jerusalem artichoke plants during 2018 season.

Planting date	Dry matter (%)			Inulin (%)		
	Whole	Cutting	Mean	whole	cutting	Mean
15 th March	22.41	21.81	22.11	9.83	9.17	9.50
1 st April	23.73	22.13	22.93	10.12	8.95	9.54
15 th April	21.52	20.37	20.95	9.35	8.26	8.80
1 st May	20.33	19.13	18.73	8.63	7.63	8.13
Mean	22.00	20.86		9.48	8.50	
L.S.D.0.05						
Planting dates (PD)		0.14			0.12	
Planting materials (PM)		0.16			0.15	
PD X PM		0.35			0.19	

Table 7: Effect of planting dates and planting materials on dry matter and inulin percentages of Jerusalem artichoke plants during 2019 season.

Planting date	Dry matter (%)			Inulin (%)		
	Whole	Cutting	Mean	Whole	Cutting	Mean
15 th March	20.22	20.21	20.47	9.61	9.31	9.46
1 st April	21.63	20.03	20.83	9.33	8.82	9.08
15 th April	19.92	18.75	19.34	8.57	7.73	8.15
1 st May	18.75	17.06	17.91	7.95	7.37	7.66
Mean	20.26	19.01		8.87	8.31	
L.S.D.0.05						
Planting dates (PD)		0.12			0.10	
Planting materials (PM)		0.15			0.13	
PD X PM		0.31			0.26	

Conclusion

Through this study and under the conditions of Upper Egypt, it is possible to recommend planting Jerusalem artichoke plants with the whole tubers during the first week of April in newly reclaimed lands to obtain the highest amount of yield.

References

- Alian, F.S. and M.M. Attia, 2011. Physiological Studies On Jerusalem artichoke 1- Productivity and Quality of Jerusalem artichoke In the New Reclaimed Lands. *J. Plant Production, Mansoura Univ.*, 2(12): 1607 – 1617.
- Boyle, P.J. and W.J. Baukwill, 1955. The use of cut sets and treatment of the cut surfaces. Commonwealth Bureau of Pastures, and Field Crop. Hurley. Berkshire.
- Degidio, M.G., C. Cervingi, T.B. Donini and V. Pignatelli, 1998. Production of fructose from cereal stems and polyannual cultures of Jerusalem artichoke. *Ind.Crops Prod.* 7: 113-119.
- El-Sharkawy, Z.A., M.H. El-Morsy, A.M. Abdel-Hamid and H.A. Foly, 2008. Effect of tuber cutting, Phosphorus levels and micro-elements on Jerusalem artichoke yield and quality under drip-irrigation on sandy soil. *Minia J. of Agric. Res. and Develop.*, 28(1): 167-191.
- Galindo, S.S. and J.P. Guiraud, 1997. Sugar potential of different Jerusalem artichoke cultivars according to harvest. *Bioresource Technology* 60: 15-20.
- Gomez, K.A. and A.A. Gomez, 1984. *Statistical Procedures for Agricultural Research*. 2nd Ed. John Wiley and Sons. Inc. New York, USA, 680 .
- Khereba, A.H.A., 1979. New Clones of Jerusalem artichoke. (*Helianthus tuberosus* L.) Research Bull. No. Faculty of Agriculture, Ain Shams University, Egypt
- Klaushofer, H., 1986. Zur Biotechnological fructosanhaltiger Pflanzen. *Starch*, 38: 91-94.
- Klug-Andersen, S., 1992. Jerusalem artichoke a vegetable crop, growth regulation and cultivars. *Acta-Horticulture*, 318: 145-152. (C.F. horted 1989-1995)
- Leible, L. and G. Kahnt, 1988. Effect of location, N-Fertilization, cultivar and harvest date on the yield of fermentable sugar of Jerusalem artichoke tops and tubers. *Journal of Agronomy and crop Science*, 1988, 161(5):339-352.
- Paolini, R., S. Del Puglia, V. Abbate, V. Copani, F. Danuso, G. De Mastro, N. Losavio, V. Marzi, P. Molfetta, V. Pignatelli, G. Venezia, and A.V. Vonella, 1996. Produttività del topinambur (*Helianthus tuberosus* L.) in relazione a fattori agronomici diversi. *Agric.Ricerca XVIII* 163:126-144.
- Saengthongpinit, W., and T. Sajjaanantakul, 2005 Influence of harvest time and storage temperature on characteristics of inulin from Jerusalem artichoke (*Helianthus tuberosus* L.) tubers. *Postharvest Biology and Technology*, 37: 93-100.
- Soja, G.G., G. Dersch and W. Praznik 1990. Harvest dates, fertilizer and varietal effects on yield, concentration and molecular distribution of fructan in Jerusalem artichoke (*Helianthus tuberosus* L.). *Journal of Agronomy and crop Science*, 165: 181-189.
- Winton, A.L. and K.B. Winton, 1958. *The analysis of foods*. John Wiley and Sons, Inc. London 857.