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SCIENTIFIC BASES OF JERUSALEM ARTICHOKE CULTIVATION TECHNOLOGY UNDER THE ZARAFSHAN VALLEY CONDITIONS

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Abstract

Research was conducted in Samarkand Agricultural Institute, Uzbekistan. Results showed that appropriate to grow Jerusalem artichoke (Helianthus tuberosus L.) varieties in meadow - gray soils of Samarkand region in crop rotation as an annual crop and in fodder crop rotations as a long-term culture. As an annual crop variety Fayz-baraka and accessions of K-991, №9, №105 tuber direction for human consumption and processing planting carried out under the scheme 90x30 cm planting in early spring, late autumn under the scheme 90x40 cm, with a mixture of pre-plant growth stimulant and micronutrients, as well as amendments during the growing season N_{300} + P_2O_{5-200} + K_2O_{-150} + 20 tons of manure and watering of eight times. This is to ensure the formation of high-yield commodity and seed tubers.

Keywords – biological traits, yield, tuber, green mass, inulin.

I. INTRODUCTION

In Uzbekistan, as well as in all sectors of agriculture the improvement of plant cultivation technologies, the correct selection of promising new varieties, the development of providing high-margin innovative agricultural technologies, taking into account peculiarities of local - soil - climatic conditions of the use of energy-saving technologies of cultivation to obtain a high yield per unit of food production area for processing ensuring economic growth is now considered as urgent tasks of the specialists. Jerusalem artichoke (*Helianthus tuberosus L.*) has a great importance in meeting the daily needs of people in the increasing types of food products , and the production of environmentally friendly and high-quality suitable for general use products. The main crop of Jerusalem artichoke - elevated part (stalks, leaves) as well as the underground part (roots called as 'tubers'.

Jerusalem artichoke in Uzbekistan and foreign countries is grown as a perennial crop with the yield 85-100 t/ha of green mass and 28-40 t/ha of tubers. In one quintals of green mass contains 24.1, 30 tubers of fodder units. Each feed unit contains 80-90 g of digestible protein. Tubers are well preserved. The inulin content in tubers is 11.7 %, crude protein 2 % [3, 4, 8].

The tubers are rich in carbohydrates, on average of inulin content of the dry weight of 48.31 %, in fresh weight - 11.7 %. According to reports Jerusalem artichoke reduces cholesterol in the body, normalizes the metabolism of carbohydrates and oils, has antitoxic action of the character, and inulin property of reducing the amount of sugar in the blood (hypoglycemic), established the possibility of separation of inulin tubers in a pure form. [8, 10, 11]. In Russia, on the basis of the new Jerusalem artichoke processing technology in patients with diabetes (type 1 and 2) taking inulin in the blood sugar level was reduced to 16-17 % in patients taking inulin its use decreased by 12-13 units [11]. Tubers of Jerusalem artichoke seedlings besides their positive effect on diabetes can be curative for atherosclerosis, tachycardia, hypertension, thrombophilia, anemia, tuberculosis, stomach ulcers, bloating, degenerative disc disease and many other diseases.

Jerusalem artichoke has been known and used in the IX century BC by American Indians. The plant is in the early 16th century from the coast of America Indians brought with them to Europe

as a food product, and in Europe through the French Jerusalem artichoke spread widely. In Western Europe Jerusalem artichoke as potato is used as a food product. [3,5,11]. Jerusalem artichoke appeared in Central Asia, including Uzbekistan through Russia, China and Kazakhstan. Up to the middle of the last century it was used only in specialized pig farms in the fields of crop rotations, solely as a forage plant for animals. Suitability for food purposes, selection, cultivation technology is almost not been studied.

Scientific research and practice carried out in recent years have shown the possibility of effective use of products derived from Jerusalem artichoke. Juice, fructose, alcohol, as well as the freshly harvested tubers obtained from Jerusalem artichoke are widely used in the prevention and treatment of diabetes mellitus, gout, disorders of the gastro - intestinal tract, the formation of stones in the ureters, the prevention of cancer and heart attacks [6, 8, 10] .

The scientists of the Uzbek Research Institute of Plant Industry developed new varieties which are widely distributed in Uzbekistan and providing a high-quality, cheap food, pharmaceutical, paper, and food and raw materials for the processing industry, to address the problem of providing the population with dietary staple. In the last 20 years in the number of cultivated plants which took their place in daily use of research carried out piecemeal to the study of plant biology. In 1996-2002 Komilova M. conducted research in Samarkand Agricultural Institute on study of the collection of Jerusalem artichoke, planting schemes, the density of plants per hectare, as well as the quantity of tubers for seed production [1, 3].

In Uzbekistan up to these days were not conducted evidence - based study of Jerusalem artichoke cultivation technologies to local conditions, their use as annual and perennial cultures, along with other cultures, to place them in the appropriate crop rotation and seed development features.

II. MATERIALS AND METHODS

The aim of research carried out at the Samarkand Agricultural Institute is the development and introducing of agricultural technology system (selection of varieties, planting dates, circuit placement and density of planting, processing technology of seed tubers before planting, irrigation regime, fertilizer rates, storage of seed tubers, etc.) and scientific substantiation of Jerusalem artichoke seed.

The cultivars Fayz-baraka, Novinka, Leningrad, Interes, and accessions K- 991, K- 99/2, №9 and №105 have been studied. The experiments were performed with four replications.

The length of each plot was 15.5 m, with 4 rows, and area 56 sq/m. Area of one – row variant was 504 sq/m consisting of 36 rows. The plots were placed in 4 tiers, at the beginning of the rows and at the end with 10 meters, laterally to 4 rows were allocated protective zone. Methods for each test carried out on the basis of the objectives of research tasks.

Field experiments, planting, phenological observations, biological measurements, care for crops, determination of yield were carried out according to the procedure of the Ministry of Agriculture and Water Resources of Uzbekistan (1991), the Guide of Leningrad Agricultural Institute (1979), All - Russian Research Institute of Plant Industry (1984, 1986), the All-Russia Research Institute of Potato Farming (M. 1967, 1989), the Uzbek Crop Research Institute (1999), the State Commission for Variety Testing (1974) as well as other sources for the research methodology. Agrochemical indicators of the arable layer of the soil experimental field studied by the methods of I.V.Tyurin (1980), I.M.Maltsev and L.P.Gritsenko (1983), Granvald - Lyazhu (1980), V.P.Machigina (1980) and P.V.Protasov (1980). Statistical analyses was conducted on CropStat.

III. RESULTS AND DISCUSSION

1. Assessment of Jerusalem artichoke accessions in terms of growth, development and productivity

In experiments conducted in a meadow - gray soils of Samarkand region the growth, development, growing as an annual and perennial crop planting in the spring and summer, the

estimation of crop formation, highlighted promising cultivars and accessions useful as annual crop field crop rotation were studied (Table 1). Yield of tubers ranged from 19,9 up to 26,7 t/ha at autumn planting and from 19,3 up to 26,4 t/ha at spring planting.

Among the studied cultivars and accessions identified as annual crops for human consumption the best was Fayz - baraka and for fodder purposes suitable for silage, as well as with tubers of hay tab such cultivars as Novinka, Leningrad, Interes and accessions №9 and №105. They are with oval form of tubers, in every bush 6-8 tubers, average weight of tuber is 60 g or more, the vegetation period is 170-180 days.

Table 1. Productivity indicators of artichoke varieties (2002-2005)

Variants	Planting scheme, cm	One bush yield		Number of tubers pieces	Average tuber weight from one bush, g	Tuber yield			Yield, t/ha	
		Above ground, g.	Tubers, kg.			Tuber pieces thousand/ha	Seed from 1 bush, g	Seed Thou-sand/ha	Green mass	Tu-bers
Autumn planting										
1	90x20	1050,1	413,4	10,1	40,9	525,2	8,1	421,2	55,8	21,8
2	90x30	1495,7	652,3	10,8	60,4	378,0	8,0	280,8	53,7	23,6
3	90x40	2100,0	992,8	11,1	89,4	293,0	10,0	264,0	57,4	26,7
4	90x50	2200,0	913,7	10,9	83,8	228,9	10,0	210,0	45,8	19,9
Spring planting										
1	90x20	902,0	521,0	10,0	52,1	527,0	8,0	421,6	55,5	21,6
2	90x30	1404,0	762,0	9,3	82,0	330,1	8,0	275,0	54,4	23,2
3	90x40	2000,0	951,3	10,2	93,2	255,0	8,9	222,5	56,5	26,4
4	90x50	2100,0	900,2	10,0	90,0	210,0	9,1	191,1	45,4	19,3
	$S_{\bar{x}}$ (%)									2,1
	LSD_{05}									7, 5

2. The study of the formation of the crop at different planting schemes and plant density of promising varieties of Jerusalem artichoke

Based on our research to identify the optimal planting scheme, a plant standing and the formation of high-quality commodity and seed of promising varieties of Jerusalem artichoke in the first year of planting it is advisable to install on each hectare 31700 plants. However, the same amount of Jerusalem artichoke plants of various schemes of placement in an increase in the number of plants per hectare Novinka from 22200 to 55600 in early spring (before 1 March) and late fall (25 Nov.-1 Dec.) experienced normal growth and development of plants and during late autumn planting tubers.

Harvest from a bush aboveground part was from 902 to 2200 g, and the yield of tubers from 413.4 to 992.8 g, the number of seed tubers fraction 8,1-10 pieces. The yield of marketable tubers was 26.7 t/ha. The highest yield of green mass was 56,7-57,4 t/ha and tubers - 26,4-26,7 t/ha. When placed on each hectare area in the spring and summer of 27800 plants (90x40 cm) at a high yield of marketable tubers yield. Seed tubers fraction at planting scheme 90x40 cm, placing 37100 plants obtained from 275.0 to 280.8 thousand tubers.

For commercial crop under the scheme 90x40 cm placing 27.8 cm plants in the autumn planting and producing seed tubers consider it expedient from the harvest obtained by planting in early spring under the scheme 90x30 cm placed on a hectare of 37000 plants.

3. Development of the timing of planting and processing methods before landing varieties of Jerusalem artichoke tubers

Seed tuber of Jerusalem artichoke varieties before planting at different times (spring and autumn) were treatment (water control, stimulants of growth, micronutrient fertilizers, growth stimulants mixture + micronutrients) and were planted. In each plot were planted 200 tubers, and observed the dynamics of germination of seed tubers at 10th, 20th and 30th March than the control was 27-31% higher (Table 2).

In the treatment of seed tubers with a mixture of growth stimulants and micronutrients with the rapid emergence holes tubers fully ascended, leading to an increase in the number of stems. The control version number of stems was 2.9 in the variant with the processing of growth stimulants - 4.2, a mixture of micronutrients - 3.8, and in a variant of tubers processing the mixture of growth promoters plus micronutrients number of stems was 4.6. When planting a significant difference was not observed on the options in the fall.

The highest a high Faiz-Baraka was observed in the spring planting tubers treated with a mixture of growth stimulants and micronutrients - 87.6 t/ha of green mass and 34.5 t/ha of tubers , as compared to control additional yield was 10.6 t/ha of green weight and 5.4 t/ha tubers. In the autumn planting tubers treated with a mixture of growth stimulants and micronutrients yield of green mass amounted to 85.0 t/ha and tubers 33.5 t/ha , to the control variant without pre-plant tuber yield of green mass amounted to 75.1 t/ha and tubers 28.7 t/ha.

Thus, it was found that under conditions of the Zarafshan Valley in late autumn and early spring planting of tubers treated with a mixture of growth factors and microfertilizer provides yield increase by 13.8 % of green mass and 18.5 % of tubers.

4. The study of patterns of green mass and tubers formation with different number of irrigation and fertilizer application rates

The experiments were at various irrigation regime: 1) at four time of irrigation: to bloom - 2 watering, during flowering - 1 and after flowering to ripening - 1; 2) six times irrigation: to flowering- 3, during flowering- 2, after flowering - 1; 3) eight times irrigation - before flowering - 4, during flowering - 2, after flowering to maturity - 2.

During the growing season from 1st May the dynamics of growth (height) of plant is studied during the month. On 1st May in Novinka cultivar the hight was 75.6 cm, in the autumn 1st October it was 205.6 cm. At six irrigation the high was 290 cm, at eight irrigation was 395.8 cm, the number of stems varied from 2.1 to 3.5. Commodity tubers in a bush were at 4 irrigation - 9, and at 8 irrigations reached up to 14.6 tubers (Table 3).

In experiments it was evident the influence of the amount of irrigation on the dynamics of accumulation of crop varieties of Jerusalem artichoke. In Novinka at 4

Table 2. The effect on germination, the number of stems and yield in processing in different periods of seed tubers of artichoke varieties Fayz – baraka with micro fertilizers and growth stimulants (2007-2009)

Sorts name	Planting time	Pre-treatment of seed tuber	Germination %		Number of stems	Productivity, t/ha		Differences			
			20.03	30.03		green mass	tubers	Green		tubers	
								t/ha	%	t/ha	%
Fayz-baraka	Autumn	Control (water)	31	75	2,7	75,1	28,7	-	100	-	100
		Micronutrients (B, Mn, Cu)	43	81	3,6	82,0	31,0	6,9	109,2	2,3	108,0
		Growth stimulator	60	96	3,8	84,0	32,6	8,9	111,8	3,9	113,6

		Mixture of growth stimulants and micronutrients	62	100	4,2	85,0	33,5	9,9	113,2	4,8	116,7
	Spring	Control (water)	33	76	2,9	77,0	29,1	-	100	-	100
		Micronutrients (B, Mn, Cu)	48	88	3,8	84,5	32,0	7,5	109,7	2,9	110,0
		Growth stimulator	69	100	4,2	85,8	33,6	8,8	111,4	4,5	115,5
		Mixture of growth stimulants and micronutrients	71	100	4,6	87,6	34,5	10,6	113,8	5,4	118,5
Novinka	**Autumn**	Control (water)	32	76	2,8	76,2	26,7	-	100	-	100
		Micronutrients (B, Mn, Cu)	35	86	3,0	82,3	29,6	6,1	108,0	2,9	110,9
		Growth stimulator	55	93	3,5	84,0	30,1	7,8	110,2	3,4	112,7
		Mixture of growth stimulants and micronutrients	62	94	4,1	85,1	31,0	8,9	111,7	4,3	116,1
	Spring	Control (water)	31	71	2,9	80,2	28,0	-	100	-	100
		Micronutrients (B, Mn, Cu)	44	86	3,2	83,5	29,1	3,3	104,1	1,1	104,0
		Growth stimulator	61	94	3,5	85,0	30,2	4,8	106,0	2,2	107,8
		Mixture of growth stimulants and micronutrients	65	100	4,2	86,4	32,0	6,2	107,7	4,0	114,3
		$S_{\bar{x}}$ (%) LSD_{05}				2,9 3,3	3,4 2,6				

irrigations the yield of green mass amounted to 33.2 t/ha and tubers - 12.4 t/ha; at 6 irrigations green weight was 48.7 t/ha and tubers - 21.4 t/ha; at 8 irrigations green mass reached 80.0 t/ha and tubers 30.4 t/ha. In comparison with four time irrigations at increased times of irrigations the yield or green mass increased more then twice and tubers' yield up to 18 t/ha more. In the variety Fayz-baraka this pattern is maintained at four watering yields of green mass - 38.2 tons, 13.9 tons of tubers, while the eight irrigation itself - 76.1 m and 33.1 m, respectively, at eight irrigation - 76.1 tons and or 33.1 compared with a four-watering extra yield was 37.9 tons and 19.2 tons per hectare.

Table 3. Effect of watering amount on growth dynamics and yield varieties of artichoke (2006-2008)

Number of watering	Height of plant by date						Number of stems after harvesting, pieces	Number of tubers from one bush	Productivity, t/ha		Margin, %
	1.05	1.06	1.07	1.08	1.09	1.10			Green weight	Tubers	
Novinka											
4	75,6	120,7	140,3	170,8	190,6	205,6	2,2	9,0	33,2	12,4	127,4
6	101,0	158,7	194,7	259,1	280,3	290,0	3,1	9,6	48,7	21,4	168,9
8	160,7	210,1	260,6	309,8	364,0	381,0	3,5	14,6	80,0	30,4	351,4
Fayz-baraka											

4	66,4	98,7	120,7	160,8	198,3	201,4	2,1	9,0	38,2	12,9	129,3
6	105,4	140,7	184,0	220,8	260,1	280,8	2,9	9,3	52,8	24,2	182.2
8	150,1	195,7	237,8	297,2	351,4	395,8	3,5	12,9	76,1	33,1	376,4
$S_{\bar{x}}$ (%)									3,3	2,8	
LSD_{05}									3.0	2.4	

The highest crop varieties in Novinka N_{-300} + P_2O_{5-150} + K_2O_{-150} + 20 tons of manure made of green mass of 77.5 t/ha of tubers - 29.5 m, or in terms of feed units - 27.4 tons, whereas the variety Faiz-baraka green mass yield was 77.5 t/ha and 28.5 t/ha of tubers or 27.1 fodder units (Table 4).

Table 4. Influence of mineral fertilizers on productivity of artichoke, t/ha

Variants	Yield data						Average t/ha		
	2007		2008		2009				
	Green weight	Tubers	Green weight	Tubers	Green weight	Tubers	Green weight	Tubers	Feeding unit (green w/tubers)
Novinka									
Without	35,0	12,0	36,0	11,8	37,0	11,9	36,0	11,9	8,5/3,5
N_{-300}	49,8	16,8	49,5	17,3	51,0	18,1	50,1	17,4	12/5,1
$N_{300}+P_2O_{5\ 200}$	56,0	18	55,8	21	54,0	21,0	55,4	20,0	13,2/6,0
$N_{300}+P_2O_5$	73,0	24,8	71,8	24,6	71,5	25,3	72,1	24,9	17,3/7,4
NPK+20 ton	77,9	30,1	78,1	29,0	76,5	29,4	77,5	29,5	18,6/8,8
Fayz-baraka									
Without	35,7	8,4	36,0	8,0	36,3	8,2	36,0	10,9	8,6/3,2
N – 300	50,2	19,1	51,0	17,8	52,4	17,7	51,2	18,2	12,2/5,4
$N_{300}+P_2O_{5\ 200}$	60,0	20,4	59,0	21,0	59,5	20,1	59,5	20,7	14,2/6,2
$N_{300}+P_2O_5$	74,0	23,8	75,1	24,0	75,9	24,2	75,0	24,0	18/7,2
NPK+20 ton	76,8	27,9	74,9	28,0	80,8	29,6	77,5	28,5	18,6/8,5
$S_{\bar{x}}$ (%)							2,7	3,2	
LSD_{05}							3,6	3,0	

IV. CONCLUSIONS

On the basis of studies it was concluded about a value of Jerusalem artichoke. In the context of the Zarafshan Valley conditions Jerusalem artichoke varieties grown in field crop rotations as annual crops in livestock fodder crop rotations as a perennial crop. Cultivar Fayz - baraka and accessions K- 991, №9, №105 are used as an annual crops which tubers for food purposes and processing for planting in the early spring and late fall. For the growth of commercial crop varieties of Jerusalem artichoke in the autumn there should be planted 7800 plants under the scheme 90x40 cm for growing seed tubers in early spring the tubers derived from the fields of the first year- 37.0 thousand plants according to the scheme 90x30 cm. Pre-treatment of seed tubers of varieties of Jerusalem artichoke mixture of growth stimulants and micronutrients and planting in late fall and early spring provides yield of green mass is 13.8 % and 18.5 % of tubers. Fertilizer varieties of Jerusalem artichoke in the growing rate of N_{300}+ P_2O_{5-200} + K_2O_{-150} + 20 tons of manure and irrigation provides eight times the formation of high- yield commodity and seed tubers. Subsequently, on the basis of selection, preparation of the starting material from botanical seeds obtained in the country of new varieties developed innovative new technologies of cultivation of Jerusalem artichoke in a meadow - gray soil.

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