Romanian Biotechnological Letters *Vol. 21, No. 4, 2016*

ORIGINAL PAPER

Productivity and Tuber Quality of *Helianthus Tuberosus* L. Cultivated on Different Soil Types in Serbia

Received for publication, November 20, 2014
Accepted for publication, February 23, 2015

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Abstract

In this paper were studied the morphological characteristics, productivity and tuber quality of the Jerusalem artichoke grown in different soil types. The study was conducted on soils of different texture and agrochemical properties: humoglay (the locality: Ivanovo 1), alluvium (the locality: Ivanovo 2) and chernozem on loess and partially gleyed soil (the locality: Starčevo). Prior to the experiment setting, the agrochemical analyses of the soil were conducted, and the mechanical composition was determined. Field experiments were carried out in the years 2007, 2008 and 2009 in a randomized complete block design with four replications. Of the total number of observed indicators, in six was recorded significant variability: average tuber weight (AWT), number of tubers per plant (NTP), fresh tuber: yield per plant (FTYP), average depth of excavation (ADE), total sugar content (TS) and α-amino-N (αAN), whereas in the other six, there were no statistically significant variations. In this group, there are the following indications: tuber length (TL), potassium (K), sodium (Na), total nitrate (TN), calcium (Ca) and phosphorus (P). Tuber colour (TC) and tuber shape (TSh) are presented descriptively. According to the examined parameters, the best soil type was the chernozem one with signs gleyzation in loess.

Keywords: *Helianthus tuberosus L., soil types, tuber, yield, chemical composition*

1. Introduction

Helianthus tuberosus L., commonly known as the Jerusalem artichoke, belongs to the family *Asteraceae*. Until the mid-twentieth century, its tubers were mainly used for feeding pigs. After this period, an increased interest in the use of artichoke tubers in human nutrition and for production of bioethanol was noted, so that the breeder works were directed towards obtaining varieties which would suite these purposes. *H. tuberosus* L. also has many other application areas such as: green or ensiled forage, a cover crop in marginal area, source of sugars and inulin for foods, crude material for the production of various chemicals, pharmaceuticals and industrial applications, etc. (BALDINI et al. [1]). In addition, it was used as a raw material for the production of motor fuel alcohol during the Second World War and has been sporadically used for this purpose until the end of 20th century (CHEKROUN et al. [2]). Jerusalem artichoke is an excellent livestock feed, also serves multiple ecological functions. It shows significant ecological and commercial importance for its strong stress tolerance, very high yield potential and utilisation as biofuels (LIU et al. [3]).

Tubers may be removed from the soil from the end of September until March, when the bitter taste disappears and they become sweet. The obtained yields depend on cultivation method, and it can range from 10 to 30 t ha^{-1} (CHEKROUN et al. [2]). According to KAYS & NOTTINGHAM [4], fresh tubers contain 80% to water, 15% to sugars and about 2% to protein, whereas according to CHEKROUN et al. [2], when they are dry, they contain 20-30% of dry matter, 1.5−5.0% of proteins, 0.2% of oil and 1.1−1.4% to minerals. Sugars make up to 80% of tuber dry mass and the main carbohydrate is inulin, a polymer of fructose with a glucose unit at the end of the chain (CHEKROUN et al. [2]). Due to the presence of inulin, the tubers considered to be a good source of dietary fibres (KAYS & NOTTINGHAM [4]). Also, due to the content of macro- and micronutrients they can be used as a high-quality animal feed (SEILER [5]). The aboveground mass and fresh and cooked tubers may be preserved by ensiling which, with the addition of preservatives, substantially meets the needs of ruminant nutrition (MIHAILOVIĆ et al. [6]; LIU et al. [3]; LIU et al., [7]). For bioethanol production, sugar yield per unit area is of utmost importance. The yield of sugar depends on its share in tubers, tuber yield per plant and the number of plants per unit area. The utility value of Jerusalem artichoke tubers depends on their mass, number and the soil depth at which they are formed. In addition, significant research attention is paid to increasing the yield of Jerusalem artichoke tubers and green biomass, its content of inulin, total sugar content for bioethanol production, and the quality of aboveground biomass for silage and biofuel use, as well as to improving plant traits which are important for processing by machinery, to the tolerance to drought, frost and pathogens (KAYS & NOTTINGHAM [4]). When assessing the suitability for the cultivation of Jerusalem artichoke, soil types and the soil texture are some of the most important characteristics to be taken into account. With regard to this, the aim of this study was to determine which would be the type of soil, according to its texture and fertility, the most suitable for the production of Jerusalem artichoke tubers in the District of South Banat.

2. Materials and Methods

During a three year period (2007, 2008 and 2009), field and laboratory trials were carried out with tubers of *Helianthus tuberosus* L., produced on a few localities in the District of South Banat, differing in soil type: humoglay at locality L1 Ivanovo 1 (N 44° 70′ 13″, E 20° 72′ 09″); alluvium at locality L2 Ivanovo 2 (N 44° 73′ 19″, E 20° 70′ 13″); and chernozem on loess at locality L3 Starčevo (N 44° 81′ 06″, E 20° 69′ 84″) (NEJGEBAUER et al. [8]).

Agroecological conditions. Meteorological factors during vegetation were different in each of the four study years (Table 1 and Table 2). The development of the above and belowground organs of Jerusalem artichokes, the dynamics of biomass accumulation, the yield of tubers and leafy stalks and their chemical composition are all fundamentally influenced by ecological conditions, variety traits and the technology (IZSÁKI & KÁDI, [9]). Meteorological conditions during this research were at long-term average and significantly higher than plant conditionally–optimal needs, (see Table 1).

Table 1 *Average air temperature of Jerusalem artichoke vegetation period, °C.*

Year	2007	2008	2009	(1999−2009)
I period (April and May)	17.10	16.60	17.80	16.30
II period (June, July and August)	24.70	23.40	22.60	23.10
III period (September and October)	17.50	18.40	18.90	18.20
Vegetation period	18.20	18.00	18.10	17.60

Total and monthly precipitation varied a lot by year. Smallest precipitation was in 2008 and highest in 2009 (Table 2).

Table 2 *Average precipitation of Jerusalem artichoke vegetation and winter period, mm.*

Year	2007	2008	2009	(1999−2009)
I period (April and May)	80	82	62	109
II period (June, July and August)	128	143	296	209
III period (September and October)	176	106	83	115
Vegetation period	384	331	440	426
Winter period	356	240	437	244

Soil and plant material sampling. The testing of soil texture class was conducted before the setting of cultivation trials (Table 3) in samples taken from the soil depth of 0 – 30 cm. Agrochemical analysis of the soil samples from the same soil depth were conducted each year, prior to and following the tubers extraction from the soil (Table 4). During the experiment, the sampling of tubers of *H. tuberosus* L. was conducted at all localities immediately after their extraction from the soil.

Field experiment. The experiment was conducted according to the randomised block design with four replications. Preceding crop every year was pea. Fertilizer doses were applied in NPK (5:15:30) ratio of 500 kg per hectare per year. The size of the basic plot was 10 m^2. Every year, on all tested localities, manual planting used to be carried out in the last third of March at the row spacing of 70 cm, with the row distance of 50 cm. Two tubers of the average weight of 30 grams were planted at soil depth of 10 cm, by a Deep hole method. During the vegetation period, the measures of crop care comprised only regular weed control by hoeing. Pests and plant diseases were not observed. At all localities, the tuber extraction was performed in the last decade of October, at the moment when tubers possessed the best processing quality. Twenty tubers were extracted from each of the five different plot parts. On the occasion of the extraction of the tubers, the depth to which they had been formed was measured, and their average value was calculated. The total yield of tubers per plant was measured.

Laboratory analysis of soil samples. The mechanical soil composition was determined in the average soil samples taken from the depth of 0−25 cm. The determination of the percentage content of sand, silt and clay particles in the average soil samples was performed by pipet technique using sodium pyrophosphate, whereas their textural class was defined according to the textural triangle (RESULOVIĊ et al. [10]; SOIL SURVEY STAFF [11]). The soils on which the survey was conducted belong to the texture classes presented in Table 3.

Table 3 *Weight proportion of soil particles less than 2 mm and soil texture classes of the plough soil layer (0 – 25 cm).*

Particles size (in mm)		Localities and soil types		
		Ivanovo 1 Humoglay (L1) (%)	Ivanovo 2 Aluvium (L2) (%)	Starčevo Chernozem (L3) (%)
Coarse sand	>0.2mm	0.2	9.1	0.1
Fine sand	0.2–0.02 mm	20.6	54.7	42.1
Silt	0.02–0.002 mm	35.7	12.4	31.9
Clay	<0.002mm	43.5	23.8	25.9
Soil texture classes according the textural triangle (SOIL SURVEY STUFF [11])		Clay	Sandy clay loam	Loam

The chemical analysis of the soil presented in Table 4, was performed with the use of following methods (BOGDANOVIĆ et al. [12]): pH soil reaction – by Potentiometric method; Carbonate content ($CaCO_3$) – by Scheibler's Volumetric method; Humus content – by Tjurin's method; Total Nitrogen (N) – by Kjeldahl's method; Available potassium (K_2O) – by Al-method according to Egner-Riehm; Available phosphorus (P_2O_5) – by Al-method according to Egner-Riehm.

Table 4 *Chemical characteristics of plough layer (0–25 cm) of the soils on which the trials were conducted.*

Locality: Soil type	Year	pH (KCl)	$CaCO_3$ %	Humus %	Total N %	Available mg/100 g soil	
						P_2O_5	K_2O
L1: Humoglay	2007	7.32	5.16	3.27	0.206	18.4	22.2
	2009	7.08	5.98	3.25	0.203	13.4	27.8
L2: Alluvium	2007	7.56	11.13	1.62	0.109	11.9	13.7
	2009	7.27	13.62	2.12	0.138	17.4	15.2
L3: Chernozem	2007	7.18	3.29	3.13	0.189	33.4	38.9
	2009	7.33	3.01	3.45	0.201	28.7	33.5

Analysis of morphological traits. After cleaning the tubers from remaining soil, their number, shape and colour were recorded. The length and weight of individual tubers were measured for three plants per each replication (TERZIĆ et al. [13]).

Morphological and agronomic characteristics were measured based on the *International Board for Plant Genetic Resources* (IBPGR) descriptors for cultivated and wild sunflower (IBPGR [14]; KAYS & NOTTINGHAM [4]) with modifications (Table 5).

Table 5 *Several descriptors for the characterisation of Jerusalem artichoke accessions.*

Characters	Descriptor states/scale
Qualitative descriptors	
Tuber colour (TC)	Light-brown, brown and violet-brown
Tuber shape (TSh)	Pear, spindle, oblong, slender, long slender and knobby cluster
Quantitative descriptors	
Tuber length (TL)	cm
Average weight of tubers (AWT)	g
Number of tubers/plant (NTP)	
Fresh tuber yield per plant (FTYP)	kg
The average depth of the tubers harvesting (ADE)	cm

Quality analysis. The contents of total sugar, non-sugar material (Na^+, K^+, and α-amino N), nitrogen (N), phosphorus (P) and calcium (Ca) were determined in the tubers of Jerusalem artichoke. About 150 g of a tuber pulp from each plot was prepared by Venema apparatus (Venema automation b.v., Groningen, Holland) and kept in a freezer until analyzed. The frozen pulp samples were analyzed in the sugar technology laboratory in the Sugar Factory "Jedinstvo", Kovačica, Serbia, for purity parameters with Betalyser (Dr Wolfgang Kernchen GmbH, Seelze, Germany). Betalyser is a software applet for automated routine analysis of sugar content and tuber impurities including Na^+, K^+ and α-amino–N (FIROUZABADI et al., [15]). The concentration of N was determined in the chemical laboratory of the Institute

"Tamiš", according to Kjeldahl's method (KJELDAHL [16]). The concentration of phosphorus (P) was determined with the use of spectrophotometry (Pye Unicam, SP 6-550, Cambridge, England), according to ammonium molybdovanadate method. The content of accessible Ca by the extraction with 1M of ammonium acetate, was determined using a Pye-Unicam SP 191 (Cambridge, UK) by AAS-Atomic Absorption Spectrophotometry (PANTOVIĆ et al. [17]).

Statistical analysis. The statistical significance of the difference between the calculated mean values obtained from the three-year study was obtained with by the Analysis of Variance, using the statistical package Statistica for Windows 10 (STATISTICA, [18]). All significance estimations were performed on the basis of the F and LSD tests, for the risk threshold of 5%. The interdependence of the obtained artichoke tuber yields and the yield structure parameters were examined by Correlation analysis and results were presented in tables.

3. Results and Discussions

Soil features. According to SEILER [5], more fertile soils, with a higher content of macronutrients, are suitable for growing Jerusalem artichokes. Our study was performed on various soil types, significantly differing in their mechanical composition: humoglay, alluvium and chernozem. Humoglay soil at locality Ivanovo 1 (L1) was composed of high levels of clay and a substantial content of powder fraction (Table 3), which make its mechanical composition very heavy, thus unfavourable for the handling and development of underground plant organs. In contrast, the alluvium on locality Ivanovo 2 (L2) was composed of more than 60% of sand, and thus it can be classified as sandy clay loam, which is much easier to handle and more suitable for the growth and development of artichoke tubers. Chernozem on locality Starčevo (L3) is of loam textural class with an optimal ratio of the major fractions, which is basic for high soil fertility potential (Table 3). In terms of chemical soil properties, there were similarities and differences in individual characteristics between the studied localities. Soil reaction (pH in KCl) is alkaline, not significantly differing between the localities (Table 4). The alluvium on Ivanovo 2 had a significantly higher content of $CaCO_3$ (11.1–13.6%), and a lower humus (1.6–2.1%) and total N contents (0.11–0.14%) compared to the other two localities (Table 4). The phosphorus content was the highest in the chernozem (rich supplying level), whereas the other two localities were in the class of medium supplying level (Table 4). The available potassium content is the most variable among the tested soil types; the richest supplying level had the chernozem, well supplying level had humogley while the lowest level had alluvium (Table 4).

Morphological and productive characteristics of Jerusalem artichoke tubers. ZHAO et al. [19] have studied the productivity of Jerusalem artichoke tubers in saline-alkali soils with 17.4% of total clay. The Jerusalem artichoke showed a high economic value, being a salt-tolerant as well as drought-tolerant species, which is easily grown in coastal and semi-arid areas like the North China Area.

The results of our investigation show that the influence of localities (different soil types) in the three-year period showed a statistically significant difference in the following properties of Jerusalem artichoke tubers: the length of tubers (TL), the average tuber weight (AWT), the number of tubers per plant (NTP), the fresh tubers yield per plant (FTYP) and the average depth of the tubers harvesting (ADE). In the course of the study, the tuber colour (TC) and the tuber shape (TSh) had identical characteristics at all sites regardless of the soil (site) on which they were grown: light brown and knobby cluster, respectively (Table 6). Heavy mechanical composition with a high content of clay in humogley on L1, obviously reduced tuber length (TL), average tuber mass (AWT) and tuber yield per plant (FTYP) (Table 6). At the same time, such soil composition significantly stimulated an increase in the number of produced tubers per plant (NTP = 46.8), whereas the average depth to which the tubers developed was smaller (ADE = 15.9 cm) in comparison to the tubers grown at the other two soil types (L2 and L3) (Table 6). The properties of the other two soil types (alluvium and chernozem) demonstrated the same effect on the length of the tubers (TL), the average number of tubers per plant (NTP) and the fresh tuber yield per plant (FTYP), whereas the effect on the average tuber weight (AWT) and the soil depth at which the tubers developed (ADE) between two of them differed (Table 6). In addition, on the alluvium (L2) and the chernozem (L3) Jerusalem artichoke formed significantly fewer tubers per plant (NTP) than on the humogley (L1) but the tubers were significantly longer (TL) and achieved a higher fresh yield per plant (FTYP) (Table 6). The tubers reached the highest average weight (AWT = 76.5 g) in chernozem (L3), which was significantly higher in comparison with the other two soil types (Table 6); the AWT on the chernozem was 4.1 times higher than on the humogley (L1) and 35.6% higher than on the alluvium (L2). It can be reasonably assumed that this property has been positively influenced by the favorable soil texture and good chemical properties of the chernozem (L3), especially by its rich supply with phosphorus and potassium and good humus content (Table 6). According to previously conducted studies it was found that the average weight of tubers depends on environmental factors, planting density and mineral nitrogen nutrition; it ranged from 20.7 g in variant without nutrition with nitrogen to 29.2 g in variant with two tubers planted in a running meter (RODRIGUES et al. [20]). In a study conducted by SLIMESTAD et al. [21], 20 different genotypes achieved an average tuber yield per plant of 1.33 kg (22.22 t ha^{-1}). The research of TERZIĆ et al. [13], several populations gave significant tuber weight, similar to the weights achieved by some common artichoke cultivars, which used to form 2 kg of tubers per plant, with an average single tuber weight of about 50 g (BERENJI & SIKORA [22]). In a previous research, in order to achieve a higher artichoke tuber yields and the ease of their extraction from the soil, the main target of the selection was obtaining bigger tubers, which should be formed closer to the stem (LE COCHEC [23]). According to IZSÁKI & KÁDI, [9], over the last five years, the average tuber yield amounted to ca. 11 t ha^{-1} (or 2.20 kg tuber yield per plant) on a world scale, and 10 t ha^{-1} (or 2.00 kg tuber yield per plant) in Europe. The four year investigation by IZSÁKI & KÁDI, [9] resulted in defining differences in tuber yields between the same genotypes from 15 to 28 t ha^{-1} (or 3.0 to 5.6 kg tuber yield per plant), caused by different site conditions (water supplies and soil type). In our study, the maximum soil depth (ADE) at which tubers developed was recorded on the chernozem (22.77 cm), quite less on the alluvium (18.79 cm), and the least of all three soil types on the humogley (15.95 cm) (Table 6). The research of VASIĆ et al. [24], TERZIĆ et al. [13] and TERZIĆ [25] conducted in this country with different genotypes of Jerusalem artichoke, proved to be similar to ours in a great variety of different morpho-productive traits (length of tubers (TL), average tuber weight (AWT) and the number of tubers per plant (NTP).

Table 6 *The three-year average values for some productivity parameters of Jerusalem artichoke tubers grown on different soil types.*

Locality/Soil type	TC	TSH	TL (cm)	AWT (g)	NTP	FTYP (kg)	ADE (cm)
L1: Humoglay	Light-brown	Knobby cluster	4.85*	18.33*	46.83*	1.39*	15.95*
L2: Alluvium	Light-brown	Knobby cluster	7.05*	46.58*	33.33*	2.82*	18.79*
L3: Chernozem on loess	Light-brown	Knobby cluster	7.42*	76.50*	31.58*	2.60*	22.77*
LSD 5%	–	–	*1.416*	*7.368*	*6.649*	*0.474*	*1.797*

Quality of Jerusalem artichoke tubers. One of the most important indicators of the quality of the artichoke tubers is the total sugar content (TS) whose values in our investigation ranged between 16.83 mmol/100 g on L1 (humoglay), and to 22.69 mmol/100 g on L3 (chernozem). The differences in tuber quality between the three soil types were statistically significant (Table 7), whereby the tubers grown on L3 (chernozem) contained total sugar higher by 3.75% than on the alluvium and by 5.86% than on the humogley. Since the total sugar content in tubers grown on the alluvium was significantly higher (2.12%) than on the humogley, it can be concluded that a heavy mechanical soil composition with clay content of over 43% causes lower production of sugar in tubers of Jerusalem artichoke.

Table 7 *The three-year average of some quality parameters in Jerusalem artichoke tubers.*

Locality/Soil type	TS (mmol/100 g)	αAN (mmol/100 g)	K (mmol/100 g)	Na (mmol/100 g)	TN (mmol/100 g)	Ca ($g\ kg^{-1}$)	P ($g\ kg^{-1}$)
L1: Humoglay	16.83*	0.007*	0.29^{ns}	0.00130^{ns}	3.83^{ns}	1.71^{ns}	2.59^{ns}
L2: Alluvium	18.95*	0.002*	0.29^{ns}	0.00136^{ns}	3.74^{ns}	1.95^{ns}	2.73^{ns}
L3: Chernozem on loess	22.69*	0.003*	0.39^{ns}	0.00150^{ns}	3.68^{ns}	2.11^{ns}	3.03^{ns}
LSD 5%	*0.2603*	*0.002720*	*0.07031*	*0.0004409*	*0.2603*	*0.4647*	*0.2932*

According to research of RADOVANOVIĆ et al. [26], Jerusalem artichoke tubers grown in Serbia contained 34.83% total carbohydrates, which was by over 6.4% higher in comparison to tubers grown in Romania. Similar results of the total sugar and fructo-oligosaccharides were at a level of 20% relative to the total tuber weight obtained SLIMESTAD et al. [21], whereas in investigation of RAKHIMOV et al. [27], in 13.4% of the total sugar content, fructose, glucose, sucrose and a series of D-fructofuranosides were detected.

In our study, the average content of αAN ranged among the tubers from different soils from 0.002 to 0.007 mmol/100 g, which was for about 50% less than interval in the study of TERZIĆ & ALTAGIĆ [28]. The average protein content (crude protein calculated by *KJELDAHL* [16] N x 6.25) of tubers at full maturity (7.84%) showed the same pattern as the total N and it can be compared to some other more popular crops like dried potato (8.3%), raw potato (2.1%) and raw turnip (1.9%) (SEILER [5]). This parameter affects the nutritional value of protein, with an average content for multiple populations, in the tubers of full maturity, of 9.3% (TERZIĆ [25]).

The K content was significantly higher in the tubers from the chernozem (Table 7), which may be due to the largest amount of available potassium in this soil, compared to the other two tested soil types. The Na content was identical in tubers from all soil types. The content of Na and K in all the tubers, regardless of the soil type, was favorable, and small differences between them were not statistically significant (variable K: $F = 0.357^{ns}$, $p = 0.836939$, and variable Na: $F = 1.9883^{ns}$, $p = 0.125928$). According to a research on the Jerusalem artichoke samples collected on the territory of Romania (TAMAS et al. [29]), the Ca content was 1.7 g kg^{-1} on average, the average content of Na was at 0.2 g kg^{-1}, whereas the average K content was at 17.0 g kg^{-1}. In a number of different genotypes studied by SEILER & CAMPBELL [30], variations of macro- and micronutrients were recorded up to several percent (SEILER & CAMPBELL [30]). The highest content of total nitrogen (TN) were recorded on the humoglay soil type. The stated value did not differ statistically in relation to the TN values acquired in the two other soil types ($F = 0.41\ ^{ns}$, $p = 0.798496$).

Ca content in tubers was at a similar level in all three examined soil types (1.71 to 2.11 g kg^{-1}), whereas the phosphorus content was significantly higher in tubers from chernozem, which can be explained with the highest content of phosphorus in this soil type in comparison with other two soil types (Table 7). The content of Ca and P in the tubers, as well as their interrelation, favour their use for human consumption. In our study, the ratio Ca / P in tubers was 0.69, whereas in research of TERZIĆ [25], the average Ca / P ratio was 0.98. The Ca and P ratio in survey of by MA et al. [31] was 1.66:1, and the content of Ca was, in comparison to our results, lower by 40.3%. If the Ca / P ratio is too high, the addition of phosphorus in animal feed is recommended (SEILER & CAMPBELL [30]).

Correlation analysis. Correlation analysis shows the interactions between the variables, and statistically significant correlations are allocated (Table 8). The most pronounced positive correlations were observed between TL and AWT (0.67), TL and FTYP (0.68), AWT and TS (0.69), NTP and αAN (0.61), FTYP and AWT (0.51), ADE and AWT (0.54), TS and P (0.66), K and AWT (0.64), Na and ADE (0.65), Ca and ADE (0.74) and P and ADE (0.66, each).

Table 8 *Correlation matrix between the researched parameters.*

Parameters	TL	AWT	NTP	FTYP	ADE	TS	αAN	K	Na	TN	Ca	P
TL	1.00	0.67	-0.71	0.68	0.37	0.36	-0.64	0.39	-0.07	-0.13	0.34	0.22
AWT		1.00	-0.66	0.51	0.54	0.69	-0.53	0.64	0.18	-0.31	0.43	0.53
NTP			1.00	-0.66	-0.20	-0.52	0.61	-0.38	0.22	0.09	-0.16	-0.17
FTYP				1.00	0.44	0.21	-0.48	0.15	-0.07	0.01	0.30	0.07
ADE					1.00	0.47	-0.05	0.32	0.65	-0.36	0.74	0.66
TS						1.00	-0.25	0.48	0.32	-0.42	0.26	0.66
αAN							1.00	-0.21	0.08	0.12	-0.09	0.03
K								1.00	-0.00	-0.17	0.33	0.37
Na									1.00	-0.35	0.49	0.56
TN										1.00	-0.31	-0.48
Ca											1.00	0.54
P												1.00

Statistically significant negative correlations were noticed between TL and NTP (-0.71), TL and αAN (-0.64), AWT and NTP (-0.66), AWT and αAN (-0.53), FTYP and NTP (-0.66). The calculated correlation coefficients confirm the highly significant positive relationship of tubers mass and size, and this is the most probable reason why the tuber size is listed as one of the important characteristics of high-quality cultivars of Jerusalem artichoke (BERENJI & SIKORA [22].

4. Conclusions

The physical and chemical characteristics of the soil exhibited a significant effect on the productivity and quality of Jerusalem artichoke tubers. The high content of clay in the humogley soil caused a shallower tuber development, a reduced length and weight of the tubers, as well as a lower yield along with the increase in the number of small tubers per plant. On the chernozem, due to favourable texture and chemical characteristics, the depth of development is the greatest, Jerusalem artichoke tubers are the largest and the maximum weight per single tuber, with a high content of K and P. On this soil, the best quality Jerusalem artichoke tubers were obtained from the standpoint of human and domestic animal nutrition. The sugar content in tubers was the lowest on heavy homogleyed soil and the highest on chernozem. Jerusalem artichoke tubers grown on the alluvium, were by the productive and qualitative parameters among the worst ones grown on humogley, and the best ones grown on chernozem.

5. Acknowledgement

The presented results are part of the research conducted under the Project no. 46006, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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