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Agrobiological evaluation of *Allium ampeloprasum* L. variety samples in comparison with *Allium sativum* L. cultivars

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Abstract. The purpose of investigation is to study the biological and morphological features, to establish the economic and valuable characteristics of the introduced and local forms of *Allium ampeloprasum* L. in comparison with *Allium sativum* L. and to study the effect of removal of the scape in the yield. The studies used field, statistical, settlement and analytical methods. The weight of the bulb without removing the inflorescence shoot of the cultivar Sofiivskyi was 28.4–53.3 g smaller than the variety samples No. 2 and No. 3 respectively. With removing the scape the difference increased by 60.5–68.6 g. The yield of No. 2 variety sample *Allium ampeloprasum* L. without removing the scape was lower than the standard by 1.7 t ha^{-1} while the variety sample No. 3 exceeded the standard by 1.1 t ha^{-1}. With the removal of inflorescence shoot the yields of variety samples No. 2 and No. 3 exceeded the cultivar Sofiivskyi by 1.6 and 2.2 t ha^{-1}. It has been established according to the researches that introduced forms of *Allium ampeloprasum* L. have high indicators of economic and valuable characteristics, but they are limited in the first years of cultivation, by the period of adaptation to the new soil and climatic conditions.

Key words: bulb, cultivar, garlic, variety sample, yield.

INTRODUCTION

In the context of global climate changes and the deterioration of soil and climatic conditions, the lack of stable and high yielding varieties of winter garlic, an issue becomes relevant in selection of local forms (varieties) that are characterized by high adaptive capacity and stable yields.

The cultivars of garlic in Ukraine are not very diverse, two types: hardneck and softneck, as well as a less common species both in Ukraine and in the world of *Allium ampeloprasum* L. We believe that the investigation of biology and growing technology of cultivation for the introduction of *Allium ampeloprasum* L. will contribute to Ukraine's conditions will promote the expansion of the variety of vegetable plants.

Allium ampeloprasum L. – an onion garlic, an Egyptian garlic or onion, a Spanish garlic or just a garlic-onion, an Elephant garlic, as soon as this plant is not called but most often – rocambole (Danin, 2004; Ludilov & Ivanova, 2009). Today they grow two different forms of species origin of rocambole: actually rokambole – varieties derived from *Allium scorodoprasum var. Babingtoni* (Ron, 1992; Stace, 2010; Dimpoulos et al., 2013) and the elephant garlic varieties derived from *Allium ampeloprasum var. ampeloprasum* (Sulistiorini &Van der Meer, 1993; Brewster, 1994; Flora of North America; Christopher et al., 2013;).

Since ancient times to the present the peoples of Africa and Asia use *Allium ampeloprasum* L. as an anti-helminthic, diuretic, anti-hypertensive agent (Haciseferogullari, 2005; Guarrera & Savo, 2013) and for improving digestion (Triano et al., 1998). The shredded bulbs are used to treat the initial stages of cough, sore throat and mucous membranes. The fresh juice is taken as an antispasmodic (Malafaia et al., 2015). Despite the considerable medical and economic potential of this genus, the researchers, as a rule, are concentrated to cultivated species *A. cepa* L., *A. fistulosum* L., *A. sativum* L. (Ben Arfa et al., 2015).

Allium ampeloprasum L. includes not only Elephant garlic but also cultivated forms of the leeks (Hanelt et al., 1992). It creates the inflorescence shoot with a small amount of the non-viable seeds or without them. The center of origin is North Africa and Southwest Asia (Mc Collum, 1987). Within this group of species the divergence was aggravated by different climates and technology of culture in different regions (Astely et al., 1982). According to the analysis of chloroplastic DNA (Havey, 1991; Mes et al., 1997), a close genetic similarity between *Allium ampeloprasum* L. and *Allium sativum* L. was confirmed.

The aim of the research was to study the biological and morphological peculiarities, to establish economically valuable features and correlations with the productivity of the introduced and local forms of *Allium ampeloprasum* L. in order to subsequently create an Elephant garlic based on the local form. The comparison of *Allium ampeloprasum* L. variety samples with *Allium sativum* L. cultivars due to differences in biological characteristics, yield and nutritional value such as *Allium ampeloprasum* L. has a higher nutritional value and it is characterized by less sharpness that it can be consumed by people who do not use ordinary garlic for some reason. Elephant garlic also has higher yield and higher product cost which is economically important.

MATERIALS AND METHODS

The research of the collection was carried out in 2017–2018 at the experimental field of the Department of Vegetable Growing of Uman National University of Horticulture in accordance with generally accepted methods (Bondarenko & Yakovenko, 2001; Volkodav, 2016), excepting the schemes of planting of *Allium ampeloprasum* L (Figliuolo et al., 2001). The soil of the experimental field is black, puddle, heavy loam with a well developed humus horizon (about 2.9% of humus) in the deep of 40–45 cm.

The total area: for the experiment 400 m², for plot 100 m²; for sampling – 10 m². The plots were arranged in a systematic order with a four replication. The predecessor – early vegetables. Planting was carried out by the scheme of 45×6 cm for *Allium sativum* L. and 45×10 cm for *Allium ampeloprasum* L. at the end of the first decade of October. The location of the plots was systemic. During the investigation characters

including the length and width of the leaf, the area of the leaf blade and the total leaf area per plant on the 30th, 60th, 90th days after planting (DAP) were determined. The height and diameter of the scape and the pseudostem – before harvesting using the trammel. The No. of leaves (per plant, pcs) was determined by the method of calculation, the area of the leaf blade by a calculated (linear) method, using the parameters of the length and width of the leaf by the formula 1:

$$Sn = 0.67 \times ab \quad (1)$$

where Sn – the area of one leaf, cm²; a – the largest leaf width, cm; b – leaf length, cm; 0.67 is the coefficient that reflects the configuration of the leaf.

The cold resistance were judged by the counting of alive plants after spring regrowth. The coefficient of adaptability (CA) of the winter garlic was determined by the method of A. N. Podolskyh (Podolskykh, 2004), as the ratio of the number of plants that formed the commercial bulb to the total number of planted once, and the closer the value to 1, the more adaptive is the variety. The material of the research was two breeding varieties of the species *Allium sativum* L.: Sofiivskyi (St.), Prometei, and two introduced forms of *Allium ampeloprasum* L. – variety samples No. 2 and No. 3.

Also we studied the effect of removing scape on increasing the yield of *Allium sativum* L. and *Allium ampeloprasum* L.

Proteins, fats, carbohydrates and ash content were determined using standard methods described in the procedures of the American Organization of Analytical Chemists (International Organization of International, AOAC International) (Horwitz & Latimer, 2005). Crude fat was determined using a Soxhlet apparatus with petroleum ether, according to the AOAC 920.85 methodology (Horwitz & Latimer, 2016). The content of ash was determined by burning at 600 °C to constant mass in accordance with procedures AOAS 923.03 (Horwitz & Latimer, 2016). Energy was calculated by the formula 2:

$$\text{Energy (kcal)} = 4 \times (\text{protein}) + 4 \times (\text{carbohydrate}) + 9 \times (\text{g fat}) \quad (2)$$

Free sugar was determined using HPLC, coupled with a refractive index detector using the internal standard methodology (IS, mesostiosis) (Guimarães et al., 2013).

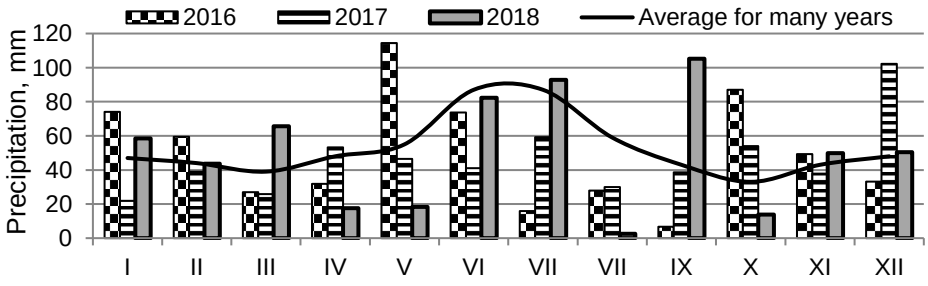

Figure 1. The amount of precipitation in 2016–2018.

For the food and chemical composition, three samples were analyzed in each genotype, and all analyzes were performed in three replicates. The results were expressed as averages and standard deviation (SD). The chemical composition and antioxidant activity were analyzed using a one-way dispersion analysis, followed by the

Tvyxi's Honesty Difference (TQ) test with = 0.05 using statistical analysis program (SAS) v. 9.1.3. All results are expressed as g per 100 g f.v.

According to Uman meteorological station the hydrometeorological conditions of 2017 were characterized by a slightly lower amount of precipitation relative to the average perennial indicators, but the uniformity of their fall during the period of the garlic vegetation was observed. The amount of precipitation for this period in 2018 was more relative to 2017, which is close to medium-long-term data, but the main number of them fell at the beginning and at the end of the vegetation which testifies to their lack of a phase of intensive growth and development of the plant, but it did not has a significant effect of precipitation, so the investigation was carried out under the drip irrigation.

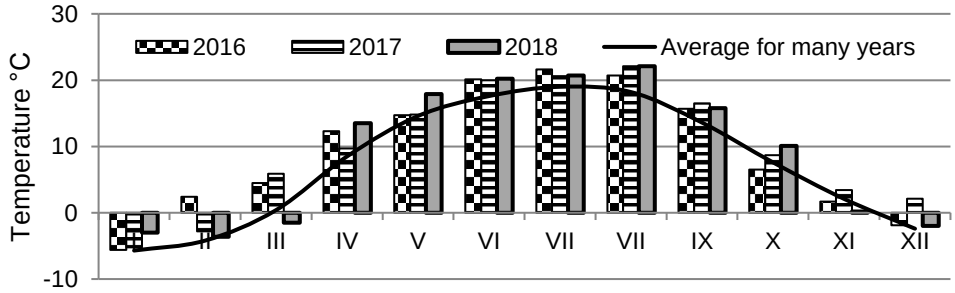

Figure 2. Average air temperature °C in 2016–2018.

The temperature of air 2016–2017 from the date of planting to the emergence of the sprouts was somewhat lower but close to the perennial which positively influenced the development of germination of the garlic plants in autumn-winter period. The temperature indexes of 2017–2018 from the date of planting to the restoration of the spring vegetation were atypically warm and it resulted the emergence of the sprouts of garlic during the autumn-winter period (Novak, 2017; Novak & Novak, 2018).

The data were statistically analyzed using Analysis of variance Microsoft Office Excel.

RESULTS AND DISCUSSION

Garlic, as a vegetatively propagated plant, is plastic and it reacts sharply to the changes in growing conditions, which may result to partial or complete freezing of crops. In the conditions of the Forest-Steppe of Ukraine for planting in the optimal period the garlic cloves are well rooted and no freezing is observed. According to the data the percentage of overwintering plants of *Allium ampeloprasum* L. in the experiment is within the range of 98.0–100% (Table 1), which indicates their high winter resistance, and plants *Allium sativum* L. – 100%. The lower level of

Table 1. Overwintering and adaptability of the studied garlic genotypes (average for 2017–2018)

Cultivar/ sample	Origin	Winter hardiness, %	Coefficient of adaptability
Sofiivskyi St.	Ukraine	100	0.95
Prometei		100	0.97
No. 2	Greece	98.0	0.45
No. 3	Ukraine	100	0.49

winter resistance of variety sample No. 2is due to its origin from Greece where the climate is milder, but the indicator of wintering is excellent for such significant change in climatic conditions.

Cold resistance and adaptability of the studied garlic genotypes

The variety samples No. 2 and 3 showed the low adaptability (CA) because in the first year of cultivation (2017) they did not form the commercial bulbs, all plants of both variety samples formed massive single-clove bulbs while in the second year of cultivation (2018) all plants formed the commercial bulb, indicating a sharp negative reaction to changing conditions of cultivation.

The cultivars of winter garlic Sofiivskyi and Prometei have high adaptability – 0.95–0.97 according to the cultivar, due to the fact that these cultivars did not change the place and the conditions of cultivation.

Morphometric indices of studied garlic genotypes

An important varietal sign is this leaf width, because this indicator is less variable among others (Skorina et al., 2014). According to this feature garlic is divided into three groups: I (up to 2.5 cm) – with the narrow leaves; II (2.6–2.9 cm) – with the leaves of medium width; III (≥ 3 cm) – with the wide leaves. The biometric measurements for 60th DAP showed that the first group includes: the standard-cultivar Sofiivskyi with a leaf width of 2.3 cm, to the second group – the cultivar Prometei – 2.5 cm, the variety samples No. 2 and No. 3 belong to the group with wide sheets – 4.5 and 4.9 cm in accordance with the specimen and exceed the standard by 95.7 and 113.0% (2.2 and 2.6 cm) (Table 2). The length of the leaf of the experimental variety samples of *Allium ampeloprasum* L. was slightly less than the cultivars of winter garlic. Thus, during the vegetation on the 30th, 60th, 90th DAP the difference between No. 2 and the standard decreased from 9.9 cm (68.8%) on 30th DAP to 5.6 cm (15.0%) on the 90th DAP. The variety sample No. 3 formed a shorter leaf 30th DAP than the standard by 7.6 cm (45.5%), 90th DAP the difference decreased to 2.6 cm (6.5%). The number of leaves of the variety samples No. 2 and No. 3 30th DAP was insignificantly lower than the standard by 0.3 pcs per plant, 60th DAP the number of leaves of No. 2 and No. 3 increased to 7.7 and 8.9 pcs per plant, where the given index was greater than the standard by 0.3 and 1.5 cm. On 90th DAP the variety sample No. 2 had 8.9 leaves per plant which is more than the standard by 1.1 pcs per plant. No. 3 was higher by this indicator than the cultivar-standard Sofiivskyi by 2.2 pcs per plant.

Table 2. Morphometric indices of the studied garlic genotypes during the vegetation on the 30th, 60th 90th days after planting (2017–2018)

Cultivar/sample	Leaf width, cm			Leaf length, cm			Number of leaves, pcs.		
	days after planting (DAP)								
	30	60	90	30	60	90	30	60	90
Sofiivskyi St.	1.5	2.3	2.5	24.3	41.9	42.8	4.5	7.4	6.5
Prometei	1.8	2.5	2.7	26.2	43.8	44.3	5.7	8.7	7.1
No. 2	2.5	4.5	3.5	14.4	33.4	37.2	5.7	8.7	7.1
No. 3	3.0	4.9	4.2	16.7	36.7	40.2	4.2	7.7	8.2
$LSD_{0.05}$	0.16	0.15	0.22	1.27	2.64	2.19	0.17	0.37	0.52

Area of the leave and leaf area index of studied garlic genotypes

The area of the leaf blade of the variety samples No. 2 and No. 3 in the initial stages of growth (30th DAP) (Table 3) was less than the standard by 7.8 and 3.3 cm², on the 60th DAP of *Allium ampeloprasum* L. variety samples exceeded the standard by 31.4% and 65.0% accordingly, 90th DAP of the standard exceeded was 12.5 and 39.5 cm², the same trend was maintained in the analysis of the total leaf area per plant. So, it is possible to assume that these variety samples are more soon-ripe than the usual garlic.

Table 3. Area of the leave of the studied garlic genotypes during the vegetation on the 30th, 60th 90th days after planting (2017–2018)

Cultivar/sample	Area of the leave, cm²			Area of the leaves per plant, cm²			Leaf area index (LAI)		
	days after planting (DAP)								
	30	60	90	30	60	90	30	60	90
Sofiivskyi St.	23.2	64.9	77.4	60.0	290.0	300.0	0.22	1.07	1.11
Prometei	25.2	72.5	89.8	110.0	380.0	390.0	0.41	1.40	1.44
No. 2	25.2	72.5	89.8	110.0	380.0	390.0	0.24	0.84	0.86
No. 3	15.4	85.3	87.1	60.0	450.0	420.0	0.13	0.99	0.93
$LSD_{0.05}$	0.99	5.51	5.23	0.06	0.29	0.22	–	–	–

Leaf area index of *Allium ampeloprasum* L. variety samples was smaller than the winter garlic cultivars according to the scheme of planting the number of plants per unit of the area is smaller. Thus, during the vegetation of plants, Prometei cultivar had a higher leaf area index than the standard by 86.4; 30.8; 29.7% on the 30th, 60th, 90th DAP, at the same time, the variety sample No. 2 exceeded the standard by 9.1% on the 30th DAP and it was lower by 21.5 and 22.5% on the 60th and 90th DAP and the variety sample No. 3 was less one than standard by 40,9; 7.5; 16.2%.

Plant height and morphometric indices of bulbs and bulbils of studied garlic genotypes

The biometric measurements have been shown that the introduced forms of *Allium ampeloprasum* L. differ significantly from each other. The variety sample No. 2 had a height of 58.7 cm which is 8.4 cm (14.3%) lower than the standard, while the variety sample No. 3 predominated the cultivar Sofiivskyi by 1.2 cm but it was smaller by 1.1 cm of the cultivar Prometei (Table 4). The variety samples No. 2 and No. 3 had the scape higher than the standard by 11.6–17.3 cm and 18.0–23.7 cm of the cultivar Prometei. By the diameter of the pseudostem, both variety samples of the species *Allium ampeloprasum* L. the cultivars of winter garlic Sofiivskyi and Prometei dominated significantly. Thus, variety samples No. 2 and No. 3 had a diameter of the pseudostem of 13.0–15.1 mm, which is higher than the standard by 4.4–6.5 mm or 51.2–75.6%. A similar dynamics is observed in the diameter of the scape, but the variety sample No. 2 had a slightly higher figure than No. 3. The diameter of the scape of the variety samples No. 2 and 3 was bigger by 4.0–3.9 mm, accordingly, and by 2.5–2.4 mm of the cultivar Prometei.

Allium ampeloprasum L. does not form the aerial bulbs (bulblet), but on the bottom and under the sheath the bulbs from 3–5 to 10 pcs. of large size bulb which have a very dense outer covering and internal transparent parchment scales.

According to the number of bulbils per stem or capsule the cultivars of winter garlic are very much dominated the variety samples of *Allium ampeloprasum* L. whereas the weight of little bulblet of one plant of the variety samples No. 2 and No. 3 is less than the standard by 61.9% and 51.1%, by 119.0% and 104.0% of the cultivar Prometei according to the sample (Table 4). The variety samples No. 2 and No. 3 have a mass of 1,000 pcs of the scape. The scape which is higher than the standard by 670.8 g and 831.1 g whereas the difference between these variety samples and the garlic cultivar Prometei is more than doubled.

It is evident of the obtained data that the number of cloves of the variety samples No. 2 and No. 3 is significantly less than the winter garlic cultivar Sofiivskyi and is more similar to the cultivar Prometei. So, the variety samples No. 2 and No. 3 have in their structure 7.1 and 5.1 large cloves according to the variety sample which is less than the standard by 2.5 and 4.5 pcs. (Table 4).

Table 4. Morphometric indices of the studied garlic genotypes (2017–2018)

Cultivar/sample	PH, cm	ISH, cm	PSD, mm	ISD, mm	NoB, pcs.	IM, g	W_{1000} pcs.	NoC, pcs.	NoS, pcs.
	Before harvesting								
Sofiivskyi St.	67.1	105.9	8.6	4.9	166.8	6.8	40.7	9.6	4.1
Prometei	69.4	99.5	10.1	6.4	78.3	9.2	120.2	5.8	6.0
No. 2	58.7	117.5	13.0	8.9	5.1	4.2	711.5	7.1	5.1
No. 3	68.3	123.2	15.1	8.8	5.2	4.5	871.8	5.1	4.7
$LSD_{0.05}$	4.23	7.21	0.44	0.37	4.67	0.38	35.05	0.31	0.27
CV (%)	7.4	9.7	24.9	26.9	120.3	37.7	95.6	28.7	16.0

PH – plant height; ISH – scape height; PSD – pseudostem diameter; ISD – scape diameter; NoB – No. of bulbils (bulblet) per stem or capsule, pcs; IM – inflorescence mass; $W_{1,000}$ – weight 1,000 pcs., bulbils (bulblet); NoC – No of cloves, pcs; NoS – Number of sheath on bulb, pcs.

The presence of a large number of covering scales affects the length of storage period of the commercial garlic and reduces the damage by pests and diseases. *Allium ampeloprasum* L variety samples have almost the identical numbers of common sheath and insignificantly dominate the standard cultivar of winter garlic Sofiivskyi, but their covering scales are very thin, white or almost transparent and have a violation of their integrity even before harvesting and during logistics operations, but this phenomenon does not make a significant influence because *Allium ampeloprasum* L. have a very thick and dense covering scales of the clove from cream to light brown color. The varieties of winter garlic do not possess such characteristics of the covering scales therefore it is important for them to preserve their integrity.

Both variety samples of *Allium ampeloprasum* L. are very similar with each other, so the bulblet of variety samples Nos. 2 and 3 are apparently similar to nut, but the variety sample No. 2 has the bulblet aligned in size, while the bulblet of the variety sample No. 3 differ significantly, the diameter of which may be from 4.0 to 20.0 mm. The bulbils' sheath are creamy and very dense, which requires pre-scarification to be planted. Under the covering scales is a thin parchment scoop similar to a film of white or almost transparent color.

Weight of bulbs and yield of studied garlic genotypes

The average weight of bulb for two years without removing the scape of the cultivar Sofiivskyi was 35.8 g, which was 28.4 and 53.3 g less than the variety samples No. 2 and No. 3 respectivly (Table 5). With the removal of the scape the difference increased to 60.5–68.6 g.

Table 5. Weight of bulb (g) of the studied garlic genotypes

Cultivar/	2017		2018		Average	
sample	RIS	WR	RIS	WR	RIS	WR
Sofiivskyi St.	43.0	48.2	28.5	36.5	35.8	42.4
Prometei	44.8	54.9	32.7	40.2	38.8	47.6
No. 2	49.1	–	79.2	103.0	64.2	103.0
No. 3	92.6	–	85.5	111.1	89.1	111.1
$LSD_{0.05}$	3.94	2.41	2.96	3.86	–	–

RIS – without removing the scape; WR – with removing the scape.

The yield (Table 6) was differed considerably over the years due to the fact that in the first year of cultivating *Allium ampeloprasum* variety samples formed only one-clove bulbs, this phenomenon can be explained by changing of the climatic conditions of cultivation and passing of the adaptation period, as the planting material of both years was the same fraction, and the storage (temperature and humidity) before planting were also the same.

In 2017 the productivity of removal of the scape in both cultivars of garlic grew by 3.4 t ha^{-1}, the yield of the Sofiivskyi cultivar grew by 27.9%, the Prometei cultivar – by 25.6%. This difference between the No. 2 and No. 3 variety samples could not be detected since one-clove bulbs were formed this year. In 2018 the increase of the yield of garlic cultivars of Sofiivskyi and Prometei for removal of the scape by 24.5% (2.5 t ha^{-1}) and 27.4% (3.2 t ha^{-1}). Increasing the yield of *Allium ampeloprasum* variety samples were almost the same – 35.0% (4.1 t ha^{-1}) and 35.5% (4.3 t ha^{-1}).

Table 6. Yield (t ha^{-1}) of the studied garlic genotypes

Cultivar/	2017		2018		Average	
sample	RIS	WR	RIS	WR	RIS	WR
Sofiivskyi St.	12.2	15.6	10.2	12.7	11.2	14.2
Prometei	13.3	16.7	11.7	14.9	12.5	15.8
No. 2	7.3	–	11.7	15.8	9.5	15.8
No. 3	12.4	–	12.1	16.4	12.3	16.4
$LSD_{0.05}$	0.53	0.76	1.03	1.11	–	–

RIS – without removing the scape; WR – with removing the scape.

Correlation coefficient of studied garlic genotypes

Bulb yield was found to be significantly and positively correlated with plant height, number of leaves per plant, bulb weight, number of cloves per bulb. This indicated that these attributes were more influencing the bulb yield in garlic and therefore, were important for bringing improvement in bulb yield.

Correlation analysis revealed that *A. sativum* and *A. ampeloprasum* had different levels of correlation between yield and morphometric characteristics. So, *A. sativum* depends on a greater extent on the weight of the bulb (r = 0.77), and in turn it depends on the leaf width, plant height and number of leaves (Table 7).

A. ampeloprasum had a greater relation between yield and weight of the bulb (r = 0.90), and the weight of the bulb considerably depended on leaf width and their number and height of the plant (Table 8).

Obtained data can be used in perspective by breeders to select the initial forms of garlic classically and by clonal selection.

Table 7. Correlation coefficient of the studied characteristic in *Allium sativum* L. cultivars

Characters	1	2	3	4	5	6	7
1	1						
2	0.18	1					
3	0.29	-0.21	1				
4	0.43	0.05	0.40	1			
5	-0.15	-0.14	0.37	0.58	1		
6	0.42	-0.35	0.30	0.38	0.08	1	
7	-0.09	0.21	-0.39	-0.52	-0.43	-0.03	1
8	0.41	-0.39	0.41	0.03	-0.19	0.77	0.14

Table 8. Correlation coefficient of the studied characteristic in *Allium ampeloprasum* L. variety samples

Characters	1	2	3	4	5	6	7
1	1						
2	-0.42	1					
3	0.64	0.06	1				
4	0.45	0.27	0.53	1			
5	-0.07	0.48	0.26	0.52	1		
6	0.71	-0.12	0.68	0.52	0.11	1	
7	-0.33	-0.31	-0.49	-0.52	-0.32	-0.24	1
8	0.68	-0.40	0.56	0.23	-0.23	0.90	-0.08

1 – leaf width; 2 – leaf length; 3 – number of leaves; 4 – plant height; 5 – scape height; 6 – weight of bulb; 7 – No. of cloves; 8 – yield.

Nutritional value of studied garlic genotypes

According to the results of nutritional value (Table 9), Elephant garlic samples had the better indices than the garlic cultivars for the content of ash and carbohydrates and it influences the caloric content.

Table 9. Nutritional value of the studied garlic genotypes

Cultivar/sample	Ash	Proteins	Fat	Carbohydrates	Energy
	g per 100 g f.w.				(kcal per 100 g f.w.)
Sofiivskyi St.	1.19	6.3	0.20	20.9	110,60
Prometei	1.62	6.2	0.31	26.7	134,39
No. 2	1.82	6.1	0.12	31.7	152,28
No. 3	1.75	4.5	0.15	35.1	159,75
$LSD_{0.05}$	0.07	0.34	0.01	1.55	8.84

The content of ash in sample No. 2 is greater than in the garlic cultivars of Sofiivskyi and Prometei by 0.63 and 0.20 g per 100 g f.w., sample No. 3 by 0.56 and 0.13 g per 100 g f.w.

The content of protein in sample No. 2 is lower than Sofiivskyi and Prometei cultivars by 0.2 and 0.1 g per 100 g f.w., sample No. 3 had a lower protein content by 1.8 and 1.7 g per 100 g f.w.

The content of fat in the garlic cultivars of Sofiivskyi and Prometei was greater than in the sample No. 2 on 0.08 and 0.19 g per 100 g f.w., in sample No. 3 on 0.05
and 0.16 g per 100 g f.w.

The carbohydrates content of No. 2 and No. 3 is greater in Sofiivskyi cultivar by 51.7–67.9%, and by calorie content - 27.6–37.3%.

The caloric value of 100 grams of samples of Elephant garlic was higher than Sofievsky cultivar by 37.7 and 44.4%, and by 13.3 and 18.9% for Prometei cultivar.

The total content of sugar samples of *Allium ampeloprasum* was between cultivar Sofiivskyi at 31.2 and 43.5%, cultivar Prometei at 29.6 and 41.7 which explains its lesser taste (Table 10).

Table 10. Free sugars of the studied garlic genotypes (g per 100 g f.w.)

Cultivar/ sample	Free sugars (g per 100 g f.w)			
	Fructose	Glucose	Sucrose	Total Sugars
Sofiivskyi St.	0.15	0.11	2.11	2.37
Prometei	0.10	tr	2.30	2.40
No. 2	0.27	tr	2.84	3.11
No. 3	0.15	tr	3.25	3.40
$LSD_{0.05}$	*0.01*	–	*0.12*	*0.18*

tr – traces.

CONCLUSION

It has been established according to the researches that introduced forms of *Allium ampeloprasum* L. have high indicators of economic and valuable characteristics, but they are limited in the first years of cultivation, by the period of adaptation to the new soil and climatic conditions, which creates some difficulties in their cultivation and reproduction, so as in the first year of cultivation, the coefficient of reproduction with cloves may be zero, but, in general, these variety samples are more productive than cultivars of the winter garlic.

The positive effect of the removal of the scape on increasing the yield of both species was established, where the increase of the garlic cultivars yield was varied within the range of 24.5–27.9% depending on the cultivars, while the increment of the yield in variety samples of Elephant garlic reached to 35.0–35.5%.

The correlation analysis showed that the representatives of both closely related species have significant interdependence between yield, bulb weight, width and number of leaves, but they vary according to the strength of these bonds.

The analysis of nutritional value showed that *Allium ampeloprasum* variety samples had a higher content of ash and carbohydrates, which depended more on calorie content, while garlic cultivars had significantly higher protein content relative for No. 2 and higher fat content relatively to both *Allium ampeloprasum* variety samples.

Therefore, according to the performed analyzes, it can be concluded that *Allium ampeloprasum* L. samples have better chemical composition and higher nutritional value.

REFERENCES

Argüello, J.A., Ledesma, A., Núñez, S.B., Rodríguez, C.H. & Díaz Goldfarb, M.D.C. 2006. Vermicompost effects on bulbing dynamics, nonstructural carbohydrate content, yield, and quality of “Rosado Paraguayo” garlic bulbs. *HortScience* **41**, 589–592.

Astely, D., Innes, N.L. & Van der Meer, Q.P. 1982. Genetic Resources of *Allium* Species. *International Board for Plant Genetic Resources.* Rome Italy. URL: http://agris.fao.org/agris-search/search.do?recordID=XF2016057248

Ben Arfa, A., Najjaa, H., Yahia, B., Tlig, A. & Neffati, M. 2015. Antioxidant capacity and phenolic composition as a function of genetic diversity of wild Tunisian leek (*Allium ampeloprasum* L.). *Journal of new sciences, Agriculture and Biotechnology* **21**(2), 957–968, URL: http://www.jnsciences.org/agri-biotech/29-volume-21/100-antioxidant-capacity-and-phenolic-composition-as-a-function-of-genetic-diversity-of-wild-tunisian-leek-allium-ampeloprasum-l.html. doi: 10.15413/ajb.2015.0121

Bondarenko, H.L. & Yakovenko, K.I. 2001. *Methodology of experimental work in vegetable and melon.* Kharkiv. Osnova. 369 pp. (in Ukrainian).

Brewster, J.L. 1994. *Onions and other vegetable Alliums*. CAB International, Wallingford, United Kingdom, 236. doi: 10.1079/9781845933999.0000

Christopher, D. Preston, David A. Pearman, Allan R. Hall, 2013. *Archaeophytes in Britain Botanical Journal of the Linnean Society* **145**(3), 257–294. doi: 10.1111/j.1095-8339.2004.00284.x

Danin, A. 2004. Distribution *Atlas of Plantsinthe Flora Palaestinaarea*. 517 pp. The Israel Academy of Sciences and Humanities, Jerusalem.

Dimpoulos, P., Raus, T., Bergmeier, E., Constantinidis, T., Iatrou, G., Kokkini, S., Strid, A. & Tzanoudakis, D. 2013. *Vascular plants of Greece. An annotated checklist*: 372 pp. Botanic gardens and botanical museum Berlin-Dahlem, Berlin and Hellenic botanical society, Athens.

Figliuolo, G., Candido, V., Logozzo, G., Miccolis, V. & Spagnoletti Zeuli, P.L. 2001. Genetic evaluation of cultivated garlic germplasm (*Allium sativum* L. and *A. ampeloprasum* L.). *Euphytica* **121**, 325–334.

Flora of North America. Electronic resource, access mode: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242101330

Guarrera, P.M. & Savo, V. 2013. Perceived health properties of wild and cultivated food plants in local and popular traditions of Italy, A review. *J. Ethnopharmacol* **146**, 659–680. URL:https://www.researchgate.net/publication/235441085_Perceived_health_properties_of_wild_and_cultivated_food_plants_in_local_and_popular_traditions_of_Italy_A_review. doi: 10.1016/j.jep.2013.01.036

Guimarães, R., Barros, L., Dueñas, M., Calhelha, R.C., Carvalho, A.M., Santos-Buelga, C., Queiroz, M.J.R.P. & Ferreira, I.C.F.R. 2013. Nutrients, phytochemicals and bioactivity of wild Roman chamomile: A comparison between the herb and its preparations. *Food Chem*. **136**, 718–725.

Haciseferogullari, H., Özcan, M., Demir, F. & Çalisır, S. 2005. Some nutritional and technological properties of garlic (Allium sativum L.*). J. Food Eng*. **68**, 463–469.

Hanelt, P., Schulze-Motel, J., Fritsch, R. M., Kruse, J., Maass, H., Ohle, H. & Pistrick, K. 1992. The Genus *Allium*. *Taxonomic Problems and Genetic Resources*, 107–123.

Havey, M.J. 1991. Phylogenetic relationships among cultivated *Allium* species from restriction enzyme analysis of the chloroplast genome. *Theor Appl Genet* **81**, 752–757. doi: 10.1007/BF00224985

Horwitz, W. & Latimer, G. 2005. Association of Official Agricultural Chemists (AOAC). *Official Methods of Analysis of AOAC* International, 18th ed. MD: AOAC International: Gaithersburg, MD, USA.

Horwitz, W. & Latimer, G. 2016. Association of Official Agricultural Chemists (AOAC). *Official Methods of Analysis of AOAC* International, 20th ed.; MD: AOAC International: Gaithersburg, MD, USA

Ludilov, V.A. & Ivanova, M.I. 2009. *Infrequents and underperformances vegetable crops (biology, cultivation, seed production): production and practical edition*. M. FGNU «Rosinformagrortekh», 196 pp. (in Russian).

Malafaia, C.R.A., Silva, B.P., Tinoco, L.W. & Parente, J.P. 2015. Structural characterization and gastroprotective property of a novel glucofructan from *Allium ampeloprasum* var. *porrum*. Carbohydr Res **402**, 44–49.

Mc Collum, G.D. 1987. Onion and allies. In: N.W. Simmonds (Ed.), *Evolution of Crop Plants*, 186–190. Longman S. & T., England.

Mes, T.H.M., Friesen, N., Fritsch, R.M, Klaas, M. & Bachmann, K. 1997. Criteria for sampling in *Allium* based on chloroplast DNAPCR-RFLP's. *Syst Bot* **22**(4), 701–712. doi: 10.2307/2419436

Novak, A.V., 2017. Agrometeorological conditions of 2016–2017 agricultural year (according to Uman meteorological station). *Bulletin of the Uman National University of Horticulture*, No. **11**(2), 57–59. (in Ukrainian).

Novak, A.V. & Novak, V.G. 2018. Agrometeorological conditions of 2017-2018 agricultural year according to the data of the meteorological station Uman. *Bulletin of the Uman National University of Horticulture*, No. **12**(2), 73–75. (in Ukrainian).

Podolskykh, A.N. 2004. *Scientific basis of rice breeding* [Dr. Sci. Agr., Thesis]. Kzylorda, 274 pp. (in Russian).

Ron, L, 1992. *Growing Great Garlic*, 2nd Edition, Filaree Productions, pp. 7.

Skorina, V.V., Bergovina, I.G. & Skorina, Vit. V. 2014. *Winter garlic selection*. Gorki. BGSKHA. 123 pp. (in Russian).

Stace, C.A., 2010. New *Flora of the British Isles (3rd ed.).* Cambridge, UK.: Cambridge University Press. 903 pp.

Sulistiorini, D. & Van der Meer, Q.P. 1993. *Allium ampeloprasum* L. cv. group Leek. In: Siemonsma, J.S. and KasemPiluek (Editors). *Plant Resources of South-East Asia* Vegetables. Pudoc Scientific Publishers, Wageningen, Netherlands No. **8**, 62–64.

Triano, E.C., Ruiz Cabello, E., Fernández Luque, A., Gómez Miranda, A., Jiménez Conejo, A., Gutiérrez Campaña, J.A., Postigo, J.A., CastroMontes, J., Sánchez Najarro, J.F., Marín Osuna, J.R., Martos, M., Mérida Moral, M.D., Mérida Ramírez, M.J., Moral, R. & Hinijosa, R. 1998. *Recuperatus tradiciones. Etnobotánica del Subbético Cordobés*. Ayuntamiento de Carcabuey. Córdoba: Carcabuey (in Spanish).

Volkodav, V.V. 2016. *Method of state sorting of agricultural crops (potatoes, vegetables and melons)*. K. 94 pp. (in Ukrainian).