Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2019, 9(2), 212-216

ORIGINAL ARTICLE

Comparative estimation of productivity of local forms of Elephant garlic

O.I. Ulianych, V.V. Yatsenko, G.Ya. Slobodyanyk, L.V. Soroka, I.A. Didenko

Uman National University of Horticulture, Uman, Ukraine. E-mail: slavikskiavin16@gmail.com

Received: 18.05.2019. Accepted: 17.06.2019

The biological peculiarities and morphological features of introduced forms of the Elephant garlic (*Allium ampeloprasum* L.) in comparison with the cultivar of winter garlic (*Allium sativum* L.) Sofiivskyi were investigated. It was found that Elephant garlic variety samples are more responsive to changing conditions of cultivation than those of *Allium sativum* L. The winter resistance of the elephant garlic variety samples was within the limits of 98.0-100%. Elephant garlic plants do not form aerial bulbs, but on the bottom and under the covering scales the bulb is formed from 3-5 to 10 pcs of bulbs that is they reproduce by the baby bulbils propagation. The variety samples No. 2 and No. 3 have 7.1 and 5.1 relatively of large cloves in their structure. The weight of the bulb without removing the inflorescence shoot of the cultivar Sofiivskyi was smaller than the variety samples No. 2 and No. 3 relatively by 28.4-53.3 g. With the removal of the inflorescence shoot the difference increased by 60.5-68.6 g. The yield of Elephant garlic without removing the inflorescence shoot No. 2 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. With removing the 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}. As a result of researches it was established that introduced forms of Elephant garlic have high indicators of economic and valuable characteristics but they are limited in the first years of cultivation, during the period of adaptation to new soil and climatic conditions which creates some difficulties of their cultivation and reproduction.

Keywords: Elephant garlic; leaf; variety sample; bulb; aerial bulb; bulbil; 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 (Beljaev et al., 2017, 2018).

The varieties 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 Elephant garlic. We believe that the investigation of study biology and growing technology of cultivation for the introduction of Elephant garlic 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 (Kaska et al., 2013; Ludilov & Ivanova, 2009). Today they grow two different forms of species origin of rocambole: actually rokambole - varieties derived from *Allium scorodoprasum var. Babingtoni* (Dimpoulos et al., 2013; Stace, 2010) and the elephant garlic varieties derived from *Allium ampeloprasum var. ampeloprasum* (Lee et al., 2013; Flora of North America, 2019).

Since ancient times to the present the peoples of Africa and Asia use *Allium ampeloprasum* L. as an anti-helminthic, diuretic, anti-hypertensive agent (Garcia-Herrera et al., 2014) and for improving digestion (Bernaert et al., 2012). 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. (Arfa et al., 2015).

Elephant garlic includes not only garlic with the large bulbs but also cultivated forms of the leeks (Silvertand BCHJ et al., 1995). It creates the inflorescence shoot with a small amount of the fasle seeds or without them. The center of origin is North Africa and Southwest Asia (Mc Collum, 1987; Hay et al., 2018). 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 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 inflorescence shoot to changing the yield.

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 total area: for the experiment - 400 m², for plot - 100 m²; for accounting - 10 m². The plots were arranged in a systematic order with a fourfold repetition. The predecessor - early vegetables. Planting was carried out by the scheme of 45 × 6 cm (*Allium sativum* L.) and 45 × 10 cm (*Allium ampeloprasum* L.) at the end of the first decade of October. The location of the plots is systemic. During the investigation they determined 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). The height and diameter of the inflorescence shoot and the pseudostem - before harvesting using the trammel. The number of leaves 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:

$Sn=0.67 \times ab$

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 winter resistance is counted after spring regrowth. The material of the research was one breeding varieties of the species *Allium sativum* L.: Sofiivskyi (St.), and two introduced forms of *Allium ampeloprasum* L. Also they studied the effect of removing the inflorescence shoot to yielding.

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. 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 and Novak, 2018).

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 wintering plants of Elephant garlic in the experiment is within the range of 98.0-100%, which indicates their high winter resistance, and plants *Allium sativum* L. - 100%. The lower level of winter resistance of variety sample No. 2 is 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.

The biometric measurements for 60th DAP showed that the first group includes: the standard-cultivar Sofiivskyi with a leaf width of 2.3 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 1). The length of the leaf of the experimental variety samples of Elephant garlic was slightly less than the varieties 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/plant, 60th DAP the number of leaves of No. 2 and No. 3 increased to 7.7 and 8.9 pcs/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/plant which is more than the standard by 1.1 pcs/plant. No. 3 was higher by this indicator than the cultivar-standard Sofiivskyi by 2.2 pcs/ plant.

Table 1. Morphometric indices of Elephant garlic plants in the conditions of the Right-Bank Forest-Steppe of Ukraine during the vegetation on the 30th, 60th 90th days after planting (average for 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. (*A. sativum)*	1.5	2.3	2.5	24.3	41.9	42.8	4.5	7.4	6.5
No 2 (*A. ampeloprasum)*	2.5	4.5	3.5	14.4	33.4	37.2	5.7	8.7	7.1
No 3 (*A. ampeloprasum)*	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*

The area of the leafy blade of the variety samples No. 2 and No. 3 in the initial stages of growth (30th DAP) was less than the

standard by 7.8 and 3.3 cm², on the 60th DAP of Elephant garlic 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 (Table 2). So, it is possible to assume that these variety samples are more soon-ripe than the usual garlic.

Table 2. Area of the leave of Elephant garlic plants in the conditions of the Right-Bank Forest-Steppe of Ukraine during the vegetation on the 30th, 60th 90th days after planting (average for 2017-2018).

Cultivar/sample	Area of the leave, cm²			Area of the leaves per plant, cm²		
	Days after planting (DAP)					
	30	60	90	30	60	90
Sofiivskyi St. (*A. sativum)*	23.2	64.9	77.4	60.0	290.0	300.0
No 2 (*A. ampeloprasum)*	25.2	72.5	89.8	110.0	380.0	390.0
No 3 (*A. ampeloprasum)*	15.4	85.3	87.1	60.0	450.0	420.0
LSD (0.05)	*0.99*	*5.51*	*5.23*	*0.06*	*0.29*	*0.22*

The biometric measurements have been shown it is evident that the introduced forms of Elephant garlic 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 (Table 2). The variety samples No. 2 and No. 3 had the inflorescence shoot higher than the standard by 11.6-17.3 cm. By the diameter of the pseudostem, both variety samples of the species Elephant garlic the cultivars of winter garlic Sofiivskyi dominated significantly. Thus, variety samples No. 2 and No. 3 had a diameter of the false stem 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 inflorescence shoot, but the variety sample No. 2 had a slightly higher figure than No. 3. The diameter of the inflorescence shoot of the variety samples No. 2 and 3 was bigger by 4.0-3.9 mm, accordingly.

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

According to the number of bulbils per stem or capsule the varieties of winter garlic are very much dominated the variety samples Elephant garlic whereas the weight of little bulbils 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% (Table 3).

Table 3. Biometric indices of Elephant garlic L. plants in the conditions of the Right-Bank Forest-Steppe of Ukraine during the vegetation on the 30th, 60th 90th days after planting (average for 2017-2018).

Cultivar/sample	Plant height, cm	Inflorescence shoot height, cm	Pseudostem diameter, mm	Inflorescence shoot diameter, mm	No. of bulbils (bulb-tubers) per stem or capsule, pcs.	Inflorescence mass, g	Weight 1000 pcs.,bulbils	Total number of cloves, pcs.	Number of dry scales on bulb, pcs.
	Before harvesting								
Sofiivskyi St. (*A. sativum)*	67.1	105.9	8.6	4.9	166.8	6.8	40.7	9.6	4.1
No 2 (*A. ampeloprasum)*	58.7	117.5	13.0	8.9	5.1	4.2	711.5	7.1	5.1
No 3 (*A. ampeloprasum)*	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*

The variety samples No. 2 and No. 3 have a mass of 1000 pcs of bulbils. Of the bulb-tubers which is higher than the standard by 670.8 g whereas the difference between these variety samples 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. 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.

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. Elephant garlic variety samples have almost the identical numbers of common covering scales and insignificantly dominate the cultivar-standard 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 Elephant garlic 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 bulb-tubers of variety samples Nos. 2 and 3 are apparently similar to nut, but the variety sample No. 2 has the bulb-tubers aligned in size, while the bulb-tubers of the variety sample No. 3 differ significantly, the diameter of which may be from 4.0 to 20.0 mm (Figure 1).

Figure 1. Variety samples *Allium ampeloprasum* L.

The bulbils' covering scales 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. The average weight of bulb for two years without removing the inflorescence shoot of the cultivar Sofiivskyi was 35.8 g, which was less than 28.4-53.3 g for the experimental variety samples No. 2 and No. 3 (Table 4). With the removal of the inflorescence shoot the difference increased to 60.5-68.6 g.

Table 4. Weight of bulb (g) of Elephant garlic L. introduced forms in the conditions of the Right-Bank Forest-Steppe of Ukraine.

Cultivar/sample	2017		2018		Average	
	RIS	WR	RIS	WR	RIS	WR
Sofiivskyi St. (*A. sativum)*	43.0	48.2	28.5	36.5	35.8	42.4
Prometei (*A. sativum)*	44.8	54.9	32.7	40.2	38.8	47.6
No. 2 (*A. ampeloprasum)*	49.1	-	79.2	103.0	64.2	103.0
No. 3 (*A. ampeloprasum)*	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 inflorescence shoot; WR - with removing the inflorescence shoot.

The yield varied considerably over the years due to the fact that in the first year of cultivating of Elephant garlic variety samples formed only one-clove bulbs, this phenomenon can be explained by «depression of plants», which manifests itself as a result of changes in the climatic conditions of cultivation. So, on average for two years without removing the inflorescence shoot, the yield of varietie sample No. 2 was lower than the standard by 1.7 t ha^{-1}; at the same time, the variety sample No. 3 exceeded the standard by 1.1 t ha^{-1} (Table 5). With removing the inflorescence shoot, the yield of all variants increased. So, the variety samples No. 2 and No. 3 exceeded the cultivar Sofiivskyi by 1.6 and 2.2 t ha^{-1}.

Table 5. Yield (t ha^{-1}) of Elephant garlic introduced forms in the conditions of the Right-Bank Forest-Steppe of Ukraine.

Cultivar/sample	2017		2018		Average	
	RIS	WR	RIS	WR	RIS	WR
Sofiivskyi St. (*A. sativum)*	12.2	15.6	10.2	12.7	11.2	14.2
Prometei (*A. sativum)*	13.3	16.7	11.7	14.9	12.5	15.8
No. 2 (*A. ampeloprasum)*	7.3	-	11.7	15.8	9.5	15.8
No. 3 (*A. ampeloprasum)*	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 inflorescence shoot; WR - with removing the inflorescence shoot.

Conclusion

We registered that introduced forms of Elephant garlic have high economic value, 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 these variety samples are more productive than varieties of the winter garlic.

References

Astely, D., Innes, N. L., Van der Meer, Q. P. (1982). Genetic Resources of Allium Species. International Board for Plant Genetic Resources. Rome Italy.

Beljaev, V., Vol'nov, V., Sokolova, L., Kuznecov, V., & Matsyura, A. (2017). Effect of sowing techniques on the agroecological parameters of cereal crops. Ukrainian Journal of Ecology, 7(2), 130-136. doi:http://dx.doi.org/10.15421/2017_30

Belyaev, V., Meinel, T., Grunevald, K., Sokolova, L., Kuznetsov, V., & Matsyura, A. (2018). Influence of spring soft wheat, peas and rape cultivation technology on soil water regime and crop yield. Ukrainian Journal of Ecology, 8(1), 873-879. doi:http://dx.doi.org/10.15421/2018_287

Ben, A. 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, doi: 10.15413/ajb.2015.0121

Bernaert, N., De Paepe, D., Bouten, C., De Clercq, H., Stewart, D., Van Bockstaele, E., De Loose, M., & Van Droogenboreck, B. (2012). Antioxidant capacity, total phenolic and ascorbate content as a function of the genetic diversity of leek (*Allium ampeloprasum* var. porrum). Food Chem, 134, 669-677

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

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

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

Flora of North America. Available from: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242101330

Garcia-Herrera, P., Morales, P., Fernandez-Ruiz, V., Sanchez-Mata, M. C., Camara, M., Carvalho, A. M., Ferreira, I. C. F. R., Pardo-de-Santayana, M., Molina, M., & Tardio, J. (2014). Nutrients, phytochemicals and antioxidant activity in wild populations of Allium ampeloprasum L., a valuable underutilized vegetable. Food Res Int, 62, 272-279.

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.

Hay, F., Vaghefi, N., Strickland, D., Hadad, R., & Pethybridge, S. (2018). First report of Colletotrichum fioriniae causing anthracnose of elephant garlic (*Allium ampeloprasum* var. ampeloprasum) in New York, USA. New Disease Reports, 38, 1. http://dx.doi.org/10.5197/j.2044-0588.2018.038.001

Kaska, A., Toprak, F. C., & Alan, A. R. (2013). Gynogenesis induction in leek (*Allium ampeloprasum* L.) breeding materials. Current Opinion in Biotechnology, 24, 28-47.

Lee, J. S., Kim, I. J., Youn, C. K., Ahn, K. S., Kim, K. H., & Nam, S. Y. (2013). Effect of sowing date on growth and yield of elephant garlic (Allium ampeloprasum var. ampeloprasum) in the middle region Korea. Kor J Hort Sci Technol, 31(2), 51 (in Korean).

Ludilov, V. A., & Ivanova, M. I. (2009). Infrequents and underperformances vegetable crops (biology, cultivation, seed production): production and practical edition. Moscow. FGNU "Rosinformagrortekh" (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. Pp. 186-190. In: Simmonds, N. W. (Ed.), Evolution of Crop Plants. 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, 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, 2, 73-75 (in Ukrainian).

Silvertand, B. C. H. J., Jacobsen, E., & Van Harten, A. M. (1995). Genetic variation and control of plant regeneration in leek (*Allium ampeloprasum* L.). Plant Breed, 114, 333-336.

Stace, C. A. (2010). New Flora of the British Isles (Third ed.). Cambridge University Press, Cambridge, UK.

Volkodav, V. V. (2016). Method of state sorting of agricultural crops (potatoes, vegetables and melons). Kiev (in Ukrainian).

Citation: Ulianych, O.I., Yatsenko, V.V., Slobodyanyk, G.Ya., Soroka, L.V., Didenko, I.A. (2019). Comparative estimation of productivity of local forms of Elephant garlic. Ukrainian Journal of Ecology, 9(2), 212-216.