Ecology and Evolutionary Biology
2020; 5(2): 29-34
http://www.sciencepublishinggroup.com/j/eeb
doi: 10.11648/j.eeb.20200502.13
ISSN: 2575-3789 (Print); ISSN: 2575-3762 (Online)

Perspectives Culture of the *Lophanthus anisatus Benth.* and Peculiarities of Its Ontogenesis in the Conditions of the Lowland Zone of Transcarpathian

Kormosh Svitlana[1, *], Vashchenko Vladimir[2], Mytenko Inna[3, *]

[1]Laboratory of Vegetable and Aromatic Crops, Transcarpathian State Agricultural Experimental Station, Velyka Bakta, Ukraine

[2]Department of Breeding and Seed Production, Dnieper State Agrarian and Economic University, Dnieper, Ukraine

[3]Laboratory of Genetic Resources, Institute of Vegetable and Melon Growing, Merefa, Ukraine

Email address:

korsveta1967@gmail.com (K. Svitlana), selekt_ddaeu@ukr.net (V. Vladimir), mytenko.iob@gmail.com (M. Inna)

[*]Corresponding author

To cite this article:

Kormosh Svitlana, Vashchenko Vladimir, Mytenko Inna. Perspectives Culture of the *Lophanthus anisatus Benth.* and Peculiarities of Its Ontogenesis in the Conditions of the Lowland Zone of Transcarpathian. *Ecology and Evolutionary Biology*. Vol. 5, No. 2, 2020, pp. 29-34. doi: 10.11648/j.eeb.20200502.13

Received: May 22, 2020; **Accepted**: June 15, 2020; **Published**: August 5, 2020

Abstract: The lowland zone of Transcarpathia has a number of advantages and potential opportunities (natural and climatic conditions, economic and organizational prospects) for growing *Lophanthus anisatus Benth*. However, this culture is not widespread in Ukraine. The following issues remain unresolved during its cultivation - enrichment of species and varietal composition, study of morphological and biological features of plant development and adaptive potential of the species and obtaining high yields of good quality, regardless of the extreme climatic conditions observed recently. The article highlights the results of scientific research on the ontogenesis of *Lophanthus anisatus Benth*., reveals its economic significance and the possibility of expanding the scope and creation of a market for plant raw materials (spicy greens, medicinal raw materials) in this region. Based on the scientific literature and the results of their own research, the authors proposed a more detailed classification of the species of the genus *Agastache L*., which includes the species *Lophanthus anisatus Benth.* A deep study of the collected samples of home selection of the species helped to identify the features of the life cycle in the lowlands of the Transcarpathian region. The article presents the results of the study of the influence of the hydrothermal regime on the formation of anise hyssop and ecological plasticity of the samples of the source material. We have identified the main stages and periods of plant development and conditions that affect the formation of vegetative and generative organs of plants, which helped to identify the most adaptive samples for further selection of this valuable aromatic plant. We have created a competitive variety Pochatok with high: adaptive properties, quality of raw materials and a significant amount of essential oil for specific agro-climatic conditions. The issues covered in the article are important, valuable and relevant not only for this region in particular, but also for Ukraine as a whole. The results of the scientific research with anise hyssop show that the agro-climatic conditions of the lowland zone of Transcarpathia are favorable, and the cultivation of this non-traditional aromatic plant is economically profitable. In these conditions it passes through all the stages of its development and forms a huge green mass, the yield of which makes up 14,5 t/ha (output of the dry matter– 4,4 t/ha, essential oil – 1.27% of the a. d. m. (absolutely dry mass). The level of profitability from growing and use of *Lophanthus anisatus Benth*. makes up – 61,7%, the economic effect (additional profit) is 15732 UAH.

Keywords: *Lophanthus.*, Agricultural Significance, Samples, Selection, Productivity, Growth, Variety

1. Introduction

Aromatic plants and honey plants are relevant in the business and consumption chain. The group of aromatic plants includes more than 2000 species that can be used as medicinal, edible, honey, plants, spices and also are good sources of vitamins. However, in Ukraine these plants are not widespread, only 12-18 species are used in industrial production, while in Western Europe, they are widespread - 30-35 species are used in similar climatic conditions [1, 2].

Domestic crops meet only 40% of all needs of plant raw materials. It is economically unprofitable to import these products from abroad, so the necessity arises to provide the processing industry with the necessary plant raw materials by expanding the range of valuable species and introducing promising rare plants into the culture, as well as the deep study of the plants' development and growth, and cultivation in specific agroclimatic microzones. [3-5].

Due to its rich chemical composition (vitamins, mineral salts, essential oils, glycosides, flavonoids, bitter substances and other useful compounds) and useful (antiseptic and bactericidal) properties, they are a source of vegetable raw materials for canned food, confectionery, vodka, paints and varnishes, as well as the cosmetic and pharmaceutical industries, are excellent honey plants and are used in ornamental horticulture. The creation of decorative flower beds with this spices is becoming widespread. One of the promising uses of aromatic plants, which is gaining popularity in the region, is the creation of herbal drinks for general consumption. These species of aromatic plants are especially valuable for small areas, such as Transcarpathia, because they are not demanding with regard to the growing conditions and can grow on lands unsuitable for other major agricultural crops. Transcarpathia is a special region, which combines a number of specific factors, namely: it is scarce, the vast majority of soils are heavy and low humus, but the climatic conditions of the region are extremely favorable for growing aromatic plants. Given the prospects for use and economic efficiency in cultivation in the region, special attention should be paid to*: Levisticum officinalis C. Koch, Ocimum basilicum L., Lophanthus anisatus Benth. and Leonurus guinguelobatus Gilib*., which can take a worthy place in the production of products with an original taste for the food industry and serve as raw materials for other industries. Among these valuable plants anise hyssop is a little studied species in Ukraine, in general, and in Transcarpathian as well, which has great opportunities for zoning against the background of positive factors in the development of the region. The interest in *Lophanthus anisatus Benth* is growing.

Every year, the soecies becomes more popular in the household agriculture. Note that this region is a creative area, where a wide network of health facilities, factories of canned fruits and vegetables with spices, baby food with flavorings is being operated and developed, so it is rather promising to grow rare aromatic plants, like *Lophanthus anisatus Benth.*

Lophanthus anisatus Benth. is a herbaceous perennial of the Lamiaceae family, a valuable medicinal, edible and technical crop. The plant is drought-resistant, does not like waterlogging, but needs a sufficient amount of water during the first year of cultivation. Anise hyssop is cost-effective and highly profitable for growing in the lowlands of the Transcarpathian region.

In many world cuisines *L. anisatus Benth*. – is an irreplaceable herb. Fresh and dried young shoots are used for baked products, as a component of spicy compositions and condiments for various dishes, as a flavoring for vodka, added to compotes, jelly, mousses, and puddings. The spice is added to stewed, baked dishes and fried fish, meat and salads. Healing drinks are prepared from hyssop. In terms of medicinal properties (contains macro- and microelements that are vital for the human body) it is not inferior to ginseng, is a powerful immunomodulator, increases the overall tone of the human body. It is especially useful for the elderly (slows down cell aging). Other useful properties inherent to this plant are its honey productivity and decorative properties. The essential oil is used in the production of soaps and perfumes. The waste obtained after processing is successfully used to feed animals [3, 6].

Despite all its value and usefulness, this species is rarely used in Ukraine. The reason for this is the lack of diversity of species and varietal composition (four varieties of the same species have been registered in Ukraine: Syniy Veleten' and Leleka (1999), Memory of Kapelev and Pochatok (2002). Different types of anise hyssop are being used abroad, even the very decorative *Lophanthus berbery*, *the Mexican*, the wrinkled variety, etc.) [7]. There is a lack of scientifically based information on the impact of environmental factors on plant development, the formation of green mass and seed productivity.

The recent global changes in climatic conditions, namely a significant increase in the amplitude of fluctuations of the daytime and night temperatures, a decrease in precipitation and its disproportionate distribution over the months lead to a loss of quantity and quality of vegetable raw materials. And this necessitates the search for new ways to create genotypes, which are characterized by minimal response to abrupt changes in climatic conditions. Today the breeders are faced with the new tasks of creating adaptive varieties and hybrids with a high degree of genetic protection of the crop from changing environmental factors. Therefore, a number of scientists [8–10] consider it important to study the impact of hydrothermal regime on the growth and development of plants of major cereals, legumes and vegetables. They identified the main critical periods of development, during which the plants are sensitive to changes in rainfall and fluctuations in average daily temperatures, studied the impact of these factors on the formation of yields of major crops. Other scientists [11] are looking for contrasting forms with high parameters of abiotic adaptability, which can solve the problem of providing forms with a high frequency of variability of parameters of productivity traits at different stages of selection of these plants.

According to the analysis of printed and online publications, it was discovered that the above problems have not been studied in relation to aromatic plants. Therefore, we have a task to study the reasons influencing the formation of plants and the productivity of valuable raw materials of *Lophanthus anisatus Benth* more carefully.

Transcarpathian State Agricultural Experimental Station has been introducing less common aromatic crops since 1989. The study of aromatic plants in the lowlands of Transcarpathia opens up new areas of their use and opportunities to enrich the diversity of the local flora. However, it should be noted that the introduction of new plant species is limited to their poor assortment, and the manufacturer needs highly profitable

varieties. Therefore, our institution conducts scientific work to study the peculiarities of growth and development of plants, selection work to create varieties and hybrids of rare promising species, including anise hyssop, adapted to specific conditions of the agro-climatic zone.

Taking into consideration the aforementioned, the purpose of scientific research *on Lophanthus anisatus Benth.* was to analyze the status and the possibilities of using a promising variety in Transcarpathia, to propose a scientific hypothesis on the extended classification of the species of Agastache L genus, to identify the main stages of the ontogenesis and life cycle periods of *Lophanthus anisatus Benth*. plants.

2. Materials and Methods of Research

For a long time (2013–2018) samples of different ecological and geographical origin (Crimea, Central and Western Ukraine, Moldova) had been studied in the collection. All the samples were of the same of *Lophanthus anisatus Benth*. The results were equated to the local variety Pochatok (2002), which was the standard.

The study was conducted for six years, on he soddy podzolic soils, characterized by a low humus content of 1.9%, pH level of 5.5, easily hydrolyzed nitrogen - 13.4 mg per 100 g of soil, phosphorus - 19.1 mg per 100 g of soil, exchangeable potassium - 12.3 mg per 100 g of soil. Peculiarities of passing the periods of phenological phases were studied according to the methodical instructions of I. M. Beideman [12] and T. A. Rabotnov [13]. Field and laboratory studies, description of plants were carried out according to the guidelines of the leading scientific institutions of Ukraine [14-18].

Anise hyssop is a heat-loving plant and for a normal development it requires a sum of active temperatures in the range from 3200 to 3600°C. According to these indicators, the Transcarpathian region, in a six-year period, was characterized by high heat supply. The amount of active temperatures above 5°C ranged from 3415°C (2018) to 3783°C, the amount of active temperatures above 10°C – from 3285.6°C (2013) to 3598.0°C, which was sufficient for the full development of the plants.

L. anisatus Benth. is a drought-resistant plant, but there are periods when it is extremely sensitive to moisture and these are the periods of seed germination, planting of the seedlings and the formation of vegetative and generative organs.

Having analyzed the humidification regime during the six years, it was found that, in 2013, the amount of precipitation was 442.3 mm per year and this figure is lower than the average long-term data (618.0 mm) by 175.7 mm. During the period of 2014 and 2015, the amount of precipitation decreased by 1.9–2.1 and 1.7–1.9 times and amounted to 324.6 mm and 358.3 mm, which is 293.4 mm and 259.7 mm less compared to the long-term averages. During the period of 2016–2017, 2.3–2.8 and 2.1–2.5 times less precipitation was observed and it amounted to 402.1 mm and 295.9 mm, which is 215.9 and 322.1 mm less than the long-term average. And only in 2018, this difference was the smallest and reached only 73 mm.

The difference in precipitation can be seen between the months as well. During the growing of plants (March-April) there was a much lower amount of precipitation compared to the average long-term indicators, but during this period the plants were able to use moisture reserves accumulated during the winter-spring period, which has a significant impact on plant regrowth. However, during the period of flowering and seed formation (June-August) there was a fairly significant lack of precipitation, which had an impact on the formation of generative organs and seed formation.

3. Results of Research and Their Discussion

The *Lophanthus anisatus Benth*. variety appeared in nature relatively recently. It was introduced into the culture in the south of the United States and in Canada, as well as in the countries of southern Europe as a honey plant, a source of essential oil, a medicinal and ornamental plant. In Ukraine it is grown in small areas – up to 100 hectares, in Moldova and in the Crimea – on areas up to 1000 hectares.

Despite the value and usefulness, anise hyssop is a non-traditional species in Ukraine in the absence of diversity of species and varietal composition (1 species and 4 varieties), and it has a greater variety abroad (5 species). We have generalized the botanical classification of the genus of *Agastache L.*, species *Lophanthus anisatus Benth.* (Table 1). Four varieties of *Lophanthus anisatus Benth* have been registered in Ukraine: Syniy Veleten' and Leleka (1999), Memory of Kapelev and Pochatok (2002). However, there are promising forms of essential oil varieties – with white, pink, and blue flowers. It is more common abroad and five species are grown: barberry, Mexican, wrinkled, fennel and anise hyssop, the first two of which have very decorative inflorescences.

Lophanthus anisatus Benth. is a perennial herbaceous plant of the Lamiaceae Lindl. family. The root is fibrous, well developed. Shoots are numerous, quadrangular, strongly branched and each branch ends with a dense inflorescence - a raceme (cluster), 7-12 cm long.

Table 1. *Generalized classification of the genus Agastache L.*

Category	Name	Description
Kingdom	*Plantae*	Terrestrial organs have chlorophyll in chloroplasts
Section	*Anthophyta*	Vascular plants with seeds and flowers, double fertilization
Class	*Magnoliopsida*	Germ with two cotyledons, reticulate veining leaves, the second growth is due to the cambium.
Order	*Lamiadale*	Reduction of the calyx, stamens to one circle, the number of carpels to two and seed germs to one in each nest.
Family	*Lamiaceae* L	Perennials, inflorescences - racemes. Fruit nut, 4 in one nest
Genus	*Agastache* L.	Leaf lobes: large, widely spaced, inverted ovate, coarsely toothed (pointed)

Category	Name	Description
Types		Perennial forms. Long-petiolate, cordate-lanceolate, toothed leaves. The flowers are bilobed.
Agastache scrofularifolia	*Agastache rugosa* L.	*Agastache ɐerberi L.* *Agastache ʍexicana L.* *Agastache foeniculum L.* *Lophanthus anisatus Benth.*

The leaves are opposite, on long petioles, serrated, heart-lanceolate, 7–10 cm long and 5–7 cm wide, blue, blue-violet, magenta, pink, and white. Seeds are small, brown. The fruit is a smooth, oblong-oval nut. The weight of 1000 seeds is 0.5–1.2 g. The plants are up to 180 cm tall, the diameter of the plant is 100–110 cm.

Observations of the phenological phases of plant growth and development, in the collection, allowed to determine their nature. Under favorable meteorological conditions, the plants of anise hyssop began to grow in the 2nd-3rd decade of March, and in the 1st decade of April in case of unfavorable conditions.

The seeds germinated at a temperature of 15–20°C and germination appeared after 14–16 days (at the optimum temperature of 20–25°C during 7 days), the formation of roots and the first pair of real natural leaves required a temperature of 15–18°C (under these conditions, the formation of roots on the plant was intense, but the consumption of substances for respiration was slow and the plants adapted well to self-feeding). In the phase of accumulation of spare substances, lowering the temperature by 1–3°C accelerated the growth of generative organs and increased productivity.

The plants on the 25th–28th day of growth formed one stem during the first year, and 4 to 5–10 stems during the following years. On the 45th to 50th day, the generative organs developed on the plant, and tassels began to form. Flowering of plants began on the 75th–78th day and lasted up to 35–55 days.

The flowering period of the plants was prolonged due to the simultaneous flowering on the central and lateral shoots and was characterized by the completion of the formation of first and second order branches. In the flowering phase, the plant reached a height of 75–120 cm. The plant formed seeds weighing from 14.3 g to 30.6 g, depending on growing conditions, and the weight of 1000 seeds was from 0.8 g to 1.2g.

The formation of complete plant raw material of anise hyssop lasted 65–75 days. During the whole period of growth first and second order shoots were formed on the plant, which ended in a raceme-like inflorescence. The growing processes of plants were completed in the phase of the beginning of seed formation. Under unfavorable weather conditions, these processes lengthened or shortened. After pollination, the process of seed formation lasted 30–45 days, after which the formed and ripened seed acquired a characteristic dark brown color. In the anise hyssop plant the period from germination to seed maturation lasted 138–145 days.

It is important to select plant samples of anise hyssop after a short growing season, as they are characterized by rapid growth, increased photosynthetic activity, short period and the ability to form plant raw materials at higher temperatures, rapid accumulation of large amounts of biochemicals.

The results of phenological observations in the collection indicate that the duration of the growing season in the plants is shorter during the first year of cultivation (119–130 days) than in subsequent years (132–159 days). The regrowth of the anise hyssop plants depended on the average daily temperatures during the spring period.

At higher temperatures, the plants began to vegetate in the 3rd decade of March, in the cooler period, the regrowth phase of plants occurred in the 1–2nd decade of April. Note that the decrease in temperature and insufficient rainfall led to a reduction in both interphase periods and the vegetation period as a whole.

Elevated average daily temperatures and more precipitation during the period of green mass formation prolonged the period of plant development. The reduction of the period of green mass formation (from regrowth to the phase of mass flowering) contributed to the increase in the yield of marketable raw materials (the possibility of two mowings) of anise hyssop, which increased the economic attractiveness of this culture. According to this indicator, the following varieties were singled out LAM-1, Leleka and Syniy Veleten' (83–82 days from mass germination to mass flowering, with a standard of 85 days), which were characterized by increased yields (15.9 t/ha, 15.3 t/ha and 15.5 t/ha, respectively) (Table 2).

According to the results obtained, the variability of the duration of the life cycle of L. anisatus Benth. plants is conditioned by the fluctuations in temperature and humidity.

Table 2. *Characteristics of collection samples of anise hyssop according to the growing season and yield of green mass (phytomass) (average during 2013-2018).*

Name of the sample	The duration of the period from mass germination to phases, days			Yield of green mass, t/ha
	flowering	seeds ripening (production)	deviation from the standard ±	
CRBS	90	142	+2	13,7
LAM-1	83	141	+1	15,9
Pochatok (St)	85	140	–	14,5
LAM-2	87	142	+2	14,4
LA (Moldova)	85	141	+1	15,1
Leleka	82	132	-8	15,3
Syniy Veleten'	82	134	-6	15,5
HIP_{05}		1,4		0,6

Insufficient rainfall in the early stages of the growth and development of the plants contributes to the prolongation of their duration, and elevated summer temperatures and lack of moisture reduce the duration of the period of formation of the generative organs of the cornflowers. Since anise hyssop is a multi-cut crop, when cutting the plants during flowering

(spicy greens), it is possible to obtain two full-fledged slopes, which make up the yield of this crop. Therefore, it is important in breeding work to create precocious varieties that are characterized by a short duration of the period before the flowering phase of plants.

An important aspect of the scientific work with aromatic plants, including anise hyssop, is the creation of competitive varieties. The results of long-term research were used to create the variety Pochatok (Figure 1) on the basis of individual family selection, which is characterized by a height of 150–180 cm.

Figure 1. *Variety Pochatok.*

The root is fibrous. The bush has many stems that are strongly branched. The leaves are petiolate, cordate-lanceolate, opposite, sparsely toothed, 8–12 cm long and 4.5–6.0 cm wide. The leaf surface is dark green, the lower part of the leaf is light green and slightly lowered. The flowers are bisexual, blue or blue-violet color, which are collected in a 9–14 cm long bouquet cluster, the size of which is 2 to 8 cm on the side branches.

On the main inflorescence there is up to 360–430 flowers. The fruit is a smooth, dark brown nut. The weight of 1000 seeds is 0.7–1.2 g. The yield of above ground mass, from the third year of cultivation is 14.5 t/ha, and 0.28–0.30 t/ha in case of seeds. The plant is not demanding to soils, responds well to fertilizers. It can grow for up to 10 years in one place, maintaining high productivity. The raw material consists of all the green mass (inflorescences and leaves make up 50–70%, and stems – 45-30%). The weight fraction of essential oil is 0.9–1.5%.

According to the results of the research, the highest yield of green mass of anise hyssop variety Pochatok in the lowlands of Transcarpathia was collected on the plantation from the 3rd year of cultivation. Calculations made on the basis of technological maps show that the costs of planting, plant care and harvesting of raw materials made up 43,500 UAH/ha in the standard CRBS and 45,720 UAH/ha in the case of the variety Pochatok (Table 3).

Table 3. *Average yield, production costs, and profitability from production of plant raw materials of anise hyssop varieties (for two years*).*

Indicators	Unit	CRBS (St)	Pochatok
Yield of green mass during flowering	t/ha	12,2	14,5
Yield of dry products	t/ha	3,3	4,4
Sales price of dry products*	UAH/kg	17	17
Production costs	UAH/ha	43500	45720
Production cost of dry products	UAH/kg	13,2	10,0
Costs from sales of dry products (revenue)	UAH/ha	55998	73950
Profit from the sale of dry products	UAH/ha	12498	28230
The level of profitability	%	28,7	61,7
Economic effect (additional profit)	UAH/ha	x	15732

*The calculation was based on prices for 2015

Analysis of the data shows that the profit from the cultivation of the CRBS, which was taken as a standard, was 12498 UAH/ha, in the new variety Pochatok (Bakta) – 28230 UAH/ha, the level of profitability was 28.7%, and 61.7%, respectively. The production test on the experimental farm of the scientific institution (area – 1.5 ha, profit 13200 UAH/ha) and the individual sector (individual sector – area 2.5 ha, level of profitability – 72.3%) confirms the high profitability of the growing of anise hyssop variety Pochatok in the region.

4. Conclusions

Therefore, when studying the species of *Lophanthus anisatus Benth.* it was established that it is promising for growing in the lowlands of Transcarpathia. Prospects are conditioned by: 1) a wide range of uses in the food and pharmaceutical industries, perfumes and cosmetics, paints and varnishes and others; 2) unpretentiousness to growing conditions and the ability to grow on soils unsuitable for growing basic vegetables and green crops; 3) filling a new niche in the market of the region.

As a result of a long-term study of the diversity of a plant valuable in its properties, we have generalized the classification of the genus *Agastache L.* and established the duration of the phases of plant development, which may affect the formation of valuable traits. The source material for selection of varieties was isolated. The results of a long-term study of the diversity of the culture and its biology were embodied in the creation of a precocious, highly productive variety Pochatok, which is also resistant to major diseases and pests.

References

[1] T. M. Cherevchenko, D. B. Rakhmetov, M. B. Gaponenko. Conservation and enrichment of plant resources through introduction, selection and biotechnology: a monograph. K.: Phytocenter, 2012. p. 9–10.

[2] L. M. Derzhypilsky. Medicinal plant growing and berry growing. Kosiv: Pysanyi kamin, 2006. p. 17–19.

[3] O. A. Korablyova. Useful plants in Ukraine: from introduction to use: monograph. K.: Phytosociocenter, 2012. p. 9–10.

[4] L. A. Kotyuk. Introduction of aromatic plants of the family Lamiaceae Lindl. In the Central Polissya of Ukraine. Zhytomyr: ZhNAEU, 2018.211 p.

[5] O. A. Melnychuk, L. A. Kubinska. Introduction of non-traditional spicy aromatic plants in the Kremenets botanical garden "Perspective directions of scientific researches of medicinal and essential oil cultures", pp. 59-63, March 25, 2020 (Materials of the IV All-Ukrainian scientific and practical conference of young scientists, Ukrainian, 2020).

[6] L. G. Nazarenko. Etheronos of the south of Ukraine. Simferopol: Tavriya, 2008. 144 p.

[7] A. Sukharev (2007). Unique hyssop. Journal of Ogorodnik, 9: 4-6.

[8] V. A. Dragavtsev, A. F. Averyanova (1983). Mechanisms of interaction of genotype – environment and homeostasis of quantitative traits of plants. Journal of Genetics, T. 19. № 11. 1806-1810.

[9] A. P. Orlyuk, K. V. Goncharova (2003). The problem of combination of high productivity and ecological stability of winter wheat varieties. Journal of Coll. Science factors of experimental evolution of organisms: K: Agrarian science, p. 180 - 187.

[10] A. A. Zhuchenko. Adaptive potential of cultivated plants. Chisinau: Shtiintsa, 1988. 767 p.

[11] V. Sichkar, O. Ganzhelo, G. Lavrova (2013). Increase of soybean adaptability in arid conditions as the main direction of modern selection in the South of Ukraine. Journal of Visnyk of Lviv National Agrarian University. Series Agronomy. Lviv National Agrarian University, 17 (2): 187.

[12] I. N. Beideman. Methods of studying the phenology of plant communities. Novosibirsk: Nauka, 1974. 156 p.

[13] T. A. Rabotnov (1950). Life cycle of perennial herbaceous plants in the meadow cenoses. Journal of Proceedings of the USSR Academy of Sciences. Series IV, 6: 63-74.

[14] Modern methods of selection of vegetable and melon crops./ed. T. K. Gorova, K. I. Yakovenko [3 rd ed., Revised and added]. Kharkiv: Osnova, 2001. 642 p.

[15] Anatomical methods of research of cultivated plants. M., 1986. p. 16–17.

[16] Biochemical methods of analysis of essential oil plants and essential oils: a collection of scientific works /ed. A. Karpacheva. Simferopol, 1972. 107 p.

[17] B. A. Dospekhov Methods of field experience. M.: Kolos, 1985. 351 p.

[18] A. V. Andrushchenko, K. M. Kryvytskyi (2007). Methods of examination of varieties of Lophanthus anisatus Benth on the DHS. Journal of Protection of plant variety rights, Vol. 2, Part 3. p. 347–353.