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LEVISTICUM OFFICINALIS L. IN THE CONDITIONS OF TRANSCARPATHIA AND ASSESSMENT OF ADAPTIVE ABILITY OF THE SOURCE MATERIAL FOR SELECTION

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Problem setting. During the last years there is a positive tendency of increase of a demand on the plant raw material and production of the non-traditional flavor aromatic plants on the homestead plots.

A fast development of the social infrastructure (increase of the processing and canning enterprises, medical-health resorts, green tourism development, creation of recreation centers, and so on). The favorable agro climatic conditions of the region can serve a bases for creation and widening of the planting basis in the productive scales, and use of the useful low spread aromatic plants, to which the lovage (sea parsley) can be referred. However, in order to provide the needs of the producer of the aromatic flavor raw materials with the competitive highly productive sorts we should have them in sufficient quantity, which, we don't really observe nowadays. The main reason of impossibility of transformation of such a valuable plant as sea parsley on the industrial bases – is the lack of information as to its biological and morphological peculiarities, the valuable qualities are not fully discovered, and the adaptive selection material and sorts are absent, the technological peculiarities of growing are not exposed as well. In the State Plants Sorts Register there are only two sorts (selection of ZSAES – Mriya (2008) and Coral (2015).

Global changes of climate in Ukraine demand a qualitatively new approaches to the creation of the new sorts of agricultural crops. The essential increase of amplitude response of the meteorological factors their redistribution according to the months, leads to the loss of the productive raw materials of aromatic crops, including the lovage, and this conditions the necessity of creation of the new genotypes, which have a minimal reaction on the sharp changes of the climate conditions [1].

The sort composition of the sea parsley does not correspond to the demands of the modern market. Today the selection demands the new tasks among which the topical one is the creation of the highly adaptive sorts and hybrids of agro ecological orientation with the high degree of genetic protection of crops from the changeable ecological factors of environment. That's why the selection process which is being done by the scientists of Zakarpatian State Agricultural Experimental station with the sea parsley, is directed on the creation of ecologically-flexible early ripen sorts with the high level of forming the yield capacity of the plant raw materials and quality. We should mention, that for solving these tasks, we should realize a selection of the source material and involve into the crossing the forms with the wide specter of adaptive reaction on all the stages of individual development of a plant, adequate to the conditions of the environment. The conducting of the investigations in various geographic-ecological conditions gives the possibility to define the degree of adjustment of the genotype to the environment of the concrete zone according to the factors of changeability of the basic characteristics. As it is known, that the valuable characteristics of the sort depend not only on the inherited genetic peculiarities, but on the influence of the factors of the environment.

Important characteristics of the plant's adaptive ability are growth, development, forming the stable high productivity in the strictly defined agro climatic conditions, independent from the changeable biotic and abiotic factors. In order to obtain the highly qualitative crops of the planting raw materials of the flavor aromatic plants it is necessary to work out the model of a new sort, which would include the important characteristics, being the following: energetic potential of the zone of growing a new sort, a detailed description of the valuable selection characteristics and parameters of their display, which influence the productivity and output of the qualitative raw materials, stability to unfavorable ecological factors.

Creating the sorts that would correspond to the demands of the modern time is a topical and precise work. The results can be obtained, if into selection process there will be included the local populations and sorts of lovage, of the different ecological-geographical origin with the wide specter of adaptive abilities. [2-4]. For the practical selection an important meaning has the assessment of both – the source material and the material, obtained in the process of the selection. Defying the parameters of the qualitative characteristics and defying the boundary admissible low level of productivity and quality in the concrete agro climatic conditions will contribute to a more precise selection of pairs for crossing according to the valuable household characteristics.

The task of the investigations, that stands before the researchers of ZSAES is to evaluate in the low land conditions of Transcarpathia the source material samples of the sea parsley, to define the dependence between the characteristics, which form the yield capacity and to define the stable forms to the changeable agro ecological factors, for involving them into the selection process.

Analysis of the latest investigations and publications. Selection on adaptive abilities is based on the grounds of specifics of combinations of all the valuable characteristics. An important meaning has the establishment of the correlative connections between the formation of the valuable characteristics, yield capacity and meteorological factors, definition and choice of the highly effective, adaptive to the conditions of the growing zone sources [5]. The most integral factor of adaptive ability of the plants is the high productivity, which is defined by a complex of characteristics of the genetic system of a plant. The highest crop is formed under the optimal combination

of the elements of productivity and the household valuable characteristics [6,7].

Sea parsley is a rather spread culture, but is minor studied. A deep study of both morphologic-biological peculiarities of the culture and forming the peculiarities of the productivity under the influence of the changeable meteorological conditions, on which our work is directed, will contribute to welfare of the most effective forms for involving them during all the stages of the selection process on the adaptive ability and creation of the competitive sorts.

Aim of the article. Showing the results of investigations of the source material of lovage, is aimed at the establishment of dependence between the peculiarities which form the high productivity, selection of samples with the high ecological flexibility, which would provide the increased crops under the essential changes in temperature and downfalls, defying these valuable sources of characteristics of productivity. This gave an opportunity to achieve the results in the selection process, aimed at the creation of the sort (Coral (2015) with the stable high productivity, adaptive ability to the changing conditions of growing and stability against drought.

Materials and methods of research. The investigations took place in the conditions of the open soil on the fields of Zakarpatian State Agricultural Experimental Station of NAAS during 2011 - 2017. The material for research were 7 collection samples of the sea parsley (including the two sorts of the domestic and local form). The gained results were compared with the generally accepted standard sort Mriya (which was first included to the State Register of Sorts of Plants of Ukraine in 2008). The assessment of the collection sorts samples had been made according to the growth and development of plants, to the duration of vegetation period of plants, depending on the extreme growing conditions, productivity and output of the biologically active sources.

The peculiarities of passing through the periods of ontogenesis and phonologic phases of lovage plants had been studied according to the methods of I.M. Beideman [8] and T.A. Rabotnov [9]. The selection work had been done according with the methods recommendations of the leading scientific institutions [10 - 13], the description of the plants had been made under the classification of the peculiarities worked out by the author [14]. The statistical processing of the results of investigations had been done with the accordance of the method of disperse analysis and with the methods recommendations and using of the computer programs "Statistik" and "Statistik-6" [15,16].

Results of investigations. The most characteristic indicators of adaptive ability of agricultural cultures is the duration of the vegetation period and yield capacity of the highly qualitative raw material. During the period of research, we have defined the characteristic features of the sea parsley, which have the correlative connections with the crops: stems amount, leaves size, output of the goods raw material and height of a plant. When studying the collection samples, we have established that the high detached correlation dependence is observed between the (r= -0.916; r= -0.869; r= -0.674). There had also been established a high dependence between the productive raw material output and the size of the leaf (r= 0.807; r= 0.674) and the plant's height, length of the leaf and raw material output (r= 0.582; r= 0.511). The average correlative dependence is being observed between the weight of a plant and its height (r= 0.352).

The duration of the sea parsley vegetation period depends on the limiting factors, which are the temperature and downfalls. The seeds of this culture begin to grow under the temperature of 7 - 8^{0}C, the optimal temperature is 12 - 15 ^{0}C. the first sprouts are noticed on the 15-th day. Forming of the fully formed sea parsley raw material for the food industry (bushy phase) takes place during 29 – 40-th day, formation of the generative organs (flowers, blossom cluster) begins during 52 - 57-days. The mass blooming of the sea parsley (raw material for the pharmaceutical branch) takes place during 66 - 71-days. At the end of blossoming the plants have three or four formed flower spikes, each of which has one central umbel and 19 - 34 – side ones. In the process of blooming the big leaves gradually die out, and those, that are formed on the stem are considerably smaller. The height of the bush with the blossom cluster is up to 120 - 180 cm and more. After pollinating the process of seeds formation lasts 45 - 48 days, after this the seed gets its characteristic coloring. The period of plant's development of lovage from the sprouts to a full seeds ripening lasts in average for 115 - 127 days (table 1).

Table 1 – Duration of the phases of development of the sea parsley collection samples (in average during 2011-2017)

Samples	Vegetation period from sprouts, days		
	mass bushing	seeds ripening	violation from the standard, ±
Sea parsley			
Mriya St	37	115	-
Lovedge	38	118	+3
MLL	37	116	+1
Redei	34	113	-2
K-3	40	117	+2
KJ	30	107	-8
Coral	32	116	+1
LSD_{05}	-	2,1	-

We should mention that for the food industry people gather the spicy greens of the sea parsley in the phase of the mass bushing, when the plants reach the height of 60,0-80,0 cm. When studying the source material, we

have made the gradation of the formation of the productive raw materials according to the ripening, which consists of the five groups, being: pre early – period from the beginning of growth to the raw material gathering (rosette leaves) is up to 29 days; early – 30 - 40 days; medium ripen – 41 - 50 days; late ripening – 51 - 60 days; very late ripening – more than 60 days. The samples of the source material of lovage we have included to the early category. Thus, among this very category we can single out the samples and forms which have the shortest duration period to the mass bushing. In the conditions of the low lands of Transcarpathia we have divided the collection samples of the sea parsley (table 2).

Table 2 – Sources of lovage ripening in the low land conditions of Transcarpathia (average during 2011-2017)

Ripening, days	Sample
Early 30-40	-
30-32	KJ, Coral
33-35	Redei
36-38	Mriya (St), Lovedge, MLL
39-40	K-3

According to the results of the many years researches, we have singled out the sources of the early ripening. The household correspondence was seen in the samples of KJ (after 30 days), Coral (after 32 days), Redei (after 34 days).

The next factor that forms and influences the productivity of the plants is the height. According to the height of the plants in the sea parsley we have singled out the five categories, being: the first category – very low plants – lovage under 30 cm; 2-nd category – low – plants with the height of 31-45 cm; 3-rd – medium – 46-60 cm; 4-th – high – 61-75 cm; 5-th – very high – more that 75 cm. During the period of study of the source material of lovage according to the height, the best characteristics that belong to the high category had the following samples: MLL (73,3 cm), Coral (72,0 cm), Lovage (70,9 cm) and Mriya (70,3 cm). The stable height display has the sample MLL (73%).

Formation of the huge amount of rosette complex leaves of the lovage is an important feature when growing the plants. According to this feature, the best ones were the samples – KJ (31 p.), K-3 (30 p.), Redei and MLL (22 p.). the following samples have the stability of forming the considerable amount of productive organs being Redei and MLL (72.5 and 70.1 %).

When growing the spicy crops, a high economic effect provides the output of the goods-qualitative plant raw material, as according to these characteristics its realization takes place. Due to the results of the conducted research, the high output of the goods production (rosette leaves) is a characteristic feature of the sorts of foreign selection Redei – 56.2 % and Lovedge, the samples MLL - 53.6 and – 53.5 %. Thus, only the sorts Redei and Mriya possess the stable indicator, which violated within the frames of 69.3-70.2 %.

When studying the parameters of the size, in the conditions of Transcarpathia there had been established, that the smallest part of the lovage was the leaf, the length of which made up 8-9 cm, and the width – 5-6 cm. The average one has the length 10-13 cm and the width – 10 cm. To the big category we can refer the leaves with the length of 14-17 cm and the width of 11-14 cm. The many years' study gave us the opportunity to define the samples that can be singled out according to the complex of peculiarities that form the crops (table 3).

Table 3 – Characteristics of the early ripen perspective samples of lovage

Name of sample	Height of plant, cm	Plant's size, cm		Stems amount, p.	Crops	
		length	width		t/ha	± to standard
MLL	73.3	11.7	8.7	22	28.3	+5.4
Coral	72.0	11.6	8.5	28	28.0	+5.1
Redei	68.0	11.1	7.8	22	27.3	+3.1
Lovedge	70.3	12.3	8.5	20	24.2	+1.3

Forming the biomass of the plants and its amount show us how the type or the sort had adapted to the conditions of growing. The sea parsley is a multicity culture, that can be mowed up to 2-3 times. However, the basic amount of biomass the plant forms during the first mow, during the next mows the output of the productive mass reduces in half. That's why the perspective ones for the selection are the samples of lovage with the mass of the plant during the first mow not less than 330-503 g and the goods raw material output at the level of 50-56%. All the samples in the collection increase the mentioned above parameters (table 4).

In average during the period of study the biggest biomass was in the following samples: MLL – 707.5 g and the output of the green matter made up 53.6 %, Coral – 700.0 g i 52.0 %, Redei – 682.5 g and 56.2 %, K-3 – 652.5 and 51.1 %.

Table 4 – Sources according to the mass of the lovage plant

Mass of the plant, g	Samples
330.0-412.5	-
412.6-502.5	-
502.6-592.0	Mriya, KJ
593.1-682.5	Lovedge, K-3, Redei
682.6-775.0	MLL, Coral

The results obtained show that in one agro ecological zone but during the different years due to the heat and moisture the sorts vary considerably when taking into consideration the yield capacity, which was within the level of 1.3-3.3 кg/m^2 or 13.0-30.3 t/ha. The division of the samples had shown, that the best interval for lovage is 3.5 t/ha and we singled out 5 categories of crops (table 5). We should mention that the average crops indicators during the seven years were within the measures of 22.9-28.3 t/ha and the samples of the source material can be referred to three categories: medium productive, biologically highly productive and highly productive.

Table 5 – Sources of lovage yield capacity for selection (average during 2011-2017)

Gradation	Sample
(VLP) very low productive– 13.0-16.5 t/ha	-
(LP) low productive– 16.6-20.1 t/ha	-
(MP) medium productive – 20.2-23.7 t/ha	Mriya, KJ
(BH) biologically highly productive – 23.8-27.3 t/ha	Lovedge, K-3, Redei
(HP) highly productive – 27.4-31.0 t/ha	MLL, Coral

An important indicator of the quality of plants raw material is the content of biologically active sources, which give the plants the peculiarities, thanks to which they are being used in the food and other branches.

Accumulation of the dry matter in the samples violated within the measures from 16.2 % (K-3) to 23.0 % (KJ), the ascorbic acid was in the high concentration in the sorts of MLL – 32.3 мg/100 g and KJ – 26.0 мg/100 g, the lowest concentration was in the sorts of foreign selection Lovedge and Redei, being 16.3 and 21.2 мg/100 g. The mass part of the essential oil made up 0.16-0.28 % on the raw mass. The essential output of the essential oils is a characteristic feature of the samples MLL – 0.28% or 0.93% on the absolutely dry matter and KJ - 0.22 % or 0.80 %.

Using the laboratory method and visual assessment in the critical period of the sustainable high temperatures we have established a high coefficient of drought stability in the sorts which have green and dark green coloring of the leaves (Lovedge, MLL and Redei). These sorts have a high indicator of water restoration, however, with a high level of water storage. The results of the researches showed, that the highest indicators of coefficient of drought stability and water restoration are seen in the early and medium ripen sorts. With the method of multiply correlation analysis we have established the basic peculiarities of drought sustainability which are responsible for forming productivity under the different level of water supply (table 6).

Table 6 – Dependence of crops on the peculiarities of drought sustainability of lovage samples during the years, different in the level of water supply

Factor of drought sustainability	Coefficient of drought sustainability			
	Moisture (2011, 2016, 2017)		Dry (2012-2015)	
	r	r (lim)	r	r (lim)
Growth intensity	0.83	0.64-0.93	0.91	0.87-0.97
Length of a leaf	0.64	0.41-0.76	0.75	0.54-0.83
Width of a leaf	0.48	0.41-0.65	0.67	0.56-0.89
Water restoration ability	0.28	0.21-0.35	0.14	0.23-0.38
Stability to dehydration	0.35	0.28-0.43	0.16	0.07-0.16
Ability to reutilization in drought conditions	0.30	0.27-0.32	0.67	0.52-0.75
Height of a plant	0.76	0.66-0.85	0.77	0.67-0.87

The defying factors for lovage is the intensity of growth of the plant in the beginning period of development, height of the plant, which correlates with the creation of the strong root system (r= 0.83-0.91, r=0.76-0.77) and leaves' size both in the drought and moisture years.

When creating the sorts of lovage we should pay attention on the complex of biological, genetic and household peculiarities, which are being shown in one genotype. An important aspect in selection is to consolidate the highest minimal level of productivity due to the fast changing agro climatic factors. The parameters of productivity can change depending on factors of environment, technological provision and genetic potential of the culture. By means of investigations we have established the basic indicators of valuable features of lovage productivity and its optimal parameters for creation the model of the sort with a fuller and effective display of the potential productivity (table 7).

Table 7 – Basic indicators and optimal parameters of the model of lovage sort

Indicators	Parameters
Period sprouts/growing – mass bushing, days	25-30
Height of a plant, cm	70-90
Diameter of a plant, cm	55-70
Stems amount, pieces	22-30
Leaf length, cm	11-13
Leaf width, cm	7.5-8.7
Output of the commodity raw material (leaves),%	50-60
Potential crops, t/ha	25-35
Essential oil output, % on raw mass	0.25-0.35

Conclusions. Growing the sea parsley in Transcarpathia is a perspective direction, which is conditioned by a wide specter of usage in the food, canning, pharmaceutical, perfume-cosmetology and other branches, by the undemanding factors as to the growing conditions, and by the ability to grow on the soils, that are not suitable for growing the main vegetable and green cultures, filling the new niche of the spicy cultures on the market of the given region.

As a result of a durable study of variety of the valuable according to its peculiarities crop, we have established the correlation connection of factors that form the productivity, border parameters of the basic selection characteristics and the model of a new sort with the optimal parameters had been elaborated. The results of a long term study of the sea parsley are implemented when creating the highly productive, stable to the basic diseases and pests sort Coral.

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