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EVALUATION OF INBRED LINES OF *SALVIA SCLAREA* L.

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Abstract. *In the process of breeding the species Salvia sclarea L., a fundamental objective was to diversify the initial breeding material and select lines with valuable quantitative characters and increased content of essential oils. As a result of research conducted with a large number of inbred lines, it was found that there are lines with full flowering in the first year of vegetation, as well as lines with an increased content of essential oils. Finally, lines with an essential oil content exceeding 2% (dry matter) were identified: M-69 453-82 S_{16} – 2,191%; M-69 428-82 S_{16} – 2,227%; M-69 815-82 S_{16} – 2,140%. Lines with essential oil content exceeding 1%: AP 2-11 S_6– 1,642 %; AP 11-11 S_6– 1,642 %; AP 28-11 S_6– 1,221 %; AP 30-11 S_6– 1,912 %; AP 66-11 S_6– 1,643 %; AP 67-11 S_6– 1,573 %; NC 6 -11 S_6– 1,356 %; NC 4 -11 S_6– 1,358 %; NC 19 -11 S_6– 1,499 %; NC 38 -11 S_6– 1,646 %; NC 98 -11 S_6– 1,810 % etc. Thus, the selected lines were subjected to inbreeding during the flowering phase, in order to reproduce promising lines, which will later be included in breeding programs. The aim of the investigations was to create, evaluate and select initial breeding material with high-performance genetic potential.*

Keywords: Salvia sclarea L., inbred lines, inflorescence, vegetation period, essential oil.

INTRODUCTION

In the Republic of Moldova, the genus *Salvia* L. is represented by 12 species [5; 6; 7;11; 14]. In cultivation, *Salvia sclarea* L., *S. officinalis* L., as well as the decorative species *S. splendens* Ker. Gawl. are used. As a medicinal plant, *S. sclarea* L. has been known and used in phytotherapy since antiquity [1; 3; 4; 5; 6; 7; 8; 10]. The use of aromatic and medicinal plants in perfumery, cosmetics, pharmacology and the food industry is continuously developing both in our country and in the European Union. The areas cultivated with these species have expanded in recent years. Their importance becomes even more evident in the context of climate change, which requires the creation of varieties resistant to drought and high temperatures, which ensure constant and quality productivity. The research results demonstrate that in dry years the *S. sclarea* L. genotypes included in the

study ensured high productivity [1; 2; 9]. The use of medicinal plants for therapeutic purposes is based on the active principles, the compounds that are synthesized and accumulated. It is known to have antiseptic, antispasmodic, sedative, carminative, diuretic, etc. actions, as well as being used as a flavoring agent and preservative in food products [3; 4; 5; 6; 7;11]. Scientific studies focused on *S. sclarea* L. are focused on diversifying the initial breeding material adapted to climate change. Breeding work is necessary to contribute to the cultivation and expansion of cultivated areas with *S. sclarea* L. genotypes. The process of creating new varieties, with increased plasticity, that meet the requirements of producers depends on the existence of a vast initial breeding material that includes inbred lines with valuable agronomic indices. In this context, the creation, evaluation of inbred lines and the identification of genotypes with valuable breeding indices, which would ensure increased productivity of the raw material, as well as of the essential oil, represent a primary task. The aim of this study is to create and select inbred lines with high-performance breeding qualities, which will later be included in the hybridization process.

MATERIALS AND METHODS

The biological material used in the present study was represented by 63 inbred lines $S_6 – S_{16}$ of different origins: 28 - derived from the Ambra Plus variety; 17 – Natali Clary; 13 – M–69; 2 – Cr. p.; 1–S. - Turkmen/N; 1–S–1122; 1–V–24, second year of vegetation. The field experiment with inbred lines of *S. sclarea* L. began on November 16, 2022. The varieties they came from served as controls for the inbred lines obtained. During the vegetation period, phenological, biometric and visual assessments were carried out. The morphological characters that determine the productivity and amount of essential oil were studied: plant height, inflorescence length, number of branches of I and II degree, as well as the number of whorls on the central spike of the inflorescence. Diversification of the initial breeding material in *S. sclarea* L. in recent years continued by the inbreeding method. The plants selected as parents of future lines were forcibly self-pollinated by closing the inflorescence in an insulator, at the beginning of the flowering phase, forcing pollination with its own pollen. Previously, the inflorescences were subjected to a special toilet [1; 2; 7;10]. The essential oil content was determined in the full flowering phase, by hydro distillation of fresh inflorescences in the Ginsberg apparatus [12; 15; 16;17]. The plant material was sampled in the morning, between 8:00 and 10:00, during the mass flowering period, when the seeds in the vertices of the central spike of the panicle were brown in color. The crushed plant material (100 g of inflorescences) is placed in a flat-bottomed flask, volume 1000 ml, then 200 ml of water is added, the distillation process lasts one hour. At the same time, the moisture content of the raw material is determined for each sample,

using the oven drying method at a temperature of 105°C, for 8 hours. To determine the moisture content, samples of plant material are taken from each sample in aluminum bottles, which are preliminarily weighed. Then, the bottles with plant material are weighed until dry. After the samples are dried, they are weighed. The data are included in the laboratory records, which are later needed to recalculate the essential oil content from the fresh substance to the dry substance, thus avoiding possible errors related to differences in moisture content. The essential oil samples were dehydrated with anhydrous Na_2SO_4 and stored in a freezer for further analysis The statistical interpretation of the obtained experimental data was carried out according to the methods in force and using the STATISTICA program. [8;12;13; 15;16].

RESULTS AND DISCUSSIONS

Multiannual research conducted on the species *S. sclarea* L. has demonstrated that obtaining inbred lines with new, valuable characters through the inbreeding method is effective [1; 7; 10]. Scientific research on the creation and diversification of initial breeding material, its evaluation being carried out within the IGFPP of USM. The investigations focused on the study of inbred lines (S_6-S_{16}) of *S. sclarea* L. from different origins. Climate change requires the creation of initial breeding material, genotypes resistant to drought and high temperatures. The creation of inbred lines with high essential oil content, which flower in the first year, is an important goal in salvia breeding. The results of the evaluation of the inbred lines demonstrated that they possess certain valuable quantitative characters, such as: plant height, inflorescence length, number of branches of degree I and II, number of whorls on the central spike of the inflorescence, increased essential oil content. Evaluating the inbred lines in 2024, the second year of vegetation, genotypes were selected that stood out for total flowering in the first year of vegetation: AP 2-11 S_6; AP 29-11 S_6; AP 30-11 S_6; AP 30-11 S_6; AP 32-11 S_6; AP 35-11 S_6; AP 41-11 S_6; AP 49-11 S_6; AP 59-11 S_6; AP 62-11 S_6; AP 63-11 S_6; AP 64-11 S_6; AP 66-11 S_6; AP 67-11 S_6; AP 73-11 S_6; AP 77-11 S_6; AP 81-11 S_6; AP 82-11 S_6; AP 97-11 S_6; AP 106-11 S_6; AP 108-11 S_6; AP 113-11 S_6; AP 115-11 S_6; NC 1-11 S_6 ; NC 4-11 S_6 ; NC 6-11 S_6 ; NC 38-11 S_6; NC 45-11 S_6; NC 56-11 S_6 ; NC 60-11 S_6 ; NC 75-11 S_6; NC 77-11 S_6 ; NC 78 -11 S_6; NC 96 -11 S_6; M-69 489 S_{16}; Cr. p. 11 S_{16}; Cr. p. 99 S_{16}; V-24-86 844 S_{14}; M-69 286 S_{14}; M-69 257-82 S_{16}. Inbred lines are distinguished by the periods of flowering and technical ripening. In the second year of vegetation, these lines showed satisfactory development: plant height from 95.7 cm in line AP 11-11 S_6 to 126.4 cm in line NC 4-11 S_6 (Tab. 1). It is important that the proportion of inflorescence length constitutes over 50% of plant height, which promises high productivity. Examining the lines by character - inflorescence length, which varies from 46.8 cm to 68.7 cm, it was found that these

lines have long, large inflorescences with a large number of branches. The length of the inflorescences varied from 50.6 cm in the line (AP 11-11 S_6) to 68.7 cm (line NC 6 -11S_6). Thus, the length of the inflorescence constitutes over 50% of the plant height. Compact inflorescences, (11.8-19.4) degree I branches and (19.2-49.2) degree II branches. These quantitative characters directly influence the synthesis and accumulation of essential oil in the raw material.

Table 1. Quantitative characters in inbred lines of *Salvia sclarea* L., 2nd year of vegetation, year 2024

Inbred line code	Plant waistline, cm	Inflorescence length, cm	Number of ramifications		Essential oil, %, dry matter,
			first degree	second degree	
	X ± sX	X ± Sx	X ± sX	X ± sX	
AP 2-11 S_6	87,1±8,9	46,8±8,0	11,8±1,7	21,2±4,7	1,642
AP 11-11 S_6	95,7±6,3	50,6±5,4	14,2±1,7	25,4±6,4	1,208
AP 28-11 S_6	126,0±8,5	61,8±4,9	16,0±3,2	30,8±11,0	1,221
AP 29-11 S_6	121,2±10,5	61,2±8,1	15,0±1,9	29,0±7,0	0,940
AP 30-11 S_6	102,9±4,6	59,0±3,0	14,0±1,6	27,0±9,6	1,912
AP 32-11 S_6	119,1±7,2	60,6±5,7	14,4±2,0	27,0±8,6	1,719
AP 33-11 S_6	110,2±7,3	54,7±7,1	13,2±1,3	26,4±6,5	1,586
AP 34-11 S_6	108,1±6,4	56,4±5,1	15,8±3,0	34,4±12,0	0,889
AP 35-11 S_6	100,0±7,5	52,7±4,5	13,6±1,5	28,4±6,6	1,395
AP 41 -11S_6	114,9±8,9	59,7±5,1	14,6±2,3	28,6±9,6	1,476
AP 49-11 S_6	118,7±3,2	62,3±9,5	15,2±2,3	31,0±8,3	0,966
AP 54-11 S_6	122,2±9,3	61,4±6,1	15,8±2,3	34,0±8,0	0,875
AP 59-11 S_6	125,1±8,0	63,7±6,4	15,0±2,1	28,2±7,7	0,742
AP 62-11 S_6	98,3±9,7	52,6±8,6	12,8±2,1	23,3±10,4	1,192
AP 63-11 S_6	112,3±9,7	57,2±5,4	14,0±1,8	25,2±9,0	1,358
AP 64-11 S_6	119,9±5,5	61,9±4,4	15,4±2,6	30,2±7,8	1,279
AP 66-11 S_6	120,0±5,5	65,7±3,7	14,8±2,1	30,2±8,2	1,643
AP 67-11 S_6	119,7±9,4	62,1±4,9	16,2±2,3	28,6±8,6	1,573
AP 68-11 S_6	99,1±4,7	49,7±5,0	12,6±0,9	22,2±5,0	1,008
AP 73-11 S_6	114,5±6,5	59,6±5,8	14,2±1,4	26,8±4,8	1,276
AP 77-11 S_6	108,3±6,3	55,0±5,7	13,4±1,3	22,4±6,0	0,782
AP 81-11 S_6	108,7±10,8	55,0±5,3	13,4±1,8	27,4±10,0	1,165
AP 82-11 S_6	112,1±6,0	53,3±11,8	14,4±2,4	28,0±9,6	0,801
AP 97-11 S_6	113,5±10,7	58,0±6,4	14,2±1,1	26,0±6,9	2,250
AP 106-11 S_6	102,6±6,3	55,9±5,5	14,2±1,7	25,4±7,0	1,485
AP 108-11 S_6	114,1±5,4	60,2±3,4	15,0±2,1	26,4±7,9	1,049
AP 113-11 S_6	124,4±5,9	67,6±3,8	17,6±1,8	43,4±11,6	0,692
AP 115-11 S_6	120,4±11,7	57,9±5,2	13,8±1,7	24,6±6,9	1,232
NC 1 -11 S_6	108,6±8,5	54,4±5,4	13,2±1,6	26,2±10,4	0,949
NC 6-11 S_6	144,2±11,4	68,7±6,9	17,6±1,8	33,2±10,6	1,356
NC 4 -11 S_6	126,4±4,9	61,6±4,7	19,4±2,8	49,2±14,0	1,358
NC 11 -11 S_6	104,5±6,1	56,3±5,8	15,6±3,8	28,6±9,1	1,753
NC 13-11 S_6	107,0±6,4	54,5±6,0	14,0±1,8	33,8±5,2	1,131
NC 19 -11 S_6	107,9±8,3	55,2±4,5	13,8±1,9	30,0±9,2	1,228
NC 38 -11S_6	131,9±7,2	65,3±4,1	16,0±2,4	35,6±7,4	1,646
NC 45 -11S_6	127,0±9,0	60,8±5,3	15,0±2,1	34,8±10,7	1,264
NC 56-11 S_6	110,7±7,0	54,8±4,5	14,2±1,9	28,2±5,2	0,943

NC 60-11 S_6	132,9±11,1	66,3±8,3	16,2±2,3	33,4±9,4	0,904
NC 61-11 S_6	112,2±6,7	59,8±7,9	14,6±2,3	32,0±13,3	1,703
NC 75-11 S_6	122,7±7,8	60,4±4,1	15,4±1,3	37,2±12,1	0,726
NC 77-11 S_6	103,5±4,4	55,8±2,5	13,8±1,7	28,0±7,3	0,713
NC 78-11 S_6	102,1±4,1	54,3±4,1	13,8±1,9	25,4±6,0	1,202
NC 96-11 S_6	102,4±7,0	55,1±5,2	14,6±2,6	28,8±8,1	1,107
NC 98-11 S_6	120,8±9,1	64,7±6,8	14,6±1,8	30,0±9,6	1,810
NC 100-11S_6	119,1±5,9	58,0±6,6	13,6±1,5	25,2±5,0	1,663
M-69 489 S_{16}	111,7±4,7	57,0±4,8	12,6±1,3	19,2±4,0	0,934
M-69 418 S_{16}	97,2±2,1	50,9±1,6	12,3±1,3	27,2±6,1	1,687
M-69 655 S_{14}	119,4±5,9	61,4±3,9	15,4±2,3	33,0±7,7	1,407
S-1122 60 S_{14}	132,8±9,7	65,9±6,0	15,8±2,3	28,0±7,3	1,208
Cr. p. 11 S_{16}	117,0±8,1	61,2±6,0	15,8±3,3	35,2±14,0	0,845
Cr. p. 99 S_{16}	119,3±7,9	61,6±3,6	15,8±2,7	37,6±9,4	1,554
V-24-86 844 S_{14}	111,1±3,2	60,6±4,1	13,8±1,7	27,6±4,6	1,110
M-69 489 S_{14}	109,5±8,3	61,4±8,1	14,6±2,1	29,8±7,2	1,331
M-69 286 S_{14}	111,6±4,9	57,8±5,2	17,8±1,9	40,0±12,8	1,616
M-69 147 S_{14}	129,7±9,0	63,0±6,3	16,6±2,3	37,8±12,0	0,962
M-69 453-82S_{14}	116,3±8,9	58,1±5,4	13,6±1,2	27,6±5,7	2,192
M-69 257-82 S_{16}	96,4±5,6	53,3±5,3	12,8±1,3	22,0±5,0	1,203
M-69 485-82 S_{16}	100,6±6,6	55,1±5,7	13,8±1,9	24,2±5,6	1,531
M-69 403-82 S_{16}	87,4±7,5	47,4±3,9	13,2±1,0	21,8±3,9	1,709
M-69 756-82 S_{16}	112,8±4,0	61,1±6,1	14,0±2,3	20,4±4,5	1,692
M-69 428-82 S_{16}	98,8±5,4	51,8±2,7	25,8±5,8	25,8±5,8	2,227
M-69 815-82 S_{16}	117,0±4,3	62,4±6,9	13,6±1,5	29,0±9,2	2,140

In inbred lines: AP 29-11 S_6; AP 34-11 S_6; AP 49-11 S_6; AP 54-11 S_6; AP 64-11 S_6; AP 66-11 S_6; AP 113-11 S_6; NC 6-11 S_6; NC 4-11 S_6; NC 11-11 S_6; NC 13-11 S_6; NC 38-11 S_6; NC 45-11 S_6; NC 60-11 S_6; NC 61-11 S_6; NC 75-11 S_6; NC 98-11 S_6, compact inflorescences were observed, with a large number of branches (30.8-49.2) of the second degree (Tab.1).

The high and very high oil content in *S. sclarea* L. is ensured by quantitative characters, which directly influence productivity. Also, inbred lines S_6 – S_{16}, not subject to inbreeding depression, with very high essential oil content in the proportion of 2.192 – 2.250%, were highlighted. The lines synthesized and accumulated essential oil in inflorescences that exceeded the quota of 1.5% (dry matter): AP 30-11 S_6 - 1,912 %; AP 32-11 S_6 - 1,719 %; AP 66-11 S_6 - 1,643 %; AP 97-11 S_6 - 2,250%; NC 11 -11 S_6 - 1,753 %; NC 38 -11 S_6 - 1,646 %; NC 98 -11 S_6 - 1,810 %; NC 100 -11 S_6 - 1,663 % etc. (Tab.1).

CONCLUSIONS

63 inbred lines S_6 – S_{16} of different origins were created and studied: 28 - derived from the Ambra Plus variety; 17 – s. Natali Clary; 13 – s. M–69; 2–Cr. p.; 1–S. s. Turkmen/N; 1–S–1122; 1–V–24. The evaluated inbred lines have different flowering and ripening periods: early, mid-early and late.

The inbred lines S_6 – S_{16} from the second year of vegetation developed

plants with a height of (87.4 – 126.2 cm), very long inflorescences (46.8 – 68.7 cm), compact, first-degree branches (11.8-19.4) and second-degree branches (19.2-49.2).

Early, medium and late lines with high content (1.005 – 1.694%) of essential oil were selected for use in hybridizations as parental forms.

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