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Morphological variability of phenotypic traits in of *oregano* samples

E.F. Myagkikh[1,*], S.S. Babanina[1], V.S. Pashtetsky[1] and M.Yu. Karpukhin[2]

[1]Research Institute of Agriculture of Crimea, Kievskaya Str., 150, RU295453 Simferopol, Republic of Crimea, Russia
[2]Ural State Agrarian University, Karla Libknekhta Str., 42, RU620075 Yekaterinburg, Russia
[*]Correspondence: myagkih_e@niishk.ru

Abstract. The purpose of the research was to study the morphological variability of collection samples of *oregano* of the Crimean Peninsula. The experiments were carried out in 2016–2018 in the Foothill Zone of Crimea. The plant material consisted of 41 samples of *origanum* collected on the Crimean Peninsula territory. The degree of identification reliability of *oregano* collection samples by morphological traits was checked. The construction of relationship dendrograms was carried out by the Ward's method based on the Manhattan distances. It was found that qualitative traits (coloration of corolla, leaf, bract, stalk and male fertility) showed themselves more consistently than quantitative ones. It was recommended to use the most polymorphic traits (entropy, $H > 1.50$ bits) for reliable identification of *oregano* samples from the Crimean peninsula: coloration of bract, stem, leaf and corolla, as well as the number of shoots and mass fraction of essential oil. The structure of the association differed by the years of study when constructing dendrograms ($r = 0.58$).Nevertheless, a fairly clear correspondence of the clusters of different years' clusters to each other was established (78% of the samples). The established correspondence indicates the reliability of the genotypes combination into separate groups (clusters) and their similar reaction to environmental conditions. The most interesting combinations of samples for further breeding work were identified - these are clusters 2 and 5 (according to the 2018 data). In 42.7% of genotypes from the second cluster, the mass fraction of essential oil was at the level of 0.25–0.55% of the absolute dry mass (4–6 points). The samples from the second cluster could be used as high-oil sources, whereas samples from fifth cluster - as sources of high productivity of 'green' raw materials (up to 1,200 g plant^{-1}). It is advisable to select parental forms from these two clusters for hybridization. The grouping of *origanum* samples used in the work divides the samples quite accurately separated them not only on qualitative, but also on economically valuable traits.

Key words: breeding, Crimea, morphological trait, *oregano*, polymorphy.

INTRODUCTION

The formation and comprehensive study of collection funds are the main tasks in the conservation of plant genetic resources (Pagnotta et al., 2013).

Origanum (*Origanum vulgare* L.) is a valuable essential oil, spice, green and medicinal plant (Ibrahim et al., 2012; Sivicka et al., 2019). The distribution area in

Europe is from south to north from the Mediterranean to Norway, in the Southwest Asia– reaches the Himalayas (Bussmann et al., 2020). *Origanum* grows throughout the Russian Federation, with the exception of the Arctic regions (Bokov et al., 2013; Pashetsky et al., 2018). The preparations derived from the plant raw materials *O. vulgare* are actively used in many fields of medicine (Vale-Silva et al., 2012; Myagkikh, 2015; Masoudi & Saiedi, 2017; Sivicka et al., 2019).

Crimea is an important breeding center of essential oil and medicinal crops in Russia (Khlipenko & Rabotyagov, 2005; Pashetsky et al., 2018).

Polymorphism of herbaceous plants is manifests itself in the variability of such morphological traits as the coloration of plant organs, morphometric parameters of both individual parts and the plant as a whole, etc. It is possible to observe a significant variation of morphological traits due to the presence of many morphotypes within the species (Andi et al., 2011; Ibrahim et al., 2012).

At the All-Russian Scientific Research Institute of Medicinal and Aromatic Plants has developed a technology for reproduction of oreganum by rhizomes (Korotkikh & Khaziyeva, 2016). The breeding is carried out by the method of green cuttings in the Scientific Research Institute of Agriculture of Crimea (Myagkikh, 2015), and valuable collection material is obtained by clonal micropropagation methods (Yakimova & Yegorova, 2015; Yegorova & Yakimova, 2019).

The International Union for the Protection of New Varieties of Plants (UPOV) has developed tests to assess the differences, homogeneity and stability (DHS) of many plant species (Pagnotta et al., 2013). However, on the website of this organization it is noted that there is no guide for UPOV testing guide for the plant species of interest (*Origanum* L. (ORIGA). Dus Guidance and Cooperation). A technique has been developed for testing for DHS test when introducing new varieties of *origanum* are added to the the State Register in Russia (*Origanum* L. (ORIGA). Dus Guidance and Cooperation) has been developed. This technique includes qualitative (discrete) and quantitative (morphometric) plant traits. All of them are subject to genotype-environmental interactions, however the degree of environmental influence varies on them (Tétard-Jones et al., 2011).

The success of breeding work depends on the polymorphism of the source material and its quantity. But at the same time, this material requires a certain classification. The multi-approach, which includes estimation the assessment of not only of individual economically valuable traits, but also of all indicators available for visual morphometricassessment, allows the researcher to group the original collection material bymorphotypes.

The purpose of this work is to study the morphological variability of collection samples of *origanum* fromthe Crimean Peninsula in order to identify their phylogenetic relationships.

The objectives of the study included:

– assessment of morphological traits according to the marking scales developed by researchers;

– verification of the identification reliability degree of *origanum* collection samples by morphological traits;

– construction of relationship dendrograms;

– construction verification.

MATERIALS AND METHODS OF THE RESEARCH

The research was carried out in 2016–2018 in the Foothill zone of the Crimea (Krymskaya Roza settlement, Belogorsky District), coordinates: 45.053442, 34.361665.

The soil in the research site was southern carbonate heavy loam chernozem with the following agrochemical characteristics: pH - 7.0–7.2, humus content in the arable layer - 2.7–3.0%, total nitrogen - 0.12%, phosphorus - 0.10%, potassium - 1.0%).

The experiments were performed in the field. Planting was carried out in 2016, a comprehensive study was carried out in 2017–2018. The area of the plot was 3 m^2 (in total there were 15 plants on the plot, accounting - 10 plants), the repetition is double; placement-randomized blocks.

The meteorological conditions of the years of the study were favorable for the development of *origanum* plants.

In 2017, significant deviations from the average annual temperature indicators were noted in March and August (the average air temperature exceeded the average annual temperature by 4.0 and 2.1 °C respectively). The spring-summer period was characterized byabundant precipitation - only in March precipitation was less than the average annual norm by 11%, while in April, May and July they were extremely higher - 215, 212 and 117% of the norm respectively. The 2018 vegetation season was characterized by increased average monthly temperatures, which differed from the average long-term indicators by 0.5–3.8 °C. Rainfall since January has been well significantly below normal. In April, when intensive growth and development of the *origanum* plants began, only 4.2 mm of precipitation fell, which is 12.4% of the average multi-year value. The amount of precipitation in May and June was 98.8 and 39.3% of the norm. Only in July there was excessive moisture (169.8% of rain precipitation). The weather conditions caused faster passage of the growing phases and consequently lower *origanum* productivity rates.

The material for the study was 41 samples of *origanum* collected in different years on the territory of the Crimean Peninsula.

The area of the plot was 3 m^2, the repetition is double; placement–randomized blocks 13 traits were assessed in actual terms and converted into a point score proposed by the authors, which were divided into two groups - quantitative and qualitative in the course of the study. The color of the corolla, leaf, bract, stalk and male fertility were attributed to qualitative traits. Quantitative traits were as follows: height and diameter of the plant, the length and width of the leaf, the number of shoots, the mass of the bush, the mass fraction of essential oil (EOMF) from the absolute dry mass (adm) and the collection of oil per unit of area, which practically also covered the yield. Each trait was taken as a polymorphic system and its level of manifestation - as an alternate state of the traits. The scales of traits manifestation were developed by the authors independently, adapting the methodology on the DHS for the material, uniformly covering the entire studied sample studied (*Origanum vulgare* L., 2020) (Table 1).

To determine the informativity of individual phenotypic traits in the definition of polymorphism, entropy H (Dud´ık et al., 2007; Straszak & Vishnoi, 2020) is calculated:

$$\mathrm{H} = -\sum_{i=1}^{k}(\mathrm{p_i} \times \log_2 \mathrm{p_i}), \quad (1)$$

where $\mathrm{p_i}$ is the probability (or frequency) of the system taking the i-th position among k possible. We calculated p as ratio number of all the samples to number of samples with a specific assessment, using table (Fig. 1). Each trait was taken as a polymorphic system and its level of manifestation - as an alternate state of the traits. For example, in total, according to the UPOV classifier, 4 possible options for the color of the corolla are noted. In our collection, sample 1 has 4 points. That is, when composing a binary matrix, the corolla color is considered as a polymorphic system, and sample 1 receives 0 points for coloring at 1, 2 and 3 points, and 1 point for coloring at 4 points.

Table1. Scales of *origanum* phenotypic traits manifestation

Trait	Marking											
	1		2		3		4		5		6	
	min	max	min	max	min	max	min	max	min	max	min	max
Corolla color	light pink		light lilac		lilac		white		-		-	
Leaf color	glaucous-green		yellow-green		dark green		green		-		-	
Bract color	weak pigmentation		medium pigmentation		strong pigmentation		no pigmentation		-		-	
Stalk color	weak pigmentation		medium pigmentation		strong pigmentation		no pigmentation		-		-	
Male sterility	fertile androecium		sterile androecium		semi-fertile androecium		reduced androecium		-		-	
Plant height, cm	0	45	46	65	66	85	85	105	-		-	
Plant diameter, cm	0	45	46	65	66	85	86	105	106	125	-	
Leaf length, mm	15.0	25.0	25.1	35.0	35.1	45.0	-		-		-	
Leaf width, mm	10.0	15.0	15.1	20.0	20.1	25.0	25.1	30.0	-		-	
Number of shoots, pcs.	0	50	51	100	101	150	151	200	251	300		
Mass of bush, g	0	300	301	600	601	900	901	1,200	-		-	
Essential oil mass fraction, % adm.	traces		0.050	0.149	0.150	0.249	0.250	0.349	0.350	0.449	0.450	0.549
Yield of oil, g m^{-2}	0.0	2.0	2.1	4.0	4.1	6.0	6.1	8.0	-		-	

1 Sample	2 Corolla color 1	3 Corolla color 2	4 Corolla color 3	5 Corolla color 4	6 Leaf color 1	7 Leaf color 2	8 Leaf color 3	9 Leaf color 4	10 Bract color 1	11 Bract color 2	12 Bract color 3	13 Bract color 4
1	0	0	0	1	0	0	1	0	0	0	0	1
2	0	0	1	0	0	0	0	1	1	0	0	0
5	0	0	1	0	1	0	0	0	1	0	0	0
7	1	0	0	0	1	0	0	0	0	0	0	1
8	0	0	0	1	1	0	0	0	1	0	0	0
9	0	1	0	0	0	1	0	0	1	0	0	0
10	0	0	1	0	0	0	0	1	0	0	0	1
11	0	0	1	0	0	0	0	1	0	0	0	1
16	0	0	1	0	0	0	0	1	0	0	0	1
17	0	1	0	0	0	0	0	1	1	0	0	0
20	1	0	0	0	1	0	0	0	0	0	0	1
22	0	0	1	0	0	0	1	0	0	0	1	0
24	0	1	0	0	0	0	0	1	0	1	0	0
25	1	0	0	0	0	0	0	1	1	0	0	0
30	0	0	0	1	1	0	0	0	1	0	0	0
31	0	0	0	1	1	0	0	0	0	1	0	0
32	0	1	0	0	0	0	0	1	1	0	0	0
33	0	0	0	1	1	0	0	0	1	0	0	0
34	0	0	0	1	1	0	0	0	1	0	0	0
35	0	0	0	1	1	0	0	0	0	1	0	0
38	1	0	0	0	0	0	0	1	1	0	0	0
39	1	0	0	0	0	0	0	1	1	0	0	0
42	0	0	0	1	0	1	0	0	1	0	0	0
64	0	1	0	0	0	0	0	1	0	1	0	0
65	0	0	0	1	1	0	0	0	0	1	0	0
70	0	0	0	1	1	0	0	0	1	0	0	0

Figure 1. The example of a binary matrix of morpho-biological traits of collection samples of *oregano*.

The degree of polymorphism of traits was assessed by comparing the calculated H with the maximum possible entropy H_{max} (Straszak & Vishnoi, 2020; Dud´ık et al., 2007).

$$H_{max} = \log_2 k \quad (2)$$

The limits of variation of the calculated entropy are $0 \leq H \leq H_{max}$.

Entropy as a measure of the diversity and organization of the system, first of all, characterizes the degree of its uncertainty or determinism.

Clustering was carried out by the Ward's method based on Manhattan distances in the statistical analysis package Statistics 10. The correlation of the two matrices (matrices of distances (relations) between collection samples of *oregano* in two year investigation) were determined using the Mantel test in the Excel add-in system - XLSTAT.

RESULTS AND DISCUSSION

The manifestation of qualitative traits was stable over sthe years (Table 2) with a relatively even distribution of *oregano* samples in groups (marking scale for example '1' or '2' point), as evidenced by the calculated value of entropy. In almost all qualitative traits it was quite tightly close to the maximum possible entropy (2.00 bits) (Table 3, 4).

There is a clear affiliation of most of the samples to some single modal class in terms of quantitative traits. For example, 65.9% of the samples in 2017 and 63.4% in 2018 were characterized by a mark of 3 points.

An interesting pattern can be traced by the number of shoots: if in the first year of life mostly all the samples (85.4%) had the number of shoots marked at 1 and 2 points, then in the second year of life 56.2% of genotypes had a score on this trait from 3 to 5 points. The same trend in the mass of the bush - in 2017 modal class was 2 points, in 2018 - 3 points, with 29.3% of the samples were characterized by the mass of the bush at the level of 4 points. This is explained by the active growth and development of origanum plants with age and the fact that the conditions for full growth are optimal enough to accumulate vegetative mass and realize its productivity potential.

Table 2. The result of two way ANOVA of *oregano* qualitative traits

Source of variation	SS	df	MS
Corolla color			
Sample	104.7805	40	2.6195
Year	0.0000	1	0.0000
Sample*Year	0.0000	40	0.0000
Error		0	
Leaf color			
Sample	136.3902	40	3.4098
Year	0.0000	1	0.0000
Sample*Year	0.0000	40	0.0000
Error		0	
Bract color			
Sample	106.2439	40	2.6561
Year	0.0000	1	0.0000
Sample*Year	0.0000	40	0.0000
Error		0	
Stalk color			
Sample	61.7561	40	1.5439
Year	0.0000	1	0.0000
Sample*Year	0.0000	40	0.0000
Error		0	
Male sterility			
Sample	17.60976	40	0.44024
Year	0.01220	1	0.01220
Sample*Year	0.48780	40	0.01220
Error		0	

Table 3. Distribution of origanum samples by levels of qualitative traits manifestation, *n* = 41, 2017 (first year of life)

Trait	Distribution of samples by trait manifestation level, %						H, bit	H_{max}, bit
	1	2	3	4	5	6		
Qualitative traits								
Corolla color	17.1	19.5	22.0	41.5	-	-	1.90	2.00
Leaf color	34.1	14.6	14.6	36.6	-	-	1.87	2.00
Bract color	56.1	19.5	7.3	17.1	-	-	1.64	2.00
Stalk color	12.2	22.0	51.2	14.6	-	-	1.75	2.00
Male fertility	56.1	31.7	9.8	2.4	-	-	1.45	2.00
Quantitative traits								
Plant height, cm	2.4	26.8	65.9	4.9	-	-	1.25	2.00
Plant diameter, cm	2.4	24.4	31.7	36.6	4.9	-	1.90	2.32
Leaf length, mm	14.6	75.6	9.8	-	-	-	1.04	1.58
Leaf width, mm	4.9	56.1	36.6	2.4	-	-	1.42	2.00
Number of shoots, pcs.	36.6	48.8	9.8	4.9	0.0	-	1.58	2.32
Mass of bush, g	24.4	53.7	22.0	0.0	-	-	1.46	2.00
Essential oil mass fraction $_{a.d.m.}$, %	17.1	29.3	17.1	26.8	7.3	2.4	2.31	2.58
Yield of oil, g m^{-2}	58.5	26.8	14.6	0.0	-	-	1.37	2.00

Quantitative traits by the year were also not variable and depended only by genotype (Table 4).

Table 4. The result of two way ANOVA of *oregano* quantitative traits

Source of variation	SS	df	MS	Source of variation	SS	df	MS
Plant height				Number of shoots			
sample	8745.1	40	218.6	sample	1.0492	40	0.0262
year	1.7	1	1.7	year	0.0399	1	0.0399
sample*year	1607.7	40	40.2	sample*year	1.4412	40	0.0360
Error		0		Error		0	
Plant diameter				Essential oil mass fraction			
sample	15029.7	40	375.7	sample	1.170269	40	0.029257
year	489.3	1	489.3	year	0.101644	1	0.101644
sample*year	5324.0	40	133.1	sample*year	0.406013	40	0.010150
Error		0		Error		0	
Leaf length				Mass of bush			
sample	1033.81	40	25.85	sample	2833057	40	70826
year	36.46	1	36.46	year	1599370	1	1599370
sample*year	313.11	40	7.83	sample*year	819021	40	20476
Error		0		Error		0	
Leaf width				Yield of oil			
sample	377.88	40	9.45	sample	180.4074	40	4.5102
year	29.91	1	29.91	year	2.0613	1	2.0613
sample*year	194.89	40	4.87	sample*year	67.7679	40	1.6942
Error		0		Error		0	

In terms of the mass fractions of essential oil from absolute dry raw materials, the reverse trend can be noted: in the year 2017, which was hot and normally moisturized during the flowering period, as well as favorable for essential oil accumulation, high oil content (from 4 to 6 points) was seen in 36.5% of the samples, and in rainy 2018 - only 14.6% (Table 5). That is, on this trait the genotype-environment interactions and the strong influence of weather conditions on the formation of this valuable economic trait were clearly visible, which is well consistent with the correlation coefficients of the mass fraction of essential oil and yield of oil varyied between $r = 0.81–0.87$ depending on the year.

Table 5. Distribution of origanum samples by levels of traits manifestation, $n = 41$, 2018 (second year of life)

Trait	Distribution of samples by trait manifestation level, %						H, bit	H_{max}, bit
	1	2	3	4	5	6		
Qualitative traits								
Corolla color	17.1	19.5	22.0	41.5	-	-	1.90	2.00
Leaf color	34.1	14.6	14.6	36.6	-	-	1.87	2.00
Bract color	56.1	19.5	7.3	17.1	-	-	1.64	2.00
Stalk color	12.2	22.0	51.2	14.6	-	-	1.75	2.00
Male fertility	51.2	34.1	14.6	0.0	-	-	1.43	2.00
Quantitative traits								
Plant height, cm	2.4	29.3	63.4	4.9	-	-	1.28	2.00
Plant diameter, cm	0.0	17.1	61.0	22.0	-	-	1.35	2.32
Leaf length, mm	14.6	82.9	2.4	-	-	-	0.76	1.58
Leaf width, mm	9.8	75.6	14.6	0.0	-	-	1.04	2.00
Number of shoots, pcs.	4.9	39.0	41.5	4.9	9.8	-	1.81	2.32
Mass of bush, g	4.9	19.5	46.3	29.3	-	-	1.71	2.00
Essential oil mass fraction $_{a.d.m.}$, %	39.0	41.5	4.9	4.9	2.4	7.3	1.89	2.58
Yield of oil, g m^{-2}	65.9	29.3	2.4	2.4	-	-	1.18	2.00

Thus, comparing two years of trials, qualitative traits were shown more consistently than the quantitative ones. However, for identification it is interesting to use the most polymorphic traits with the highest entropy. In our experiments, it is ranged from 1.04 to 2.31 bits in 2017 and from 0.76 to 1.90 bits in 2018. The lower polymorphism of traits can be explained by the age of plants - in the second year, varietal traits are more stable and less susceptible to the environmental influence. Nevertheless, for reliable identification it is advisable to use the most polymorphic traits in both years. As a reference value, an empirical value of 1.50 bits was taken as a reference value. Such traits include the coloration of the bract, stalk, leaf and corolla, as well as the number of shoots and the mass fraction of essential oil.

The next stage of the work was the construction of dendrograms demonstrating the relationship of the collection samples of origanum with each other according to phenotypic traits (Figs 1, 2).

The structure of the construction differed over the years of the study, so the Mantel test was involved in addition to visual comparison, which allows one to compare two matrices (in this case - the distance matrices, along which the dendrograms were built) with each other. This test showed that the correlation coefficient had a reliable average $r = 0.58$.

For convenience (optimal number of clusters) a combined distance of 30 units for division into clusters was taken. As a result, in both years the collection samples of origanum are combined into five clusters (clusters were counted starting from the top).

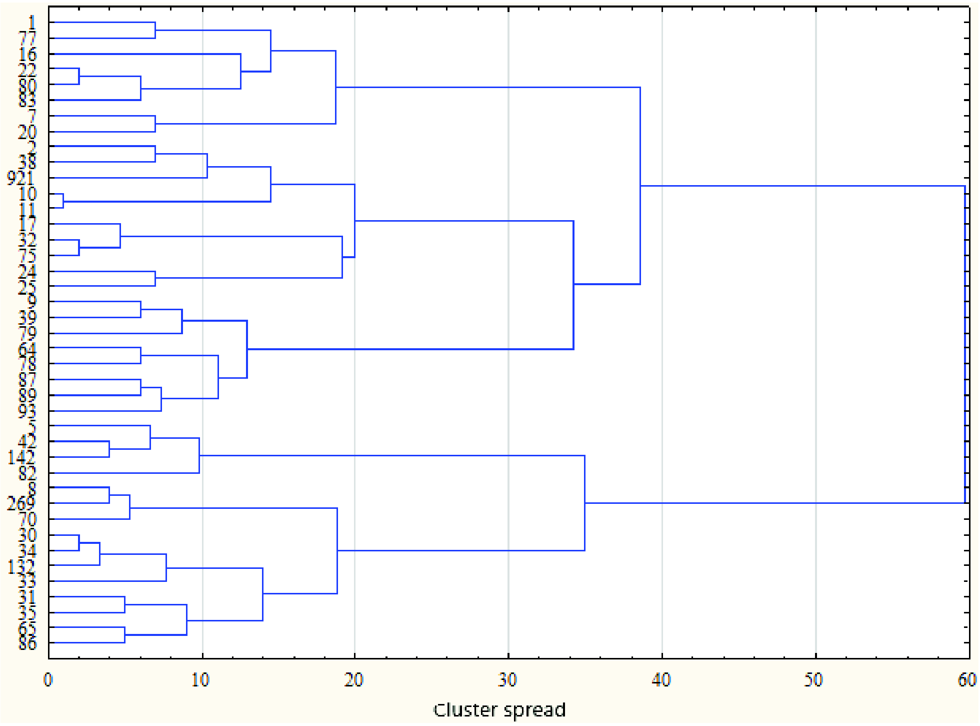

Figure 1. Dendrogram constructed on the phenotypic traits reflecting the relationship degree of origanum collection samples, 2017.

It is interesting to note that the first and fifth clusters of samples in both years coincided, and the second cluster of 2017 corresponded to the third cluster of 2018, the third cluster of 2017 - to the fourth of 2018, the fourth of 2017 - to the second of 2018. There are 78% of the samples (32 pieces) retained similarity in the construction over the years.

The occupancy of the clusters was quite similar over the years of the study. A stable grouping (the first cluster in 2017 and 2018) was formed by samples 1, 7, 20, 22, 77, 80, 83. They were characterized by an average mass of a bush (600–900 g), a low mass fraction of essential oil (from trace amounts to 0.15% of the adm) and low collection of essential oil per unit of area (up to 2.0 g m^{-2}).

The next resistant group (the second cluster in 2017 and the third in 2018) included genotypes 2, 10, 11, 17, 32, 75, distinguished by light lilac or lilac coloration of the corolla, green leaves, pigmented stalk, fertile flowers, a small number of shoots in a bush (up to 100 pcs.) and low mass of plants (up to 600 g $plant^{-1}$).

The third cluster of 2017 (fourth in 2018) was formed by samples 9, 39, 78, 79, 89. They were characterized by varying intensity lilac coloration of the corolla, lightly colored bracts, plants of medium height 66–65 cm, bush diameter - 66–85 cm, leaves

25–35 mm long and width 15–20 mm wide, low EOMF (0.05–0.25% of the adm), high bush mass (up to 1,200 g).

Sustainable construction was provided by genotypes 5, 8, 42, 70, 142, 269, which formed the fourth cluster in 2017 or the second in 2018. They were characterized by the presence of weakly pigmented stalks, leaves of medium length (25–35 mm), a rather high mass of the bush (up to 900 g).

The fifth cluster in both years was filled with samples 30, 33, 34, 35, 65, 86, 132. They were characterized by white coloration of the corolla, glaucous-green coloration of the leaf and generally intense coloration of the stalk, sprawling bushes (diameter of plants 86–105 cm), narrow (10–15 mm) and medium length (25–35 mm) leaves, high mass of plants (up to 1,200 g).

Thus, it may be concluded that clusters 3 and 5 are the most productive in terms of green mass yield.

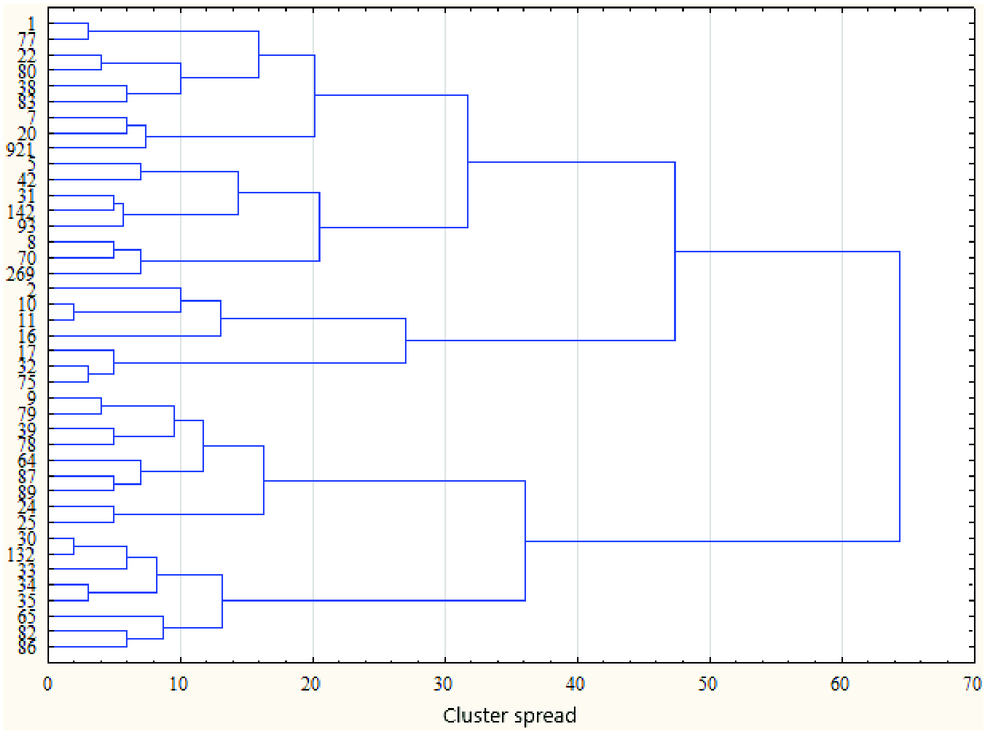

Figure 2. Dendrogram constructed on the phenotypic traits reflecting the relationship degree of origanum collection samples, 2018.

According to the authors, in the second year of plant life (the third after planting in open soil), the manifestation of quantitative phenotypic traits was more differentiated compared to qualitative ones. Therefore, it is interesting to consider the construction and grouping of samples in this year. The the first cluster was formed by samples 1, 7, 20, 22, 38, 77, 80, 83, 921 in 2018, which are characterized by large plants (up to 85 cm in height and a yield of green mass up to 900 g plant^{-1}) with a low essential oil mass fraction (from trace amounts up to 0.15% of the adm) and low a collection of essential oil (up to 2.0 g m^{-2}).

The second cluster was formed by samples 5, 8, 31, 42, 70, 93, 142, 269, having a painted corolla (light lilac or lilac), green leaves, pigmented stalks, low bush mass (up to 600 g) due to the low plant height (50% of samples - up to 65 cm) and the small number of shoots in the bush (up to 100 pcs.). However, this cluster was characterized by the presence of 42.7% of samples with EOMF at the level of 0.25–0.55% of the adm (4–6 points), which could be used as high-oil sources.

The third cluster was formed by samples 2, 10, 11, 16, 17, 32, 75, which was characterized mainly by white-flowered forms (7 samples out of 8) having intense anthocyanic coloration of stalks and bracts. The height of the bush is 2–3 points, 3 samples showed traces of essential oil (1 point), 1–2 points. In addition, this cluster included samples 10 and 11, which had EOMF of 0.490 and 0.420% of the adm or corresponding to 6 and 5 points.

Samples 9, 24, 25, 39, 64, 78, 87, 79, 89 included in the fourth cluster were characterized by tall (up to 85 cm) most yielding plants (bush mass up to 1,200 g).

The representatives of the fifth cluster (samples 30, 33, 34, 35, 65, 82, 86, 132) were characterized by the presence of exclusively high (66–85 cm) white flowered high-yield (up to 1,200 g plant^{-1}) samples with an average EOMF (up to 0.15% of the adm) and an average essential yield of oil, (up to 4.0 g m^{-2}), excluding sample 82 which had high oil content (up to 0.55% of the adm), which determines a high essential yield of oil (up to 8.0 g m^{-2}) along with high yield.

Thus, for breeding work, the contrasting clusters 2 and 5 (according to the 2018's data) were interesting for economically useful traits. For hybridization it is advisable to select parental forms from these two clusters for hybridization.

CONCLUSIONS

It was found that the qualitative traits showed themselves more consistently than the quantitative ones. For reliable identification of origanum samples of Crimean Peninsula, it is recommended to use the most polymorphic traits (H > 1.50 bits): coloration of the bract, stalk, leaf and corolla, as well as the number of shoots and mass fraction of essential oil.

When constructing dendrograms, the structure of the association differed in the years of study: according to the Mantel's test, the correlation coefficient was a reliable average $r = 0.58$. However, a fairly clear correspondence of the different years' clusters to each other was established (78% of the samples). This indicated genotype-environmental interactions in the manifestation of the studied phenotypic traits. Yet, the established correspondence of different years' clusters indicates the reliability of combining genotypes into separated groups (clusters) and their similar reaction to environmental conditions.

The most interesting combinations of samples for further breeding work were clusters 2 and 5 (according to the 2018 data). In 42.7% of genotypes from the second cluster, the mass fraction of essential oil was at the level of 0.25–0.55% of absolute dry mass (4–6 points). The samples from the second cluster could be used as high-oil sources, whereas samples from the fifth cluster - as sources of high productivity of 'green' raw materials (up to 1,200 g plant^{-1}). It would be advisable to select parental forms from these two clusters for hybridization.

Grouping of origanum samples used in the work quite accurately separated them not only on qualitative, but also on economically valuable traits.

It has been established that the grouping of origanum samples quite accurately divided samples not only on qualitative traits, but also on economic valuable traits. This may be offered to the breeders as one of the additional methods for classifying the source material and be further introduced into breeding and botanical practice.

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