UNIVERSITY OF LIFE SCIENCES ”KING MIHAI I” FROM TIMISOARA
”YOUNG PEOPLE AND MULTIDISCIPLINARY RESEARCH IN APPLIED LIFE SCIENCES”

05-06 November 2026



MORPHOMETRIC VARIATION BETWEEN TWO *ORIGANUM VULGARE* SUBSPECIES AND ITS RELATIONSHIP WITH PLANT DRY BIOMASS

Mariana, HANCZIG[1], (ORCID: 0009-0008-7963-9734), Ilinca Merima, IMBREA[1], (ORCID: 0000-0002-1436-883X), Diana, OBIȘTIOIU[1], (ORCID: 0000-0002-1481-6954)
[1]University of Life Sciences "King Mihai I" from Timișoara, Faculty of Agriculture
Corresponding author: ilinca_imbrea@usvt.ro

Abstract. *The genus Origanum comprises various aromatic species, along with numerous subspecies, varieties, and hybrids with morphological differences. The present study focuses on Origanum vulgare ssp. hirtum and ssp. vulgare. Although the chemical differences between ssp. hirtum and ssp. vulgare are well documented, quantitative morphometric comparisons of plants cultivated under the same conditions remain scarce. The aim of this study was to characterize the two subspecies through plant-level morphometric traits and to evaluate which of these traits are associated with plant dry weight. Twenty plants of each subspecies, grown in the same experimental field in western Romania, were measured at flowering in 2025 for 12 traits describing plant size, branch architecture, inflorescence development and leaf dimensions; whole-plant dry weight was determined after drying. Data were analysed by one-way ANOVA, confirmed with the Mann–Whitney test, by within-subspecies correlation analysis and by principal component analysis. Ssp. vulgare had a wider canopy (52.9 vs. 41.0 cm), taller branches (35.4 vs. 26.4 cm), longer inflorescences (15.2 vs. 10.0 cm), longer internodes (2.41 vs. 1.45 cm) and larger leaves ($p \leq 0.001$), whereas ssp. hirtum retained more leaves per branch (12.1 vs. 8.1) and formed a more compact plant. The first principal component (44.9% of variance), defined by size and elongation traits, separated the two subspecies, with a single overlapping plant. Plant dry weight was poorly predicted by morphology; inflorescence length was the only trait consistently correlated with dry weight in ssp. hirtum ($r = 0.64$; $\rho = 0.57$).*

Keywords**:** *Origanum vulgare; ssp. hirtum; ssp. vulgare; morphometry; principal component analysis; dry biomass*

INTRODUCTION

Origanum vulgare (Lamiaceae) is one of the most widely used culinary and medicinal aromatic plants, valued for its essential oil and for its antioxidant and antimicrobial properties (KOSAKOWSKA et al., 2024; NURZYŃSKA-WIERDAK &WALASEK-JANUSZ, 2025). The species is highly polymorphic, and its intraspecific variability has been organized into several subspecies that differ in indumentum, leaf size, bract colour and inflorescence structure (IETSWAART, 1980). Among them, *O. vulgare* ssp. *hirtum* (Greek oregano) and ssp. *vulgare* (common oregano) are the most frequently cultivated in Europe (ALEKSEEVA , 2020; CIOCÂRLAN, 2009). In a previous study on a separate set of plants from the same collection, biomass partitioning among leaves, inflorescences and stems was compared between the two subspecies in fresh and dried material (HANCZIG et al., 2026). The present study addresses a different question and uses an independent data set. Its objectives were to quantify the morphometric differences between *O. vulgare* ssp. *hirtum* and ssp. *vulgare* cultivated under the same conditions, to assess the variability of these traits within each subspecies, and to identify the morphometric traits associated with whole-plant dry weight.

MATERIAL AND METHODS

The study was carried out in 2025 on plants of *Origanum vulgare* ssp. *hirtum* and *O. vulgare* ssp. *vulgare* grown in the Lugoj area (Timiș County). The plants were cultivated under the same technology. From these data, the following plant-level variables were calculated: main branch height (HMB), mean height of the four branches (HB), mean inflorescence length (IL), inflorescence ratio (IR, %, the sum of inflorescence lengths divided by the sum of branch heights × 100), mean number of nodes and of leaves per branch, mean internode length (IntL), mean leaf length (LL), mean leaf width (LW) and the mean leaf length/width ratio (L/W). After harvest, the whole plants were dried naturally, in a shaded ventilated room until constant weight, and the plant dry weight (DW, g) was determined on an electronic balance with 0.01 g resolution.

RESULTS AND DISCUSSIONS

Eleven of the twelve morphometric traits differed significantly between the two subspecies according to ANOVA (Table 1).

Origanum vulgare ssp. *vulgare* formed larger plants than ssp. *hirtum*. The canopy diameter was 52.9 cm compared with 41.0 cm (+29%), the main branch reached 40.9 cm compared with 29.7 cm, and the mean branch height was 35.4 cm compared with 26.4 cm (Figure 1). The greater height of ssp. *vulgare* resulted mainly from longer internodes (2.41 vs. 1.45 cm; F = 99.81, the strongest effect among all traits) and not from a greater number of nodes, which was in fact slightly lower in ssp. *vulgare* (5.5 vs. 6.6 nodes per branch; significant by ANOVA but not confirmed by the Mann–Whitney test). Ssp. *hirtum* therefore has a compact architecture with short internodes, in agreement with the descriptions of Greek oregano as a dense, low-growing plant (IETSWAART, 1980; SKOUFOGIANNI ET AL., 2019). Inflorescences were 52% longer in ssp. *vulgare* (15.2 vs. 10.0 cm), and the inflorescence ratio was higher (42.9% vs. 38.3%), although the latter difference was at the limit of significance (p = 0.047 by ANOVA, p = 0.053 by the Mann–Whitney test). Leaves of ssp. *vulgare* were longer (2.88 vs. 2.38 cm) and wider (1.94 vs. 1.69 cm) than those of ssp. *hirtum*. The leaf length/width ratio differed only marginally (1.51 vs. 1.43; not confirmed by the Mann–Whitney test). In contrast, ssp. *hirtum* retained more leaves per branch at flowering (12.1 vs. 8.1). In ssp. *vulgare*, this trait varied very strongly (CV = 46.5%, range 2.75–15.5 leaves per branch), and several plants had only a few leaves left on the measured branches.

Leaf dimensions showed low variability (CV 5.8–13.3%), confirming that leaf size is a stable trait suitable for discriminating the subspecies. The number of leaves, the number of nodes and the number of branches were more variable in ssp. *vulgare* (CV 26–47%) than in ssp. *hirtum* (CV 16–20%), indicating a more heterogeneous population of ssp. *vulgare*, in agreement with the high morphological variability reported for this subspecies (KOSAKOWSKA&CZUPA, 2018).

Plant dry weight had the highest variability in both subspecies (CV 29.9–35.9%). The mean dry weight was 25.19 g per plant in ssp. *hirtum* and 19.29 g in ssp. *vulgare* (p = 0.019; p = 0.009 by the Mann–Whitney test). In ssp. *hirtum*, the distribution of dry weight was influenced by one exceptionally large plant (52.81 g), which was also the tallest plant of this subspecies.

Table 1

Morphometric traits and plant dry weight of *Origanum vulgare* ssp. *hirtum* and ssp. *vulgare*

Trait	ssp. hirtum (n = 20)		ssp. vulgare (n = 20)		F	ANOVA	M–W
	Mean ± SE	CV%	Mean ± SE	CV%	(1;38)		
Plant diameter, PD (cm)	41.00 ± 1.01	11.0	52.90 ± 1.90	16.1	30.61	***	***
Number of branches, NB	13.90 ± 0.49	15.8	13.30 ± 0.77	25.8	0.43	ns	ns
Main branch height, HMB (cm)	29.68 ± 1.55	23.3	40.90 ± 1.40	15.3	29.05	***	***
Mean branch height, HB (cm)	26.36 ± 1.06	18.1	35.42 ± 1.01	12.8	38.12	***	***
Inflorescence length, IL (cm)	9.98 ± 0.38	16.9	15.18 ± 0.75	22.1	38.45	***	***
Inflorescence ratio, IR (%)	38.34 ± 1.37	16.0	42.90 ± 1.75	18.2	4.21	*	ns
Nodes per branch, NN	6.55 ± 0.29	19.8	5.46 ± 0.39	32.0	4.99	*	ns
Internode length, IntL (cm)	1.45 ± 0.07	20.5	2.41 ± 0.07	12.9	99.81	***	***
Leaves per branch, NL	12.05 ± 0.53	19.6	8.05 ± 0.84	46.5	16.34	***	***
Leaf length, LL (cm)	2.38 ± 0.03	6.4	2.88 ± 0.09	13.3	29.68	***	***
Leaf width, LW (cm)	1.69 ± 0.03	7.5	1.94 ± 0.04	8.8	26.91	***	***
Leaf length/width ratio, L/W	1.43 ± 0.02	5.8	1.51 ± 0.04	10.9	4.31	*	ns
Plant dry weight, DW (g)	25.19 ± 2.02	35.9	19.29 ± 1.29	29.9	6.05	*	**

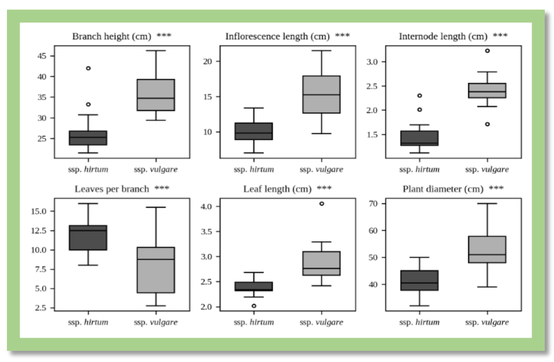


Figure 1. Distribution of selected morphometric traits in *O. vulgare* ssp. *hirtum* and ssp. *vulgare* (n = 20 plants per subspecies; *** $p \leq 0.001$, one-way ANOVA)

Within subspecies, morphometric traits explained only a small part of the variation in dry weight (Table 2). In ssp. *hirtum*, significant Pearson correlations were found for inflorescence length (r = 0.64**), mean branch height (r = 0.59**), main branch height (r = 0.57**) and internode length (r = 0.50*). In ssp. *vulgare*, only main branch height showed a weak significant Pearson correlation with dry weight (r = 0.45*), which was not confirmed by the Spearman coefficient.

The regression of dry weight on inflorescence length (Figure 3) explained 40% of the variation in ssp. *hirtum* ($y = 3.41x - 8.83$; $R^2 = 0.40$; p = 0.003), with an increase of about 3.4 g of dry weight for each additional centimetre of inflorescence length. In ssp. *vulgare* the relationship was not significant ($R^2 = 0.16$; p = 0.084). The first two principal components explained 68.5% of the total variance (Table 3). PC1 (44.9%, eigenvalue 5.38) was a size and elongation axis, with high positive loadings for mean branch height (0.93), internode length (0.91), main branch height (0.89), inflorescence length (0.84), leaf length (0.82), leaf width (0.79) and canopy diameter (0.71). PC2 (23.6%, eigenvalue 2.84) contrasted the number of nodes (0.89) and leaves per branch (0.82) with the inflorescence ratio (−0.77), and thus described the balance between the leafy and the flowering part of the branch.

The two subspecies were clearly separated along PC1 (Figure 2): all ssp. *hirtum* plants except one had negative scores and all ssp. *vulgare* plants had positive or zero scores (mean scores −1.98 and +1.98; F = 101.99; p < 0.001). The only ssp. *hirtum* plant with a positive PC1 score was the large plant discussed above. Along PC2, ssp. *vulgare* plants were spread widely, reflecting their variable leaf retention, whereas ssp. *hirtum* plants formed a more compact group. The multivariate pattern confirms that the morphological difference between the subspecies is mainly one of size and internode elongation, combined with a different balance between leaves and inflorescences.

Table 2

Correlation coefficients between morphometric traits and plant dry weight, calculated within each subspecies (n = 20)

Trait	ssp. hirtum		ssp. vulgare	
	Pearson r	Spearman ρ	Pearson r	Spearman ρ
Plant diameter, PD (cm)	0.40	0.36	0.14	0.09
Number of branches, NB	0.37	0.43	0.31	0.36
Main branch height, HMB (cm)	0.57**	0.23	0.45*	0.22
Mean branch height, HB (cm)	0.59**	0.28	0.43	0.19
Inflorescence length, IL (cm)	0.64**	0.57**	0.40	0.31
Inflorescence ratio, IR (%)	0.06	0.21	0.18	0.18
Nodes per branch, NN	0.22	0.02	-0.12	-0.30
Internode length, IntL (cm)	0.50*	0.32	-0.03	0.05
Leaves per branch, NL	0.23	0.06	-0.10	-0.27
Leaf length, LL (cm)	0.34	0.18	0.37	0.28
Leaf width, LW (cm)	0.43	0.28	0.06	0.06
Leaf length/width ratio, L/W	-0.18	-0.13	0.34	0.40

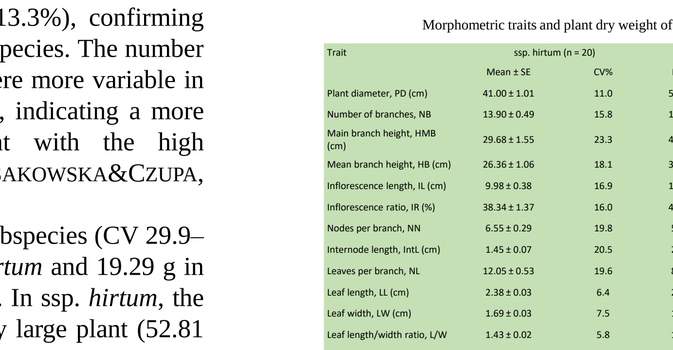


Figure 3. Relationship between inflorescence length and plant dry weight within each subspecies

Table 3

Loadings of the morphometric traits on the first two principal components (n = 40)

Trait	PC1	PC2
Plant diameter, PD (cm)	0.71	-0.24
Number of branches, NB	-0.06	-0.47
Main branch height, HMB (cm)	0.89	0.29
Mean branch height, HB (cm)	0.93	0.24
Inflorescence length, IL (cm)	0.84	-0.34
Inflorescence ratio, IR (%)	0.29	-0.77
Nodes per branch, NN	-0.12	0.89
Internode length, IntL (cm)	0.91	0.00
Leaves per branch, NL	-0.32	0.82
Leaf length, LL (cm)	0.82	0.32
Leaf width, LW (cm)	0.79	0.35
Leaf length/width ratio, L/W	0.41	0.06
Eigenvalue	5.38	2.84
Explained variance (%)	44.9	23.6
Cumulative variance (%)	44.9	68.5

Figure 2. Principal component biplot

CONCLUSIONS

Origanum vulgare ssp. *vulgare* and ssp. *hirtum* cultivated under the same conditions differed very significantly. *Origanum vulgare* ssp. *vulgare* formed wider and taller plants, with longer internodes, longer inflorescences and larger leaves, whereas ssp. *hirtum* had a compact architecture, with short internodes and more leaves retained per branch at flowering. The number of branches did not differ between the subspecies. Internode length, branch height, inflorescence length, leaf dimensions and canopy diameter were the most discriminating traits, and the principal component defined by these traits separated the two subspecies almost completely. Leaf dimensions had the lowest variability and represent stable descriptors of the subspecies.

Plant dry weight was weakly related to plant morphology. Inflorescence length was the only trait consistently associated with dry weight, and only in ssp. *hirtum* ($R^2 = 0.40$), where it may serve as a non-destructive estimator of plant biomass. The strong variation in leaf retention in ssp. *vulgare* indicates that, for production of dried leaves, harvest should not be delayed beyond the onset of flowering in this subspecies.