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EVALUATION OF THE AGRONOMIC POTENTIAL OF THE NEW *SIDERITIS HYSSOPIFOLIA* CULTIVAR DEVELOPED THROUGH BREEDING AT BRGV BUZĂU

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Abstract

Since 2019, researchers at BRGV Buzău have intensified acclimatization and breeding efforts within the genus Sideritis, with a particular focus on Sideritis hyssopifolia. Genetic resources from native areas were introduced and evaluated in comparative field trials to assess adaptability, genetic stability, and uniformity. Among the six cultivars studied, genotype G17 showed superior ecological plasticity and excellent adaptation to Romania's climatic conditions. The breeding program was completed in 2024, and G17 was proposed for official registration under the provisional name Enescu, with certification expected in 2026. The Enescu cultivar demonstrated a high green biomass yield of 6.46 t/ha and the absence of pathogens, recommending it for organic farming systems. Biomorphological evaluations highlighted valuable traits, with maximum plant dimensions recorded in the fourth year of cultivation (49.4 cm diameter and 44.02 cm height). SFurther studies will focus on biochemical characterization to assess the medicinal and therapeutic potential specific to Sideritis species. In the long term, the Enescu cultivar is intended for introduction into cultivation and promotion as a medicinal, aromatic, ornamental, and entomophilous species.

Key words*: acclimatization, genotype, germplasm, medicinal, entomophilous*

INTRODUCTION

The genus *Sideritis* belongs to the family *Lamiaceae*, widely recognized as a family of medicinal plants, and comprises aromatic annual or perennial herbaceous species extensively cultivated for medicinal, perfumery, cosmetic, culinary, and ornamental purposes (Baydar, 2025). The subgenus *Sideritis* includes approximately 125 continental endemic species distributed along the western Mediterranean coast, particularly in southeastern Spain and northwestern Africa (Obón de Castro and Rivera-Nunez, 1994; Dülgeroğlu, 2017). A shared ecological trait of *Sideritis* species is their preference for high-altitude mountainous habitats with calcareous soils, low precipitation, and high temperatures. They are perennial herbs, woody at the base, simple or branched, with silver-green stems and leaves covered by glandular trichomes that confer a woolly, velvety appearance (Negoșanu et al., 2022). *Sideritis* species are recognized as important medicinal plants, and global commercial demand is steadily increasing. The threat to wild populations due to overharvesting has necessitated the introduction of *Sideritis* species into cultivation in countries such as Greece, Bulgaria, and Turkey. Over the last decade, efforts have focused on optimizing cultivation conditions to maximize the content of bioactive secondary metabolites, thereby enhancing pharmacological potential (Chrysargyris et al., 2019). Samples of *Sideritis scardica*, *S. raeseri*, and *S. syriaca* cultivated in different regions of Greece were analyzed for essential oil content, and the results showed that qualitative and quantitative differences were attributable to abiotic factors such as soil, temperature, humidity, rainfall, and altitude (Kaparakou et al., 2023). In Romania, the only naturally occurring species is *S. montana*, locally known as "încheietoare" or "urechea-șoarecului," first documented in 1906 by Zach C. Panțu and later by Eugen Ghișa in 1961 in the botanical reserve of Zaul-de-Câmpie. *S. montana* is also found in Dobrogea. Recent climate change - primarily rising temperatures and prolonged drought periods, in

Romania (Ceccarelli, 2010) has increased the demand for new species adapted to hot and arid environments (Bradley et al., 2011). Romania shows heightened vulnerability to the frequency and intensity of extreme meteorological events, with drought representing a major limiting factor affecting plant growth over extensive areas and causing annual agricultural yield reductions of at least 30-50% (Hurduzeu et al., 2014).

Research on *Sideritis* species in Romania began after 2000 at the Laboratory of Genetics and Biodiversity Conservation within the Vegetable Research and Development Station Buzău, under the coordination of researcher Costel Vînătoru, aiming to enrich the acclimatized plant collection with new, valuable species of multiple uses. This work resulted in the development of the first Romanian cultivar of *Sideritis scardica*, officially registered in the National Catalogue of Cultivated Plants under the commercial name 'Domnesc' (Vînătoru et al., 2021) (Figure 1).



a) b)

Figure 1. Aspects of *S. scardica* cultivation in an experimental field

As a direct consequence of climate change and biodiversity decline, the Plant Genetic Resources Bank (BRGV) Buzău integrated four *Sideritis* species into its acclimatization and breeding program starting in 2021: *Sideritis scardica* L., *S. scardica* L. var. Ossa, *S. syriaca* L., and *S. hyssopifolia*, with a fifth species, *S. cypria*, added in 2022.

MATERIALS AND METHODS

The research was conducted at BRGV Buzău (45°09′N, 25°05′E, 95 m altitude) in southeastern Romania, an area characterized by a continental climate, steppe-type vegetation, and leached chernozem soil. The study period covered 2021-2024. Genetic resources of *Sideritis hyssopifolia* were acquired from its area of origin (Spain). Five cultivated genotypes (G13, G14, G15, G16, and G17) were analyzed and were spatially isolated from other *Sideritis* species in order to prevent genetic contamination (Figure 2).



a) b)

Figure 2. *Sideritis hyssopifolia* seedling: a) before and b) after transplanting

The sowing was done in the first decade of March in protected spaces. Seeds were placed in 70-cell black plastic trays filled with commercial peat under nursery conditions, with vegetation factors monitored (Figure 3).



a) b)

Figure 3. Aspects of culture technology: a) filling pallets with peat; b) thermo-hygrometer for monitoring T°C and U%

Seedlings were transplanted after 45 days (07 May 2023) at the 7-9 leaf stage and 8-10 cm height. No fertilizers, insecticides, or other agrochemicals were applied during seedling production.

The breeding methods included repeated individual selection from the first year to accumulate valuable traits, followed by negative mass selection in the second and third years to eliminate unsuitable forms and conserve superior phenotypic characteristics. At the time of the observations, no UPOV descriptor existed for the genus *Sideritis*; therefore, the basil (*Ocimum basilicum*) descriptor was provisionally adopted, given that both belong to *Lamiaceae*. Subsequently, a new evaluation descriptor for *Sideritis* species was developed and approved by BRGV for future studies.

Weighing was conducted in the BRGV laboratory on fresh plant material using a Kern 572-33 balance (±0.01 g precision). Statistical

analysis was performed using IBM SPSS v29.0. Data normality was verified prior to ANOVA. One-way ANOVA was applied per genotype, and when significant differences were observed, means were compared using Duncan's multiple range test at $p \leq 0.05$.

RESULTS AND DISCUSSIONS

S. hyssopifolia plants introduced from Spain showed high adaptive capacity, being the only species that flowered in the first cultivation year. Typical *Sideritis* traits include verticillate inflorescences (characteristic of *Lamiaceae*) and leaves resembling those of hyssop.

Temperature and precipitation are key climatic determinants for *Sideritis* species. The 2021-2024 period was marked by extremely hot summers with thermal stress and low rainfall, and springs with high precipitation. Elevated December temperatures and short frost periods in January-February did not affect root systems. In 2021, conditions favored optimal rooting and rosette formation in *S. hyssopifolia*, while July soil drought and reduced precipitation stimulated growth. High temperatures and low rainfall during May-July, coinciding with flowering and harvest phenophases in *Sideritis*, favor intensive accumulation of bioactive compounds (Sarrou et al., 2022; Mansinhos et al., 2024).

Among all *Sideritis* species acclimatized at BRGV Buzău, *S. hyssopifolia* showed the greatest tolerance to torrential rainfall, with resistance to stem breakage due to basal lignification. Reduced pubescence on stems, leaves, and inflorescences prevents excessive water retention, reducing floral stem bending and breakage (Negosanu et al., 2023).

According to Negosanu et al. (2024), first-year traits included rapid flower stalk formation (one month after transplanting), stem lignification, and strong growth and branching. In the second and third years, plants exhibited increased stem number, higher vegetative biomass (Table 1), lignification extending to tertiary branches, and two flowering waves (summer and autumn). Plant habit varied from fan-shaped to spherical, with erect, hyssop-like stems. Leaves were oval-lanceolate with serrated margins and intense green coloration due to sparse glandular trichomes.

Inflorescences were terminal (Figure 4); flowers were small with oval bracts, a tubular calyx with 4-5 mm teeth, and a light greenish-yellow corolla exceeding the calyx. Fruits were ovoid nutlets, typically four per flower, usually all reaching maturity. Pollination was entomophilous and allogamous. Oil glands were present on all aerial organs, producing a characteristic strong aroma.



a) b)

Figure 4. *Sideritis hyssopifolia*: a) jawed leaf; b) inflorescence detail

During the study period, no diseases or pests causing significant crop damage were recorded. Through the applied breeding methods, five genotypes were advanced: G13, G14, G15, G16, and G17.

Table 1. Influence of year of study on the average vegetative mass by genotype

Genotyp / Year	Vegetative mass (g) 2021	Vegetative mass (g) 2022	Vegetative mass (g) 2023	Vegetative mass (g) 2024
	Average±SD	Average±SD	Average±SD	Average±SD
G13	31.1±2.81^{b}	111.9 ±8.63^{c}	163±7.54^{b}	173.2±6.85^{ab}
G14	39.4 ±4.18^{c}	117.8±5.04^{c}	131.58±8.78^{a}	157.89±7.78^{a}
G15	35.6 ±7.04^{bc}	92.74±6.58^{a}	134.14±9.14^{a}	159.18±8.45^{a}
G16	24.9±1.66^{a}	101.02±2.3^{c}	126.5±3.94^{a}	149.79±4.52^{a}
G17	22.4±2.48^{a}	96.88±3.76^{ab}	173.76±7.70^{c}	207.60±6.95^{c}
Annual vegetative mass	30.22±3.63	104.23±5.26	145.78±7.42	163.02±6.90
Coefficient Pearson	***p<0,0001***	***p<0,0001***	***p<0,0001***	***p <0,0001***

Note: SD = standard deviation; p = Pearson coefficient; Duncan Test: Mean values followed by different letters are significantly different at the p <0.05 level.

Monitoring of quantitative traits revealed important morphological and biometric differences among the studied genotypes over the four years, with high relevance for the acclimatization and breeding of *S. hyssopifolia*. Plant height is an essential biometric component for phenotypic evaluation, and its monitoring was conducted by tracking the growth dynamics of the *S. hyssopifolia* genotypes during 2021-2024. All five genotypes showed strong development in 2021; the percentage increase in height was 47.89% in 2022, 6.26% in 2023, and 20.19% in 2024. Recorded value ranges were as follows: in 2021, minimum 20.4 cm (G16) and maximum 27.5 cm (G15); in 2022, minimum 32.1 cm (G16) and maximum 38.4 cm (G15); in 2023, minimum 32.6 cm (G16) and maximum 38.4 cm (G13); and in 2024, minimum 39.1 cm (G16) and maximum 46.9 cm (G15). One-way ANOVA followed by post hoc tests showed no significant differences among genotypes for plant height in 2021 and 2023, whereas significant differences were detected in 2022 and 2024. These findings are consistent with literature data: Santayana et al. (2005) describe *S. hyssopifolia* in its native area as a perennial species not exceeding 40 cm in height, while Mateo-Sanz and Pisco-García (2000) report a height range of 15-35 cm.

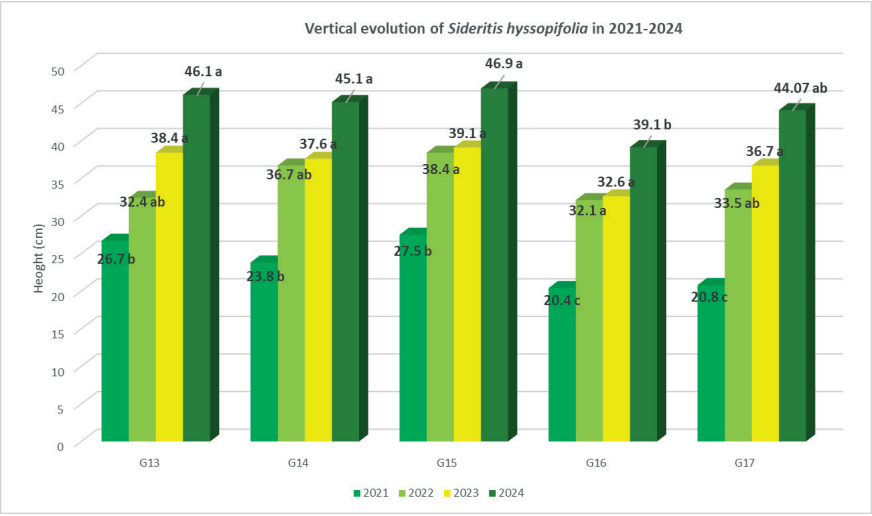

Figure 5. Vertical development of *Sideritis hyssopifolia* genotypes

The evolution of bush diameter over the four cultivation years is presented in Figure 5. One-way ANOVA with Duncan's test indicated no significant differences among the five genotypes within the same year. Value ranges were: in 2021, minimum 20.8 cm (G14) and maximum 24.8 cm (G15); in 2022, minimum 31.7 cm (G15) and maximum 43.4 cm (G17); in 2023, minimum 36.3 cm (G15) and maximum 44.82 cm (G17); and in 2024, minimum 43.6 cm (G15) and maximum 49.4 cm (G17). Although interannual growth dynamics were pronounced, within-year genotype development was relatively uniform, without major deviations (Figure 6).

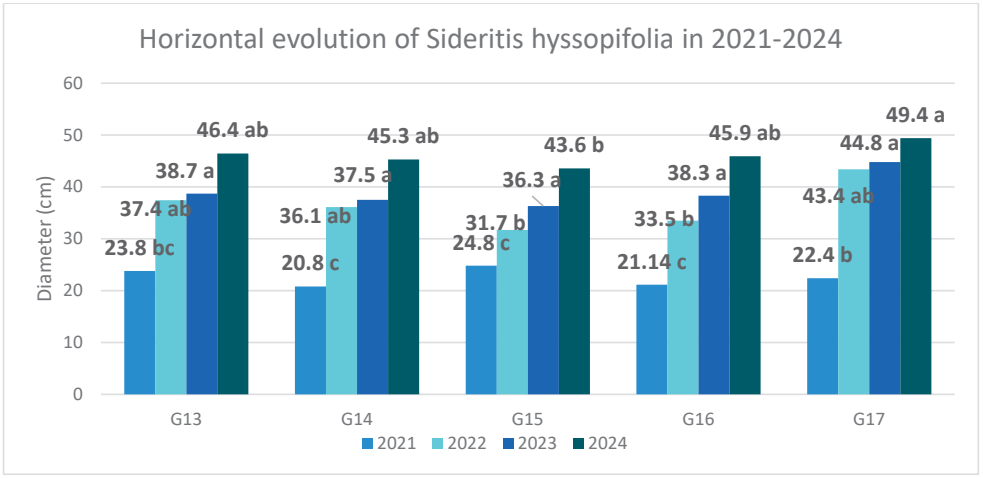

Figure 6. Horizontal development of *Sideritis hyssopifolia* genotypes

From the first cultivation year, *S. hyssopifolia* showed strong branching, producing first-, second-, and third-order inflorescences. Their distribution was dominated by third-order (tertiary) spikes (67.01%), followed by second-order (secondary) spikes (23.66%), while first-order (primary) spikes had the lowest proportion (9.33%) (Figure 7).

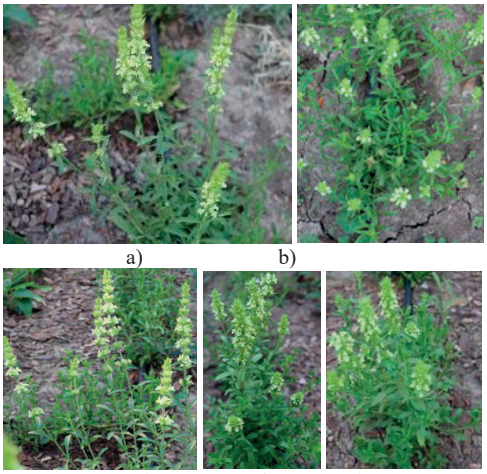

Figure 7. Images from the first year of cultivation:
a) G13; b) G14; c) G15; d) G16; e) G17

Quantitative inflorescence descriptors included mean inflorescence length and the number of verticillasters per spike order.

Maximum values for primary inflorescences were recorded in genotype G13 (15.9 cm in length, 15 verticillasters). Secondary inflorescences reached maximum values in G17 (13.4 cm in length, 7 widely spaced verticillasters). For tertiary inflorescences, genotype G13 again showed the highest values (11.2 cm in length, 11 compact verticillasters). Notably, in the first cultivation year, G17 was distinguished by a compact and well-balanced bush architecture, both horizontally and vertically.

The productivity of *S. hyssopifolia* (Table 2) was calculated based on fresh biomass expressed as g plant and t ha for each year, assuming a planting density of 32,000 plants ha. In 2022, vegetative biomass values for the genotypes were similar, within a narrow range of 92.74-117.8 g plant. Genotype G16 recorded the highest productivity per plant (117.8 g plant) and per hectare (3.77 t/ha), while G14 showed the highest production expressed as the number of flowering stems (2,304 thousand stems/ha), due to the maximum number of stems formed in the second cultivation year (72 stems/plant). In 2023, genotype G16 again exhibited the highest productivity per plant (173.7 g), resulting from a 42.62% increase in the number of flowering stems compared to 2022, and achieved a productivity of 5.56t/ha. The highest productivity, expressed as the number of stems, was recorded for genotype G14, with 3,584 thousand stems/ha, this genotype also showed the highest number of flowering stems per plant, 112.

Table 2. Evolution of production elements in *S. hyssopifolia* genotypes in the 2nd, 3rd and 4th year of culture

Year	2022					2023					2024				
Elements	Productivity/ plant			Productivity/ha		Productivity/ plant			Productivity/ha		Productivity/ plant			Productivity/ha	
Genotyp	NFS	FSM (g)	P (g)	no of 1.000 rods/ha	t	NFS	FSM (g)	P (g)	no of 1.000 rods/ha	t	NFS	FSM (g)	P (g)	no of 1.000 rods/ ha	t
G13	67	1.45	96.88	2,144	3.1	93	1.41	131.5	2,976	4.21	102.3	1.55	158.56	3,273	5.07
G14	72	1.4	101	2,304	3.23	112	1.13	126.5	3,584	4.05	113	1.24	140.12	3,616	4.48
G15	56	1.66	92.74	1,792	2.97	90	1.49	134.1	2,880	4.29	99	1.63	161.37	3,168	5.16
G16	61	1.93	117.8	1,952	3.77	87	2	173.7	2,784	5.56	95	1.70	161.5	3,040	5.16
G17	69	1.62	111.9	2,208	3.58	103	1.58	163	3,296	5.22	118	1.72	202.9	3,776	6.46

Note: NFS = number of flowering stems; FSM = flowering stem mass; P(g) = productivity/plant; t = tons.

Inflorescences are located in the upper third of the flowering stem, arranged in verticillasters (4-18), which flower sequentially. Flowering onset occurs in the second half of May, followed by the full flowering phase after 10-12 days. The onset of seed maturation takes place in mid-June, while maximum seed maturity is reached by the end of the first decade of July, when harvesting can be performed. *Sideritis hyssopifolia* requires approximately 69 days for seed maturation and is therefore considered a late-maturing species.

As is characteristic of *Lamiaceae*, the flowering and seed maturation phenophases overlap (Negosanu et al., 2022); thus, the onset of seed maturation in the basal verticillasters coincides with the flowering of the apical verticillasters. This overlap requires increased attention from breeders, as manual seed harvesting must be carried out in two or more stages. When harvesting flowering stems,

the optimal moment is when approximately 75% of the inflorescence is open (Figure 8).

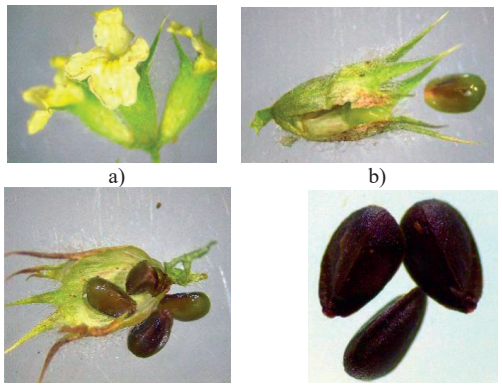

Figure 8. Phenological stage presentation: a) flowering stage; b) and c) onset of seed maturation; d) entirely matured seeds, optimal for harvesting

CONCLUSIONS

Sideritis hyssopifolia demonstrated excellent adaptability to the pedoclimatic conditions of Romania, being distinguished by abundant flowering from the first year of cultivation, the formation of a high number of flowering stems, and the production of viable seeds.

Breeding activities conducted at BRGV Buzau led to the identification of valuable genotypes, with G17 standing out for its vigor, stability, and highest productivity; this genotype has been proposed for official registration under the name 'Enescu'.

S. hyssopifolia shows high potential as a medicinal, aromatic, ornamental, and melliferous plant and can be successfully cultivated under organic farming systems. Dissemination of the obtained results, together with the availability of seed material, creates favorable premises for the expansion of this crop into commercial production.

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