

Article

Biometric Indicators of Rocket Salad (*Diplotaxis Tenuifolia* L.) Varieties

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Citation: Iskandarovich A. E., Ismatovich A. S. Biometric Indicators of Rocket Salad (*Diplotaxis Tenuifolia* L.) Varieties. American Journal Of Biodiversity 2026, 6(5), 39-46.

Received: 10th Feb 2026

Revised: 11th Mar 2026

Accepted: 20th Apr 2026

Published: 31th May 2026



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Abstract: The article presents a comparative study on the morphological and biometric parameters of rocket salad (*Diplotaxis tenuifolia* L.) varieties, including leaf number, leaf length, leaf width, leaf area, leaf area per plant, and leaf area index per hectare. During the study, the growth and development dynamics, leaf formation intensity, and agrobiological characteristics of various varieties were analyzed.

Keywords: *Diplotaxis tenuifolia* L., rocket salad, variety, biometric parameters, leaf number, leaf length, leaf area, leaf area per plant.

Introduction

There are currently no arugula (rocket salad) varieties included in the State Register of Agricultural Crops Recommended for Cultivation in the Republic of Uzbekistan.

In 2020, the State Register of Breeding Achievements Approved for Use in the Russian Federation included 34 varieties of arugula, namely: Akropol, Bud Zdorov, Gratsiya, Gurman, Djemini, Dikovina, Dragons Tang, Izumrudniye Uzori, Italyanskaya, Koltivata, Poker, Krasotka, Letnyaya Svejest, Na Zdorovye, Poker, Poliglot, Papayares, Rokoko, Rusalochka, Sokramento, San Remo, Selvadjiya, Sibiriada, Sinop, Argemona, Sorento, Sparkl, Spartak, Spidi, Temisto, Khudey Vkusno, Chudesnitsa, Evrika, and Yuzhnaya Noch [1]. These data indicate the considerable attention given to arugula cultivation in the Russian Federation and the importance attached to its wider introduction and popularization.

In subsequent years, early-maturing varieties such as Raket, Olivetta, Gratsiya, and Taganskaya Semko have been cultivated, requiring 25–30 days to reach technical maturity. Medium-maturing varieties, including Argemona, Dikovina, Strely Kupidona, Pasyans, Izumrudnaya, Poker, and Gratsiya, require approximately 30 days to reach technical maturity. The yield of early-maturing

varieties is 1.3–1.5 kg/m², whereas that of medium-maturing varieties is 2.0–2.5 kg/m². The best preceding crops for arugula are carrots, crops belonging to the Cucurbitaceae family, potatoes, legumes, and tomatoes [2]; [3]; [4]; [5]; [6]; [7]; [8];[9].

Research Methods

Field experiments were conducted using the following methodological guidelines and manuals: Methodological Guidelines for Ecological Testing of Vegetable Crops in Open Ground (Moscow, 1981); Methods of Experimental Work in Vegetable and Melon Growing (Moscow, 1992); Methods for Conducting Experiments with Vegetable, Melon, and Potato Crops (Tashkent, 2023); and Methodology for State Variety Testing of Agricultural Crops (Moscow, 2015).

Statistical analysis of the experimental data was performed using Microsoft Excel based on the analysis of variance (ANOVA) method described by B. A. Dospekhov [10]; [11]; [12]; [13]; [14]; [15].

In 2021, the number of leaves per plant in the studied arugula varieties was found to be 17.3 leaves in the Argemona variety, 18.3 in Gratsiya, 17.6 in Papayares, 13.2 in Poker, 15.8 in Rokako, 13.6 in Spartak, and 17.0 in Viktoriya. Following mathematical and statistical analysis, the number of leaves per plant showed an EKF₀₅ of 0.4 leaves and a coefficient of variation (Sx%) of 2.8%.

Experimental results

In 2022, compared with the inter-varietal average of 16.6 leaves per plant, Gratsiya produced 3.3 more leaves, Rokako 1.4 more, Papayares 1.2 more, Viktoriya 0.6 more, and Argemona 0.4 more leaves. In contrast, Poker produced 2.6 fewer leaves and Spartak 2.0 fewer leaves than the average. Following mathematical and statistical analysis, the number of leaves per plant showed an EKF₀₅ of 0.7 leaves and a coefficient of variation (Sx%) of 4.1%.

Table 1. The number of leaves per plant in rocket lettuce varieties.

Variety names	Number of leaves per plant, pcs.				Compared with the average across varieties, %
	2021-year	2022-year	2023-year	Average	
Inter-varietal average	16,1	16,6	16,8	16,5	100,0
Argemona	17,3	17,0	18,0	17,5	105,7
Grace	18,3	19,9	18,0	18,7	113,4
Papayares	17,6	17,8	19,0	18,1	109,8
Poker	13,2	14,0	13,5	13,5	82,0
Rokako	15,8	16,0	17,1	16,3	98,8
Spartak	13,6	14,6	13,5	13,9	84,1
Victoria	17,0	17,2	18,4	17,5	106,1
EKF ₀₅	0,4	0,7	0,6	0,2	–
Sx%	2,8	4,1	3,3	1,3	–

According to the data presented in Table 1, in 2023, compared with the inter-varietal average of 16.8 leaves per plant, the Rokako variety produced 3.6 more leaves, Papayares 2.2 more, Viktoriya 1.6 more, Argemona 1.2 more, and Gratsiya 1.2 more leaves. In contrast, the Poker and Spartak varieties produced 3.3 fewer leaves per plant. Following mathematical and statistical analysis, the number of leaves per plant showed an EKF₀₅ of 0.6 leaves and a coefficient of variation (Sx%) of 3.3%.

Over the period 2021–2023, the number of leaves per plant in the studied arugula varieties, compared with the inter-varietal average of 16.5 leaves, was 2.4 leaves higher in Rokako, 2.2 higher in Gratsiya, 1.6 higher in Papayares, and 1.0 higher in both Argemona and Viktoriya. In contrast, Poker produced 3.0 fewer leaves and Spartak 2.6 fewer leaves per plant. Following mathematical and statistical analysis, the number of leaves per plant showed an EKF₀₅ of 0.2 leaves and a coefficient of variation (Sx%) of 1.3%.

Thus, the highest number of leaves per plant was recorded in the Gratsiya (18.7 leaves) and Papayares (18.1 leaves) varieties, whereas the lowest number was observed in the Spartak (13.9 leaves) and Poker (13.5 leaves) varieties.

In 2021, the leaf length of the arugula varieties, compared with the inter-varietal average of 21.4 cm, was 2.6 cm longer in Argemona, 2.2 cm longer in Viktoriya, 1.7 cm longer in Gratsiya, and 0.8 cm longer in Spartak. In contrast, leaf length was 0.6 cm shorter in Papayares, 2.4 cm shorter in Poker, and 5.2 cm shorter in Rokako. Following mathematical and statistical analysis, leaf length showed an EKF_{05} of 0.8 cm and a coefficient of variation ($Sx\%$) of 3.8%.

In 2022, compared with the inter-varietal average leaf length of 22.0 cm, the Argemona variety had leaves that were 1.8 cm longer, Gratsiya 2.5 cm longer, Viktoriya 2.1 cm longer, and Spartak 1.3 cm longer. In contrast, leaf length was 0.8 cm shorter in Papayares, 2.0 cm shorter in Poker, and 6.0 cm shorter in Rokako. Following mathematical and statistical analysis, leaf length showed an EKF_{05} of 0.9 cm and a coefficient of variation ($Sx\%$) of 4.3% (Table 2).

Table 2. Leaf length of rocket lettuce varieties.

Variety names	Leaf length, cm				compared to the inter-varietal average, %
	2021-year	2022-year	2023-year	Average	
Inter-varietal average	21,4	22,0	22,1	21,8	100,0
Argemona	24,0	23,8	25,0	24,3	111,1
Grace	23,1	24,5	22,5	23,4	107,1
Papayares	20,8	21,2	22,4	21,4	98,2
Poker	19,0	20,0	19,3	19,4	89,0
Rokako	17,0	17,3	18,3	17,5	80,4
Spartak	22,2	23,3	21,8	22,4	102,6
Victoria	23,6	24,1	25,4	24,4	111,6
EKF_{05}	0,8	0,9	1,0	0,6	–
$Sx\%$	3,8	4,3	4,5	3,0	–

According to the data presented in Table 2, in 2023, compared with the inter-varietal average leaf length of 22.1 cm, the Viktoriya variety had leaves that were 3.3 cm longer, Argemona 2.9 cm longer, Gratsiya 0.4 cm longer, and Papayares 0.3 cm longer. In contrast, leaf length was 0.3 cm shorter in Spartak, 2.8 cm shorter in Poker, and 3.5 cm shorter in Rokako. Following mathematical and statistical analysis, leaf length showed an EKF_{05} of 1.0 cm and a coefficient of variation ($Sx\%$) of 4.5%.

For the 2021–2023 period, compared with the average inter-varietal leaf length of 21.8 cm, the Viktoriya variety had leaves that were 2.6 cm longer, Argemona 2.5 cm longer, Gratsiya 1.6 cm longer, and Spartak 0.6 cm longer. In contrast, leaf length was 0.4 cm shorter in Papayares, 2.4 cm shorter in Poker, and 4.9 cm shorter in Rokako. Following mathematical and statistical analysis, leaf length showed an EKF_{05} of 0.6 cm and a coefficient of variation ($Sx\%$) of 3.0%.

Thus, among the studied arugula varieties, the longest leaves were recorded in Viktoriya (24.4 cm) and Argemona (24.3 cm), whereas the shortest leaves were observed in Poker (19.4 cm) and Rokako (17.5 cm).

In 2021, the leaf width of the studied arugula varieties was 6.1 cm in Gratsiya, 5.8 cm in Argemona, 5.9 cm in Papayares, 5.5 cm in Viktoriya, 5.0 cm in Spartak, and 4.8 cm in both Poker and Rokako. Following mathematical and statistical analysis, leaf width showed an EKF_{05} of 0.2 cm and a coefficient of variation ($Sx\%$) of 2.9%.

In 2022, compared with the inter-varietal average leaf width of 5.6 cm, the Gratsiya variety had leaves that were 1.0 cm wider, Papayares 0.3 cm wider, and Argemona 0.1 cm wider. In contrast, leaf width was 0.1 cm narrower in Viktoriya, 0.3 cm narrower in Spartak, 0.4 cm narrower in Rokako, and 0.5 cm narrower in Poker. Following mathematical and statistical analysis, leaf width showed an EKF_{05} of 0.2 cm and a coefficient of variation ($Sx\%$) of 3.1% (Table 3).

Table 3. Leaf width of rocket lettuce varieties.

Variety names	Leaf width, cm				compared to the inter-varietal average, %
	2021-year	2022-year	2023-year	Average	
Inter-varietal average	5,4	5,6	5,6	5,5	100,0
Argemona	5,8	5,7	6,0	5,8	105,3
Grace	6,1	6,6	6,0	6,2	112,7
Papayares	5,9	5,9	6,3	6,0	109,1
Poker	4,8	5,1	4,9	4,9	89,5
Rokako	4,8	4,9	5,2	5,0	89,8
Spartak	5,0	5,3	4,9	5,1	91,5
Victoria	5,5	5,5	5,9	5,6	102,1
EKF ₀₅	0,2	0,2	0,2	0,1	–
Sx%	2,9	3,1	3,6	2,0	–

According to the data presented in Table 3, in 2023, compared with the inter-varietal average leaf width of 5.6 cm, the Papayares variety had leaves that were 0.7 cm wider, Argemona and Gratsiya 0.4 cm wider, and Rokako and Viktoriya 0.3 cm wider. In contrast, the Poker and Spartak varieties had leaves that were 0.7 cm narrower. Following mathematical and statistical analysis, leaf width showed an EKF₀₅ of 0.1 cm and a coefficient of variation (Sx%) of 2.0%.

For the 2021–2023 period, compared with the inter-varietal average leaf width of 5.5 cm, the Gratsiya variety had leaves that were 0.7 cm wider, Papayares 0.5 cm wider, Argemona 0.3 cm wider, and Viktoriya 0.1 cm wider. In contrast, leaf width was 0.6 cm narrower in Poker, 0.4 cm narrower in Spartak, and 0.1 cm narrower in Rokako. Following mathematical and statistical analysis, leaf width showed an EKF₀₅ of 0.1 cm and a coefficient of variation (Sx%) of 2.0%.

Thus, among the studied arugula varieties, the widest leaves were recorded in Gratsiya (6.2 cm) and Papayares (6.0 cm), whereas the narrowest leaves were observed in Rokako (5.0 cm) and Poker (4.9 cm).

In 2021, the area of an individual leaf in the studied arugula varieties was 8.1 cm² in Spartak, 8.0 cm² in Argemona, 7.7 cm² in Gratsiya, 7.6 cm² in Viktoriya, 7.0 cm² in Poker, 6.9 cm² in Papayares, and 5.2 cm² in Rokako. Following mathematical and statistical analysis, the individual leaf area showed an EKF₀₅ of 0.3 cm² and a coefficient of variation (Sx%) of 3.6%.

In 2022, compared with the inter-varietal average individual leaf area of 7.4 cm², the Spartak variety had an individual leaf area that was 1.1 cm² larger, Gratsiya 0.7 cm² larger, Argemona 0.5 cm² larger, and Viktoriya 0.4 cm² larger. In contrast, the individual leaf area was 0.1 cm² smaller in Poker, 0.3 cm² smaller in Papayares, and 3.2 cm² smaller in Rokako. Following mathematical and statistical analysis, the individual leaf area showed an EKF₀₅ of 0.2 cm² and a coefficient of variation (Sx%) of 2.6% (Table 4).

Table 4. A single leaf of rocket salad variety.

Variety names	Area of one leaf, cm2				navlararo o'rtachaga nisbatan, %
	2021-year	2022-year	2023-year	Average	
Inter-varietal average	7,2	7,4	7,4	7,4	100,0
Argemona	8,0	7,9	8,3	8,1	110,0
Grace	7,7	8,1	7,5	7,8	105,8
Papayares	6,9	7,1	7,4	7,1	97,1

Poker	7,0	7,3	7,0	7,1	96,5
Rokako	5,2	5,3	5,6	5,3	72,6
Spartak	8,1	8,5	7,9	8,2	111,0
Victoria	7,6	7,8	8,2	7,9	106,8
EKF ₀₅	0,3	0,2	0,2	0,2	–
Sx%	3,6	2,6	3,4	2,3	–

According to the data presented in Table 4, in 2023, compared with the inter-varietal average individual leaf area of 7.4 cm², the Viktoriya variety had an individual leaf area that was 0.8 cm² larger, Argemona 0.9 cm² larger, Spartak 0.5 cm² larger, and Gratsiya 0.1 cm² larger. In contrast, the individual leaf area was 0.4 cm² smaller in Poker and 2.3 cm² smaller in Rokako. Following mathematical and statistical analysis, the individual leaf area showed an EKF₀₅ of 0.2 cm² and a coefficient of variation (Sx%) of 3.4%.

For the 2021–2023 period, compared with the inter-varietal average individual leaf area of 7.4 cm², the Spartak variety had an individual leaf area that was 0.8 cm² larger, Argemona 0.7 cm² larger, Viktoriya 0.5 cm² larger, and Gratsiya 0.4 cm² larger. In contrast, the individual leaf area was 0.3 cm² smaller in both Papayares and Poker, and 2.9 cm² smaller in Rokako. Following mathematical and statistical analysis, the individual leaf area showed an EKF₀₅ of 0.2 cm² and a coefficient of variation (Sx%) of 2.3%.

Thus, among the studied arugula varieties, the largest individual leaf area was recorded in Spartak (8.2 cm²) and Argemona (8.1 cm²), whereas the smallest leaf area was observed in Rokako (5.3 cm²).

In 2021, the total leaf area per plant in the studied arugula varieties was 141.3 cm² in Gratsiya, 138.9 cm² in Argemona, 129.4 cm² in Viktoriya, 121.7 cm² in Papayares, 109.9 cm² in Spartak, 91.7 cm² in Poker, and 81.9 cm² in Rokako. Following mathematical and statistical analysis, the total leaf area per plant showed an EKF₀₅ of 4.0 cm² and a coefficient of variation (Sx%) of 3.5%.

In 2022, compared with the inter-varietal average total leaf area per plant of 123.6 cm², the Gratsiya variety had a total leaf area that was 38.0 cm² larger, Argemona 11.2 cm² larger, Viktoriya 9.6 cm² larger, Papayares 1.7 cm² larger, and Spartak 0.2 cm² larger. In contrast, the total leaf area per plant was 21.5 cm² smaller in Poker and 39.5 cm² smaller in Rokako. Following mathematical and statistical analysis, the total leaf area per plant showed an EKF₀₅ of 4.8 cm² and a coefficient of variation (Sx%) of 3.9% (see Table 5).

Table 5. The number of leaves on a single plant of rocket lettuce varieties.

Variety names	Leaf area per bush, cm ²				compared to the inter-varietal average, %
	2021-year	2022-year	2023-year	Average	
Inter-varietal average	116,4	123,6	124,9	121,6	100,0
Argemona	138,9	134,8	150,2	141,3	116,2
Grace	141,3	161,6	134,8	145,9	119,9
Papayares	121,7	125,3	141,7	129,6	106,5
Poker	91,7	102,1	94,8	96,2	79,1
Rokako	81,9	84,3	95,4	87,2	71,7
Spartak	109,9	123,8	107,0	113,6	93,4
Victoria	129,4	133,2	150,7	137,8	113,2
EKF ₀₅	4,0	4,8	4,1	3,4	–
Sx%	3,5	3,9	3,3	2,8	–

According to the data presented in Table 5, in 2023, compared with the inter-varietal average total leaf area per plant of 124.9 cm², the Viktoriya variety had a total leaf area that was 25.8 cm² larger, Argemona 25.3 cm² larger, Papayares 16.8 cm² larger, and Gratsiya 9.9 cm² larger. In contrast, the total

leaf area per plant was 11.6 cm² smaller in Rokako, 17.9 cm² smaller in Spartak, and 30.1 cm² smaller in Poker. Following mathematical and statistical analysis, the total leaf area per plant showed an EKF₀₅ of 4.1 cm² and a coefficient of variation (Sx%) of 3.3%.

For the 2021–2023 period, compared with the inter-varietal average total leaf area per plant of 121.6 cm², the Gratsiya variety had a total leaf area that was 24.3 cm² larger, Argemona 19.7 cm² larger, Viktoriya 16.2 cm² larger, and Papayares 8.0 cm² larger. In contrast, the total leaf area per plant was 8.0 cm² smaller in Spartak, 25.4 cm² smaller in Poker, and 26.4 cm² smaller in Rokako. Following mathematical and statistical analysis, the total leaf area per plant showed an EKF₀₅ of 3.4 cm² and a coefficient of variation (Sx%) of 2.8%.

Thus, among the studied arugula varieties, the largest total leaf area per plant was recorded in Gratsiya (145.9 cm²) and Argemona (141.3 cm²), whereas the smallest total leaf area was observed in Poker (96.2 cm²) and Rokako (87.2 cm²).

In 2021, the leaf area per unit of cultivated area in the studied arugula varieties was 4,037.4 m² in Gratsiya, 3,968.9 m² in Argemona, 3,697.1 m² in Viktoriya, 3,477.8 m² in Papayares, 3,139.3 m² in Spartak, 2,619.0 m² in Poker, and 2,340.6 m² in Rokako. Following mathematical and statistical analysis, leaf area per unit area showed an EKF₀₅ of 96.1 m² and a coefficient of variation (Sx%) of 2.9%.

In 2022, compared with the inter-varietal average leaf area per unit area of 3,531.2 m², the Gratsiya variety had a leaf area that was 1,086.8 m² larger, Argemona 320.3 m² larger, Viktoriya 274.8 m² larger, Papayares 49.1 m² larger, and Spartak 5.3 m² larger. In contrast, leaf area per unit area was 615.0 m² smaller in Poker and 1,126.9 m² smaller in Rokako. Following mathematical and statistical analysis, leaf area per unit area showed an EKF₀₅ of 123.3 m² and a coefficient of variation (Sx%) of 3.5% (see Table 6).

Table 6. Leaf density per unit area of rocket lettuce varieties.

Variety names	Leaf area per unit area, m ²				compared to the inter-varietal average, %
	2021-year	2022-year	2023-year	Average	
Inter-varietal average	3325,7	3531,2	3570,0	3475,6	100,0
Argemona	3968,9	3851,5	4292,4	4037,6	116,2
Grace	4037,4	4618,0	3851,6	4169,0	119,9
Papayares	3477,8	3580,3	4049,2	3702,4	106,5
Poker	2619,0	2916,2	2708,9	2748,0	79,1
Rokako	2340,6	2409,6	2725,2	2491,8	71,7
Spartak	3139,3	3536,5	3058,0	3244,6	93,4
Victoria	3697,1	3806,0	4304,5	3935,9	113,2
EKF ₀₅	96,1	123,3	118,6	65,3	–
Sx%	2,9	3,5	3,3	1,9	–

Discussion

According to the data presented in Table 6, in 2023, compared with the inter-varietal average leaf area per unit area of 3,570.0 m², the Viktoriya variety had a leaf area that was 734.5 m² larger, Argemona 722.4 m² larger, Papayares 479.2 m² larger, and Gratsiya 281.6 m² larger. In contrast, leaf area per unit area was 332.8 m² smaller in Rokako, 512.0 m² smaller in Spartak, and 861.1 m² smaller in Poker. Following mathematical and statistical analysis, leaf area per unit area showed an EKF₀₅ of 118.6 m² and a coefficient of variation (Sx%) of 3.3%.

For the 2021–2023 period, compared with the inter-varietal average leaf area per unit area of 3,475.6 m², the Gratsiya variety had a leaf area that was 693.4 m² larger, Argemona 562.0 m² larger, Viktoriya 460.3 m² larger, and Papayares 226.8 m² larger. In contrast, leaf area per unit area was 231.0 m² smaller in Spartak, 727.6 m² smaller in Poker, and 752.8 m² smaller in Rokako. Following

mathematical and statistical analysis, leaf area per unit area showed an EKF_{05} of 65.3 m² and a coefficient of variation ($Sx\%$) of 1.9%.

Thus, among the studied arugula varieties, the largest leaf area per unit area was recorded in Gratsiya (4,169.0 m²) and Argemona (4,037.6 m²), whereas the smallest leaf area was observed in Poker (2,748.0 m²) and Rokako (2,491.8 m²).

Conclusions

The highest number of leaves per plant was recorded in the Gratsiya (18.7 leaves) and Papayares (18.1 leaves) varieties, whereas the lowest number of leaves was observed in the Spartak (13.9 leaves) and Poker (13.5 leaves) varieties.

Among the studied arugula varieties, the longest leaves were recorded in Viktoriya (24.4 cm) and Argemona (24.3 cm), while the shortest leaves were observed in Poker (19.4 cm) and Rokako (17.5 cm).

The widest leaves were recorded in the Gratsiya (6.2 cm) and Papayares (6.0 cm) varieties, whereas the narrowest leaves were observed in Rokako (5.0 cm) and Poker (4.9 cm).

The largest individual leaf area was recorded in the Spartak (8.2 cm²) variety. The Gratsiya variety had the largest total leaf area per plant (145.9 cm²) and per unit area (4,169.0 m²), while Argemona showed values of 8.1 cm², 141.3 cm², and 4,037.6 m² for individual leaf area, total leaf area per plant, and leaf area per unit area, respectively. The smallest leaf area values were recorded in Rokako (5.3 cm², 87.2 cm², and 2,491.8 m²) and Poker (96.2 cm² and 2,748.0 m²).

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