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EFFECT OF SOWING RATE ON AGRONOMIC CHARACTERISTICS AND SEED YIELD OF CORIANDER *(CORIANDRUM SATIVUM L.)* IN SOUTHEAST BULGARIA

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Abstract. *Coriander is one of the most important essential oil crops cultivated worldwide. A field trial was carried out during the period 2023–2025 in Southeast Bulgaria to evaluate the effect of different sowing rates (200, 250, 300, and 350 germinating seeds per m² (g.s./m²)) on the components of productivity and seed yield of the coriander cultivar Yantar. The experiment was arranged in a randomized complete block design with four replications and a plot size of 15 m², following winter wheat as a preceding crop. The growing of plants was performed in compliance with the standard technology. The following parameters were determined: plant height (cm), number of umbels per plant, umbel diameter (cm), number of umbellets per umbel, number of seeds per umbel, seed weight per plant (g), 1000-seed weight (g), and seed yield (kg/ha). The results indicated that the sowing rate of 300 g.s./m² resulted in the highest values for most productivity traits, including number of umbels per plant, umbel diameter, number of umbellets per umbel, number of seeds per umbel, seed weight per plant, and 1000-seed weight. The tallest plants were reported at the sowing rate of 350 g.s./m². The sowing rate of 300 g.s./m² was found to be the most effective for the Yantar coriander cultivar under the agroecological conditions of Southeast Bulgaria.*

Keywords*: coriander, seed rate, elements of productivity, seed yield*

INTRODUCTION

Coriander productivity is largely determined by the complex interactions of the genotype and environmental factors as well as by the agrotechnical practices (ALI ALI et al., 2026; ANJUKRISHNA et al., 2021; GHOLIZADEH et al., 2018; KATAR et al., 2016; SZEMPLIŃSKI et al., 2018). The sowing rate is one of the key agronomic factors for the expression of varieties' biological potential. The effect of different row spacings has been studied in Turkey by OKUT et al. (2005), who concluded that 30 cm row spacing is optimal for achieving the highest yield. A field trial performed in Iran showed that sowing density has a considerable impact on seed production and yield structure (GHOBADI and GHOBADI, 2010). The highest seed yield was observed at densities of 30 and 50 plants per m². As stated by KASSU et al. (2018), the ideal seed rate in Ethiopia's southeastern mid-highlands is 30 kg/ha. A field experiment in Birjand indicated that increasing plant density led to a higher umbel number per m², 1000-fruit weight, and seed yield (MOOSAVI, 2012). According to KAIUM (2013), the spacing of 30 cm x 10 cm produced the maximum seed yield of coriander. KIZIL (2002) determined that seed rates of 20 and 30 kg/ha yielded greater seed and oil production compared to rates of 40 and 50 kg/ha. The seed rate has a significant impact on coriander production and yield components (TEKIN et al., 2023). TONEV and GRAMATIKOV (2008) reported optimal yield for the Mesten drebnoploden variety of coriander in the Dobroudja region of Bulgaria at a seed rate of 250 g.s./m². Conversely, DELIBALTOVA et al. (2012) indicated that the most effective sowing rate in southeastern

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Bulgaria is 300 g.s./m², while the highest seed yield in the Karnobat region is achieved at 310 g.s./m² for the same cultivar (GRAMATIKOV et al., 2005).

No analogous studies on the Yantar variety of coriander are available in Bulgaria, which determined the purpose of this work.

The aim of the present study was to investigate sowing rates on the elements of productivity and seed yield in the Yantar coriander cultivar, grown in southeast Bulgaria.

MATERIAL AND METHODS

The field experiment was held in the experimental area near Veselinovo village (Southeast Bulgaria) during 2023–2025. The test was performed by means of a block method with four replications; experimental field area—15 m² after the predecessor winter wheat.

Four sowing rates - 200, 250, 300 and 350 g.s./m^2 were tested. The established technology for growing coriander was followed in all its stages.

The following parameters were measured: height of plants, number of umbels per plant, diameter of umbels, number of umbellets per umbel, number of seeds per umbel, weight of seeds per plant, 1000-seed weight, and seed yield (kg/ha).

For the purpose of assessing the quantity dependence between the studied indicators, the experimental data were analyzed using analysis of variance (ANOVA), and the differences between the variants were determined by means of Duncan's Multiple Range Test at $P \leq 0.05$.

The climatic conditions determining coriander growth, development, and productivity were temperatures and precipitation, their combination, and distribution during the vegetative period. The analysis of these factors demonstrated that the average monthly temperatures during the study years were generally close to or slightly exceeded those recorded over a long-term average, fully satisfying the climatic requirements of coriander from sowing to ripening (Figure 1).

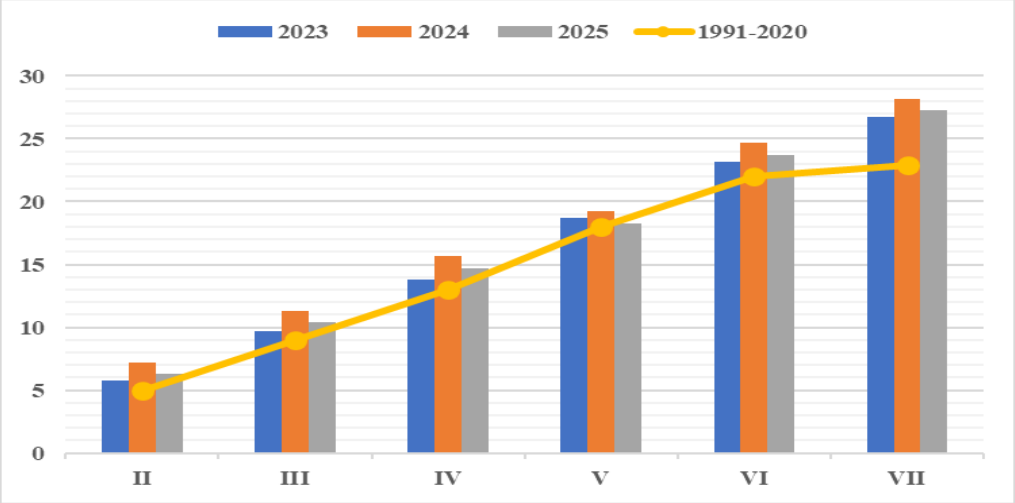

Figure 1. Average monthly air temperature, ^{0}C

Significant differences were observed in the quantity of precipitation during the individual agricultural years (Figure 2). In the first year of the experiment (2023), the amount

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of precipitation in the February-July period was 362 mm, which is 32 mm more than the multiannual period (330.0 mm). Adequate moisture supply and the uniform distribution of rainfall from the beginning of the vegetation to the beginning of ripening had a positive effect on the growth and development of coriander plants.

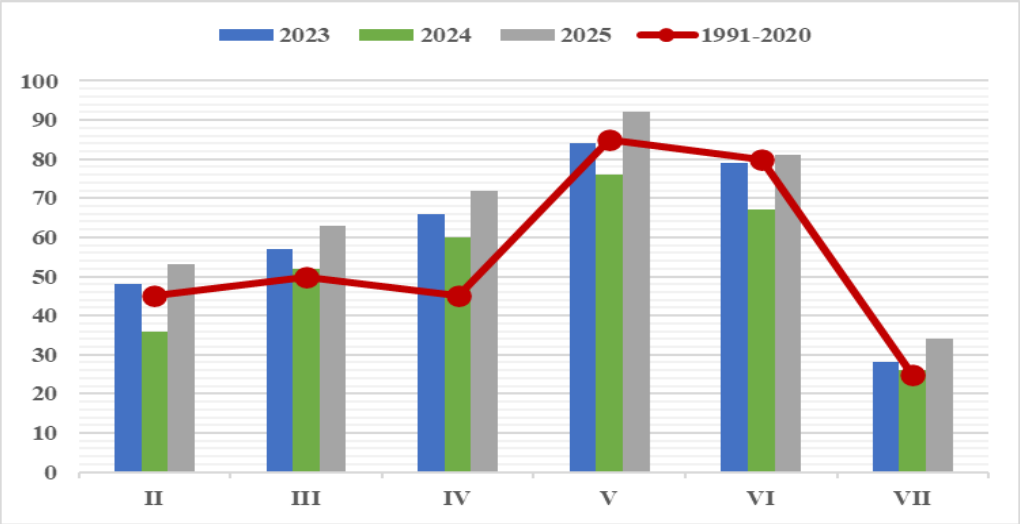

Figure 2. Precipitation, mm

In the second year of the study, the amount of precipitation during the coriander vegetation was 317 mm, which is 13 mm lower than the multiannual period. That determined the 2024 experimental year as less favorable for the productivity of coriander compared to 2023.

The experimental year 2025 proved to be the best for coriander growth and development. It was characterized by sufficient and evenly distributed precipitation fully meeting the requirements of the hybrids for moisture from emergence till ripening.

RESULTS AND DISCUSSIONS

The seed yield of coriander varied depending on the sowing rate and climatic conditions throughout the years (Table 1). The results showed that a more favorable combination of the major meteorological factors (air temperature, soil, and air humidity) during vegetation led to obtaining higher yields in the third year of the study compared to the first and the second.

The highest yield of seed (2400 kg/ha) was reported at sowing rate 300 g.s./m² and the lowest (1820 kg/ha) at sowing rate 200 g.s./m². The differences between the investigated variants were statistically significant, while differences between sowing rates of 250 and 350 g.s./m² were not statistically significant.

In the 2023 experimental year, the seed yields obtained varied from 1785 kg/ha to 2280 kg/ha, i.e., they were from 35 to 120 kg/ha lower on average in comparison with 2025. The differences between the studied variants were statistically significant. The lowest yields were obtained at sowing rate of 200 g.s./m^2 – 1785 kg/ha.

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In the second year of the study (2024), the yields obtained were within the limits of 1650 to 1895 kg/ha, i.e., they were 11.4 and 17.9% lower on average in comparison with 2023 and 2025, respectively.

Table 1

Seed yield – kg/ha

Sowing rate (g.s./m^2)	Years of study			Average for the period
	2023	2024	2025	
200	1785 ^{d}	1650 ^{c}	1820 ^{c}	1752
250	1870 ^{c}	1732 ^{b}	1998 ^{b}	1866
300	2280 ^{a}	1895 ^{a}	2400 ^{a}	2192
350	1890 ^{b}	1745 ^{b}	2010 ^{b}	1882
Average for the year	1956	1756	2057	

**The LSD test revealed substantial differences (P<0.05) between mean values between columns with distinct lowercase letters.*

On average for the period of examination, the highest yield is obtained in sowing rate 300 g.s./m² - 2192 kg/ha, and the lowest yield is realized in 200 g.s./m² (1752 kg/ha).

The results of the analysis of variance about the effect of the factors sowing rate and year, as well as their interaction, on the indicator seed yield, are presented in Table 2. The results show a statistically significant effect of the studied factors and an insignificant one of their interaction.

Table 2

Analysis of variance ANOVA

Source of Variation	Sum of Square	df	Mean Square	F	P-value	F crit
Sowing rate *	1816899	3	605633.1	54.55352	0.00	2.866266
Year*	650696.5	2	325348.3	29.30635	0.00	3.259446
Interactions ^{ns}	54412.96	6	9068.826	0.816891	0.56	2.363751
Within	399658.8	36	1110.63			

** F-test significant at P<0.05; ** F-test significant at P<0.01; ns non-significant*

The values of the elements of productivity were presented in Table 3 in average for the three years. The data showed that sowing rate had significant influence on the height of plants, number of umbels per plant, number of seeds per umbel, number of seeds per plant, and weight of seeds per plant of coriander. The height of plants varied depending on sowing rate from 72.6 to 82.5 cm. The highest values of this index were reported in sowing rate 350 g.s./m², while the lowest were 200 g.s./m². Statistical analysis showed that the results obtained were significant.

The number of umbels per plant varied from 10.5 to 12.6, depending on the sowing rate. The highest values of this index were reported in sowing rate 300 g.s./m² and the lowest one in –200 g.s./m² and were statistically significant. The differences between 250 g.s./m² and 350 g.s./m² were very small and statistically unproven.

The highest values of the characteristic diameter of umbels were reported at sowing rate 300 g.s./m² – 4.85 cm, and in the rest of the variants, they varied from 3.97 to 4.23 cm. The differences between the investigated variants were statistically significant.

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Table 3

Structural elements of the yield (mean for the period 2023 - 2025)

Sowing rate g.s./m^2	Elements of productivity						
	Height of plants (cm)	Number of umbels per plant	Diameter of umbels (cm)	Number of umbellets per umbel	Number of seeds per umbel	Seed weight per plant (g)	1000 seeds weight (g)
200	55.4 ^{d}	10.5 ^{c}	3.97 ^{d}	4.7 ^{c}	9.7 ^{b}	0.61 ^{b}	4.67 ^{d}
250	57.0 ^{c}	11.3 ^{b}	4.10 ^{c}	5.0 ^{b}	11.0 ^{b}	0.65 ^{b}	4.76 ^{c}
300	58.6 ^{b}	12.6 ^{a}	4.85 ^{a}	5.4 ^{a}	12.8 ^{a}	0.80 ^{a}	5.88 ^{a}
350	62.5 ^{a}	11.4 ^{b}	4.23 ^{b}	5.1 ^{b}	10.9 ^{b}	0.68 ^{b}	4.81 ^{b}
LSD 5%	*1.55*	*1.16*	*1.11*	*0.03*	*1.41*	*0.11*	*0.04*

The number of umbellets per umbel varied from 4.7 to 5.4 depending on sowing rates. With the increase of the sowing rate, the values of this trait increased up to 300 g.s./m²; after that, they decreased to 350 g.s./m². Statistical analysis showed that the differences between the highest and lowest values were proven.

The number of seeds per umbel varied depending on sowing rate from 9.7 to 12.8. The highest values of this index were reported in sowing rate 300 g.s./m², while in the rest of the variants, the differences were statistically insignificant.

Like the other structural elements of the yield, the weight of seeds per plant characteristic also had the highest values established in sowing rate 300 g.s./m², i.e., 0.80 g. In the rest of the variants, the values of this trait varied within the limits from 0.61 g (in sowing rate 200 g.s./m²) to 0.68 g (in sowing rate 350 g.s./m²), and statistical processing showed that the differences between them were unproven.

The 1000-seed weight varied from 4.67 to 5.88 g, the number of umbels depending on sowing rates. The highest values of this index were reported in sowing rate 300 g.s./m², while the lowest were 200 g.s./m². The differences between the investigated variants were statistically significant.

CONCLUSION

During the period of study (2023-2025), the highest seed yield (2192 kg/ha) was obtained at a sowing rate of 300 g.s./m², and the lowest one—1752 kg/ha—was obtained with a sowing rate of 200 g.s./m².

The highest plants were reported at a sowing rate of 350 g.s./m². The maximum number of umbels per plant, diameter of umbels, number of umbellets per umbel, number of seeds per umbel, weight of seeds per plant, and 1000-seed weight were recorded at a sowing rate of 300 g.s./m² when compared with other tested variants.

Under the south-east Bulgarian conditions, it is recommended to cultivate the coriander variety “Yantar” at a sowing rate of 300 g.s./m².

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