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Cultivation of Coriander in the Conditions of the Foothill Zone of the Republic of Ingushetia

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Abstract

This paper presents a comprehensive study of the features of growth and development of coriander. The study aims to assess the effect of fertilizers, sowing time and seeding rates on the passage of phenological phases, plant height, sowing quality of seeds, leaf area and essential oil content. The paper addresses the issue of using carbon derivatives (fullerenes) as growth stimulants. The effects of fertilizers and fullerenes on plant height and laboratory seed germination are compared. The effects of the pre-sowing application of nitrogen and phosphorus fertilizers and of foliar application of double superphosphate are highlighted and described. It is shown that the change in coriander leaves is dependent on the level of plant nutrient supply. The effects of sowing time and soil nutrient levels on the seed yield are considered. The study shows which factors had a greater impact on the content of essential oil in coriander fruits and, accordingly, on its harvest. The practical experience of coriander cultivation in the conditions of the foothill zone of the Republic of Ingushetia is summarized.

Keywords: coriander, fertilizer, phenological phases, fullerenes, essential oil

1. Introduction

Coriander is the main essential oil crop cultivated in the Russian Federation. Coriander fruits contain 1.4–2.1% essential oil and 18–28% fatty oil. The essential oil includes about 20 components, the main of which are linalool (60–80%), geraniol (3–5%), linalyl acetate (up to 5%). Coriander essential oil and products of its processing are used in manufacturing of perfumery and cosmetic products, and for food and medicine aromatization. Fatty oil is used in soap making, paint and varnish, textile industry and metallurgy. Oil-cakes are valuable food for animals. Leaves are used as a seasoning for various dishes. Economic problems that arose in the early nineties led to a sharp decline in the processing of coriander and violations in its cultivation, which significantly deteriorate the quality of raw materials [1-4].

The study aims to enhance the system for growing coriander in the conditions of the Republic of Ingushetia.

2. Methods and Materials

2.1. Methods

In 2015–2019, field experiments were carried out in the Republic of Ingushetia to cultivate coriander on the experimental plot of Ingush Agricultural Research Institute. The soil of the experimental plot is weakly leached, medium-thick, medium-loamy chernozems. The thickness of the humus horizon attains 46–60 cm. The humus content was from 4.80 to 4.90%. The content of mobile forms of P_2O_5 – 22.5–26.0 mg/kg of soil, potassium – from 330 to 345 mg/kg. The agrophysical and agrochemical properties of the soil make it favorable for growing coriander.

During the growing periods, a lack of moisture was observed in the soil and air temperature was above average perennial values.

The effect of sowing time, nutrient status and row spacing on the growth and development of plants was studied. The research scheme included the following factors and their variants: factor A – nutrient status: a) control (without fertilizers), b) N_{45} P_{45} (during sowing), c) N_{45} P_{45} $_+$ P_{15} (foliar feeding); factor B – sowing time: early (April 1), medium (April 25), late 5 (May); factor C – row spacing: a) 15 cm (close sowing), b) 45 cm (wide-row sowing). The experiment was carried out using the method of splitting plots. The planting method is solid (Figure 1).

Conventional cultivation methods were employed in the study. The agro-climatic conditions were considered to determine the phenological phases and calculate the duration of interphase and vegetation periods. The content of the mass fraction of essential oil was studied by the Ginsberg method.

3. Materials

The object of the study was coriander of the Yantar variety.

a b

Figure 1: Experimental plot of coriander crops at the stage of seedling emergence (a) and fruiting (b).

4. Results

Phenological observations are aimed at establishing differences in the plant growth for different experimental versions. [5]. Phenological observations enable detection of effects that do not persist before the harvest and search for the reasons for their further attenuation.

First, we studied the features of the growth phases of coriander plants depending on the growing conditions (Figure 2). Fertilization, use of biostimulants and seeding rates did not significantly affect the duration of vegetation phases. The sowing time had a significant impact on the duration of phenological phases. Later sowing accelerated the passage of individual phenological phases by at least a week. At early sowing, low positive temperatures contributed to the delayed emergence of seedlings. Earlier sowing lengthened the time of emergence of seedlings: from 15 days at late sowing, to 30 days at early sowing. The shooting phase was observed 19–26 days after emergence of seedlings.

The duration of the shooting–flowering period ranged from 17 to 25 days, and flowering–fruiting period lasted 9–12 days. Thus, the difference between the versions in the duration of coriander fruiting was no more than 10 days. The seeds were planted

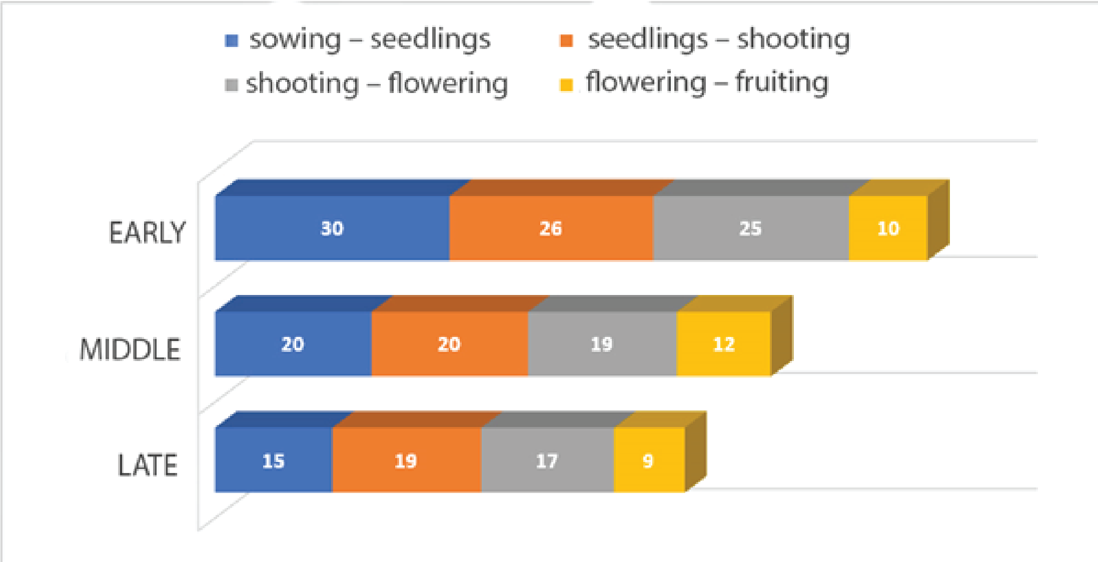
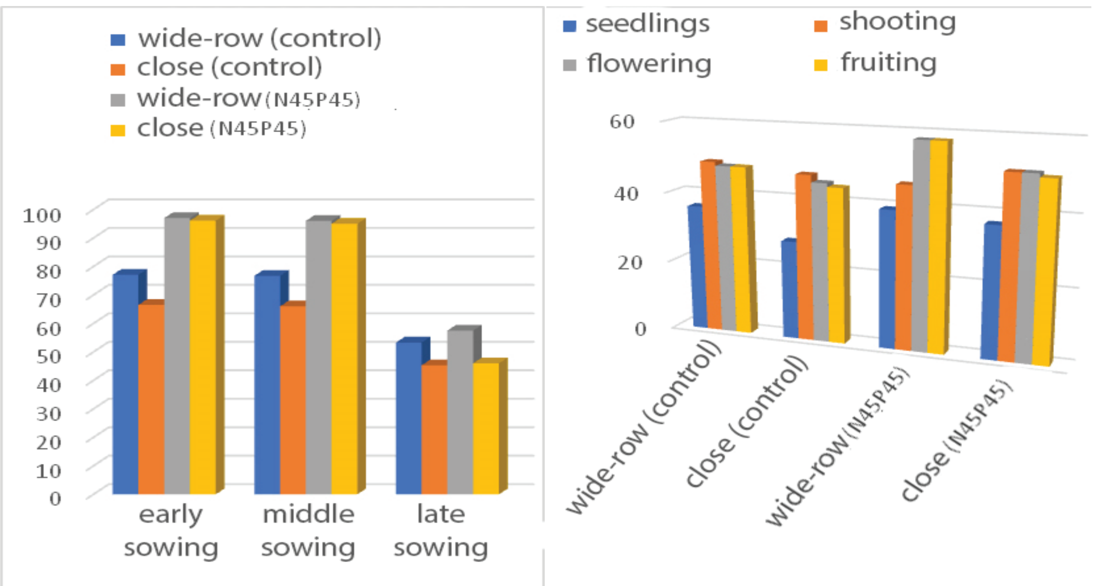


Figure 2: Duration of interphase and vegetation periods of coriander plants depending on sowing time.

on July 1 (first sowing), July 5 (second sowing) and July 9 (third sowing). However, the plants were short that negatively affected their productivity.

Plant height is a genetically determined trait, which can change significantly under the impact of weather conditions and cultivation method [3, 5].

In our experiments, the plant height was significantly affected by the cultivation method (Figure 3).



a b

Figure 3: Height of coriander plants depending on sowing time, soil fertility (a) and the effect of fullerenes (b).

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The wide-row sowing yielded higher plants in all versions, which is due to a larger feeding area and unshaded crops (Figure 3, a).

Plants sown in the first and second periods grew faster than those sown later, which was due to sufficient level of soil moisture compared to later periods.

Plants cultivated in the fertilized soil were higher to a greater or lesser extent than those grown in the unfertilized soil.

Initially, the effect of fullerenes was evident at the stage of emergence of seedlings (Figure 3, b). In the version with fullerenes, the number of seedlings exceeded that in the control, which was observed throughout all the phenological phases of coriander. The plant height was mainly affected by fullerenes rather than row spacing.

Analysis of the above data shows that cultivation of coriander in the open ground, sown in wide rows and with fullerenes applied, the plants exhibited greater height, number of plants and size of fruits compared with the control.

To determine the biological productivity of plants, it is necessary to calculate the number of seeds per 1m^2 for harvesting. This indicator varied primarily depending on sowing time, and the number of seeds was significantly affected by the method of sowing and fertilization (Table 1).

Table 1: Seed weight, g/m^2

Control					
Sowing dates					
01.04		25.04		05.05	
Sowing method					
wide-row	close	wide-row	close	wide-row	close
89.3	172.3	90.8	177.0	37.4	21.9
N_{45} P_{45} (during sowing)					
192.4	196.3	189	206.1	51.8	30.3
N_{45} P_{45} + P_{15} (foliar feeding)					
188.4	215.6	190	211.7	52.7	31.2

Later sowing time led to a 3–8-fold decrease in the yield of seeds from 1m^2. Fertilization showed a significant effect.

During growing, the content of essential oil increases and reaches its maximum by the beginning of fruiting, then the content of oil decreases. Coriander belongs to the group of essential oil raw materials with internal oil containers located on the inner surface of semi-fruits [6, 7].

In the experiments, the highest plants grown on the soil with N_{45} P_{45} + P_{15} applied (foliar feeding) formed larger seeds than plants from other versions.

According to a number of authors, there is a direct relationship between the leaf area and the yield of plants. Both foliage and photosynthetic activity of leaves are subject to changing environmental conditions and the biological features of crops and varieties [5].

This study revealed the dynamics of formation of foliage in coriander samples. Accounts of the growth of the leaf surface, carried out according to the vegetation phases of anise, showed that, regardless of the version of the experiment, the maximum foliage could be observed by the phase of mass flowering. After that, due to the decline of the lower leaves, the indices of the total leaf area decreased by the phase of fruiting.

In different versions, the leaf area per plant by the phase of fruiting ranged from 0.08 to 0.2853 m^2/m^2. (Figure 4).

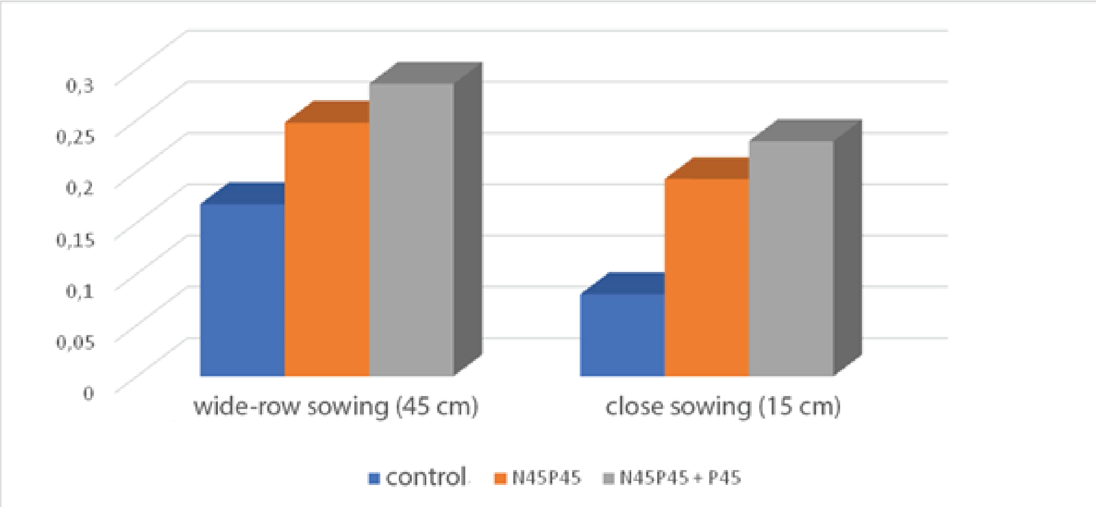

Figure 4: Coriander leaf area, m^2/m^2.

Coriander essential oil was produced by steam distillation from crushed seeds. The highest content of essential oil was obtained in the version that employed both sowing methods, on a fertilized soil (Figure 5, a).

The yield of essential oil per hectare changed accordingly. In the versions with fertilization, it was much higher, regardless of the sowing method (Figure 5, b).

5. Discussion

Duration of the phenological phases was significantly affected by sowing time. Later sowing of seeds accelerated the passage of phenological phases by at least a week. The plant height was greatly affected by the cultivation characteristics. The wide-row sowing method provided higher plants in all versions of the experiment, which is due to

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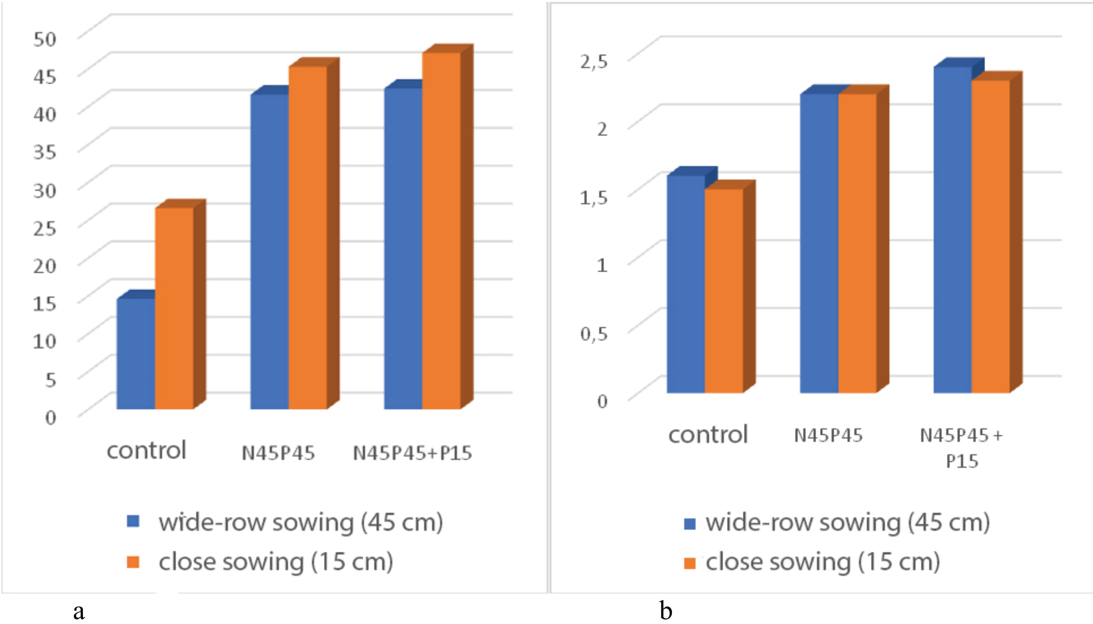

Figure 5: Content (a) and yield (b) of essential oil.

a larger feeding area and unshaded crops. Plants sown in the first and second periods developed faster than those sown later, which was due to sufficient level of soil moisture compared to later periods. In all versions with fertilized soil, the height of the plants, was higher to a greater or lesser extent than of those cultivated without fertilization. This indicator varied primarily depending on the sowing time. The number of seeds was also significantly influenced by the method of sowing and fertilization. Accounts of the growth of the leaf surface carried out according to the vegetation phases of anise show that, regardless of the version of the experiment, the maximum foliage is observed by the phase of mass flowering. The seed weight index per 1 m^2 changed primarily depending on the sowing time. The number of seeds was significantly affected by the method of sowing and fertilization. Later sowing caused a 3–8-fold decrease in the harvest of seeds per $1m^2$. The fertilization performed on April 25 had a significant impact on the plant productivity. The highest content of essential oil was observed in the version with both sowing methods employed on a fertilized soil. The yield of essential oil per hectare changed accordingly. In the versions with fertilization, it was much higher, regardless of the method of sowing.

6. Conclusion

Thus, in order to harvest high-quality coriander in the foothill zone of Ingushetia, seeds should be sown no later than in the 2nd decade of April, with a row spacing of 45 cm. In addition, nitrogen and phosphorus fertilizers N_{45} P_{45} should be applied during sowing, and foliar feeding with P15 should be performed.

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Conflict of Interests

The authors have no conflicts of interest to declare.

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