The influence of cultivation methods on the productivity and quality of essential oil crops (on the example of oregano)

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Abstract. In the conditions of the educational and production complex of the Federal State Budgetary Educational Institution of Higher Education Kabardino-Balkarian State Agrarian University in 2018-2020, a field experiment was laid to study the adaptive potential of oregano to the natural and climatic conditions of the Kabardino-Balkarian Republic. The effect of root formation stimulants Biospectrum and Corvin SP on the yield of oregano seedlings was investigated. Common data were obtained on the productivity of the common soul (Origanum vulgare) in depending on the method of obtaining planting material, according to the productivity of oregano per unit area. Based on the data obtained, an agroeconomic assessment of the effectiveness of growing oregano for green mass was made.

1. Introduction
In modern conditions, the industrial production of synthetic substances reaches high levels. At the same time, there is a parallel demand for natural preparations that are obtained from raw materials of medicinal and essential oil crops. One of the sources of essential oils is oregano (Origanum vulgare). Oregano is provided with a large amount of vitamin C, micro and macro elements, especially potassium and calcium. Essential oils contained in oregano up to 1.2% give a pleasant aroma. They have medicinal properties that fatty oils, flavanoids and tannins have. The essential oil is sold under the name hop oil.

Oregano is a good remedy for neuroses, has a calming effect on the central nervous system. They also relieve inflammation in gastric and duodenal ulcers, and are also used for diarrhea, flatulence and stomach colic, biliary dyskinesia, enterocolitis, and so on.

It should be noted that along with the treatment of the nervous system, the gastrointestinal tract, oregano is excellent for the treatment of acute respiratory diseases, bronchial asthma, chronic bronchitis. It is perfectly applied both internally and as an external agent for rinsing and inhalation. It should be noted that it reduces the risk factor for cancer.

The preparation "Oregano extract liquid" treats many ailments such as chronic bronchitis, bronchiectasis, ARVI, pneumonia, bronchial asthma. She also successfully treats the urinary and biliary systems in the form of the drug "Urolesan".

In our country, 14 varieties of this crop are widespread, which is the main source of phenols (thymol and carvacrol). In the conditions of the foothills of Kabardino-Balkaria, no studies have been carried out to study oregano. Thus, the study of the adaptive potential of this, especially useful, medicinal and essential oil plant like oregano, is especially relevant in the KBR conditions.
The aim of the research was a comprehensive study of the responsiveness of the oregano essential oil culture to the use of growth stimulants in the conditions of the foothills of Kabardino-Balkaria.

The scientific novelty was that for the first time field studies were carried out on the responsiveness of oregano plants to the growth regulators Biospectrum and Corvin SP, in the conditions of Kabardino-Balkaria, their effect on the survival rate of seedlings obtained by dividing a bush or rooting of green cuttings, as well as productivity and quality indicators of oregano.

2. The practical significance of the work
The possibility of successful cultivation of oregano in the foothills of Kabardino-Balkaria has been experimentally established. Field experiments allowed to establish the level of productivity of oregano, its economic and biological properties.

Materials and research methods. In the conditions of the educational and production complex of the Federal State Budgetary Educational Institution of Higher Education Kabardino-Balkarian State Agrarian University in 2018-2020, a field experiment was laid to study the adaptive potential of oregano to the natural and climatic conditions of the Kabardino-Balkarian Republic. Under finely dispersed moisture conditions, the most valuable oregano specimens were rapidly propagated by cuttings [6]. The object of the study was the samples of oregano (Origanum vulgare) obtained from the collection of the Crimean Research Institute of Agriculture for green cuttings, which was carried out in the 1st decade of June 2018-2019. 2 cuttings 10-12 cm long (3-4 internodes) were taken from the upper part of the shoots 35-45 cm high. Biospectrum and Corvin SP preparations were used as root formation stimulants.

The field experiment was carried out on leached chernozem. The supply of nitrogen, phosphorus is average and potassium is high. In experiment -3 repetitions, 30 cuttings were planted in each repetition. We carried out cuttings in the 1st decade of June. The preparations Biospectrum and Corvin SP were used depending on the scheme of the field experiment. In the control variant, the cuttings were placed in distilled water. In the variants with the use of rooting stimulants, the cuttings were treated and then immediately planted in the substrate. The productivity of oregano according to the variants of the experiment was determined by the following criteria: the mass of the aboveground part of the plant cut at a height of 7-8 cm from the surface of the substrate, the mass fraction of essential oil and the oil yield from 1 m2. For weighing, a laboratory balance SC 1-GOST 24104-88 was used. When evaluating seedlings, measurements were made of plant height and root length. To determine the quality of oregano seedlings, a four-point system was used.

3. Research results
The obtained data on the effect of root formation stimulants on the yield of seedlings of the studied culture are presented in table 1. The number of green cuttings of oregano that did not receive stimulation with drugs were in the range of 47-91%, with the exception of sample number eight, which had 20.0%. The root formation stimulator "Biospectrum" worked differently on the samples. Samples numbered seven and eight were at the control level of 62.3 and 88.7% versus 66.7 and 92 70%. The drug "Biospectrum" turned out to be the most effective, so on the sample number eight, the increase in comparison with the control, increased from 20.0 to 49.3%, and on sample number 34 from 47 to 83.0%. The drug "Kornevin SP" was less effective, with the exception of sample number eight.

| Sapling class | Number of seedlings% | Sample №7 | Sample №8 | Sample №34 | Sample №78 |
|--------------|----------------------|-----------|-----------|------------|-----------|
| Control      | Con                  | Biospec   | Kor       | 40,7       | 32,0      |
|              | B P                  | trom      | nevi      | 27,3       | 0,7       |
|              | B P                  | trom      | nevi      | 17,3       | 12,0      |
|              | B P                  | trom      | nevi      | 25,3       | 63,3      |
|              | B P                  | trom      | nevi      | -          | 57,0      |
|              | B P                  | trom      | nevi      | 77,7       | 50,0      |

Table 1. Influence of root formation stimulants on the yield of oregano seedlings (Origanum vulgare)
The traditional method of dividing a bush yields 5 to 12 plants per bush at 3 years of age.

In the course of field experiments, it was found that the method of green grafting is most suitable for oregano, provided that finely dispersed moistening is carried out. The dependence on the genotype of oregano plants was also established.

Table 2. Yield of planting material for common oregano (Origanum vulgare) at 3 years of age.

| Sample number | Number of shoots, pieces | Rooting of green cuttings, % | Number of green cuttings, pieces | Planting material yield, pieces |
|---------------|--------------------------|-----------------------------|---------------------------------|--------------------------------|
| 7             | 109,3                    | 67,5                        | 217,6                          | 7,2                            |
| 8             | 110,3                    | 49,8                        | 220,6                          | 5,1                            |
| 34            | 85,0                     | 84,0                        | 170,0                          | 9,3                            |
| 78            | 299,4                    | 91,8                        | 599,6                          | 12,2                           |

As noted above, oregano can be most effectively propagated by the method of green cuttings, where the multiplication factor is 1: 108-545 pieces, and with the method of division: 5-12 pieces. Sample 78 shows the highest multiplication factor, both when dividing the bush and in the number of green cuttings. In the middle of summer 2020, we carried out a registration of survival rate. As expected, the survival rate of oregano obtained by dividing the bush was up to 58%, while with green cuttings the survival rate was 94%. In 2018-2020 measurements were taken morphometric parameters and yield of green mass, depending on the methods of propagation of seedlings. During the phase of mass flowering, we carried out observations. The results are shown in Table 3.

Table 3. Morphological parameters of oregano plants (Origanum vulgare).

| Methods for obtaining planting material | Year of research | Plant height, cm | Plant width, cm | Number of generative shoots, pieces | Plant weight, g | Plant length, cm | Inflorescence width, cm |
|----------------------------------------|-----------------|------------------|----------------|-------------------------------------|-----------------|------------------|-------------------------|
| Dividing the bush                       | 2019            | 28,2             | 34,3           | 9.6                                 | 47.8            | 4.0              | 28.2                    |
|                                        | 2020            | 28.2             | 34.3           | 9.6                                 | 47.8            | 4.0              | 28.2                    |
| Cuttings                               | 2019            | 28.2             | 34.3           | 9.6                                 | 47.8            | 4.0              | 28.2                    |
|                                        | 2020            | 28.2             | 34.3           | 9.6                                 | 47.8            | 4.0              | 28.2                    |

In the course of the research, it was found that plants of oregano obtained by green cuttings were maximally developed, both in height (1.2-1.4 times higher) and in the width of the bush (1.1-1.7 times wider).

The method of green cuttings, as shown by the research results, provides an increase in all indicators in comparison with the method of dividing the bush, which is reflected in table No. 4.
Table 4. Influence of methods for obtaining planting material on the productivity of oregano (Origanum vulgare)

| Methods for obtaining plantin material | Yearsof research | Green mass productivity, g / pl | Mass fraction of essential oil% | Collecting essential oil |
|--------------------------------------|------------------|---------------------------------|---------------------------------|------------------------|
| Cuttings                             | 2019             | 76,4                            | 0,152                           | 0,356                  |
|                                      | 2020             | 321,5                           | 0,233                           | 0,424                  |
| Dividing the bush                     | 2019             | 47,8                            | 0,051                           | 0,122                  |
|                                      | 2020             | 255,5                           | 0,152                           | 0,271                  |

As can be seen from Table 4, the option with green grafting turned out to be the best compared to division. So, the productivity of green mass, the mass fraction of essential oil both from the raw mass and from the absolutely dry mass was higher during cuttings. Thus, it is advisable to plant oregano plantations at the expense of seedlings from green cuttings. In 2019, productivity was higher by 160.1 g / m², oil collection by 0.5 g / m², in 2020 by 369.9 g / m² and by 2.0 g / m², respectively.

Table 5. Productivity of oregano (Origanum vulgare).

| Method of vegetative propagation | Study year | Yield | Oil collection |
|---------------------------------|------------|-------|----------------|
| Dividing the bush               | 19         | 8,0   |                |
|                                 | 20         | 30,5  |                |
|                                 | 2019-2020 Amount | 98,5  |                |
| Cuttings                        | 19         | 8,1   |                |
|                                 | 20         | 00,4  |                |
|                                 | 2019-2020 Amount | 28,4  |                |

The data on the productivity and volume of the essential oil of oregano are well presented in table 5, so when dividing the bushes, this figure was 1698.5 g / m², and when cuttings were 2228.4 g / m², the excess was 1.3 times, for the collection oils 2.3 g / m² versus 4.7 g / m² or 2.0 times.

The mass fraction of essential oils is the most important indicator for essential oil plants, so according to the State Pharmacopoeia of the USSR (1990), it should usually be kept for oregano at the level of 0.10% of the air-dry weight.

The mass fraction of essential oil in the samples is in the range of 0.003-0.040% of the wet weight or 0.10-0.126% of the AFM, and only traces were found in the sample P8 (Table 6).

Table 6. Mass fraction of essential oil of oregano (Origanum vulgare) (2020).

| The name of the test sample | Mass fraction of essential oil% of Rawmass | Absolutely drymass |
|----------------------------|-------------------------------------------|--------------------|
| P-1                        | 0,003                                     | 0,010              |
| P-2                        | 0,012                                     | 0,038              |
| P-3                        | 0,030                                     | 0,053              |
| P-4                        | 0,050                                     | 0,075              |
| P-5                        | 0,023                                     | 0,083              |
| P-6                        | 0,020                                     | 0,095              |
| P-7                        | 0,040                                     | 0,126              |
| P-8                        | trail                                     | trail              |

The main component of the essential oil is α-terpineol, the maximum amount of which is contained in four samples (more than 50%) out of eight. The remaining samples Nos. 35, 142, which contain...
caryophyllene oxide and Nos. 24,25,39, contain γ-terpinene against the background of P-caryophyllene and germacrene. It should also be noted that the maximum amount of essential oils in the studied plants is observed in the phase of mass flowering, although it can be said that the parameters change during the entire growing season of oregano plants.

Samples were identified with high levels of α-terpinols, β-karyophyllenes and germacrene B in the conditions of the foothill zone of Kabardino-Balkaria (Table 7). Also, more than 42 components in oregano essential oil were installed.

### Table 7. Dominant components of essential oil collection samples.

| Sample № | a-terpineol | caryophyllene | germacrene and isomeric Caryophyllene | Caryophyllene oxide | Terpinen-4-ol | Thymol | Carvacrol | Linalool | U-terpineol |
|----------|-------------|----------------|--------------------------------------|--------------------|--------------|---------|-----------|----------|-------------|
| 2        | 60,69       | 9,13           | 18,34                                | 0,94               | 0,16         | -       | -         | -        | 0,44        |
| 9        | 38,27       | 9,33           | 13,04                                | 5,21               | -            | 3,55    | 0,62      | 2,56     | 3,36        |
| 10       | 5,11        | 15,10          | 19,12                                | 0,71               | 7,73         | 0,46    | -         | 4,65     | 1,76        |
| 11       | 6,68        | 16,24          | 24,78                                | 2,52               | -            | 0,38    | 0,08      | 4,69     | 7,10        |
| 13       | 4,34        | 16,03          | 27,61                                | 4,29               | -            | 0,37    | 1,61      | 1,38     | 6,59        |
| 16       | 5,05        | 19,36          | 37,17                                | 5,64               | -            | 1,80    | 0,43      | 0,87     | 8,44        |
| 24       | 8,40        | 8,26           | 10,99                                | 6,95               | -            | 0,46    | 0,48      | 1,26     | 23,48       |
| 25       | 3,59        | 16,63          | 22,93                                | 5,56               | -            | 0,06    | 4,49      | 0,46     | 14,96       |
| 30       | 57,59       | 9,05           | 13,43                                | 2,18               | -            | 0,21    | 0,19      | 0,08     | 0,54        |
| 33       | 62,92       | 9,00           | 13,67                                | 1,94               | -            | -       | 0,34      | 0,87     | 1,28        |
| 34       | 53,36       | 11,85          | 14,13                                | 3,14               | -            | 0,52    | 0,02      | 0,08     | 0,66        |
| 35       | 0,93        | 18,85          | 31,88                                | 8,85               | -            | 0,23    | 0,14      | 0,07     | 2,45        |
| 39       | 10,97       | 17,32          | 27,70                                | 0,70               | -            | 0,18    | 0,18      | 0,46     | 11,59       |
| 65       | 48,95       | 6,56           | 13,75                                | 1,56               | -            | 0,00    | 1,72      | 0,31     | 1,93        |
| 78       | 40,16       | 10,30          | 12,17                                | 7,71               | -            | 0,70    | 2,33      | 0,32     | 0,20        |
| 87       | 6,12        | 17,58          | 22,53                                | 4,32               | 11,54        | 0,57    | 5,97      | 1,86     | 4,71        |
| 89       | 45,96       | 10,05          | 12,92                                | 4,75               | -            | 0,39    | 0,13      | 2,00     | 0,36        |
| 142      | 1,99        | 20,14          | 29,77                                | 9,12               | -            | 0,07    | 0,48      | 0,02     | 4,64        |

Based on the data obtained, we made an agroeconomic assessment of the effectiveness of growing oregano for green mass.

### Table 8. Agroeconomic assessment of the effectiveness of growing oregano for green mass.

| Methods for obtaining planting material | Productivity kg/m² | Essential oil % | Production cost | Expenses | Notional net income | Production cost | Profitability level |
|----------------------------------------|---------------------|-----------------|-----------------|----------|---------------------|-----------------|---------------------|
| Dividing the bush                      | 1,69                | 0,14            | 33,6            | 11,4     | 22,2                | 6,76            | 1,94                |
| Cuttings                               | 2,23                | 0,21            | 44,0            | 13,5     | 30,5                | 6,13            | 2,26                |

Table 8 shows that the two methods are economically quite profitable, but the most effective method is cuttings, where the profitability ratio was 2.26%, and the net profit per hectare is 305 thousand rubles.

Thus, our experimental data show that propagation of seedlings by methods of dividing a bush gives from 1:5 to 1:12 pieces, while cuttings from 1:108 to 1:539 pieces.

On the experimental plot, on the plantation of oregano, obtained at the expense of seedlings by cuttings in the conditions of the foothill zone of Kabardino-Balkaria, more than 220 kg of green mass of oregano and collection of essential oil, about 47 kg, can be stably obtained, with the economic
effect of cultivation, agricultural producers of Kabardino-Balkaria republics from each hectare will annually receive more than 300 thousand rubles at minimal cost.

4. Conclusions
1. Analysis of the obtained results of complex studies of economically valuable traits of oregano samples showed that the conditions of the foothills of the Kabardino-Balkarian Republic are favorable for the cultivation of this essential oil crop.
2. Oregano vulgaris had a higher multiplication factor in fine moisture conditions by the method of green cuttings.
3. The method of green cuttings increased the productivity of green mass and the collection of oil from 1 m², respectively, 1.3 times and 2 times.
4. For the first time, in the conditions of Kabardino-Balkaria on 8 wild populations of oregano (Origanum vulgare), the composition of the essential oil was investigated for various components, where the content of essential oil was up to 0.13% of the absolutely dry weight.
5. Agroeconomic assessment of the effectiveness of growing oregano for green mass showed that both methods are economically profitable, but the most effective method is cuttings, where the profitability ratio was 2.26%, and the net profit per hectare was 305 thousand rubles.

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