Types of land massifs for essential oil crops cultivation in forest-steppe altitudinal belt of Greater Caucasus (Krasnodar territory)

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Abstract. The results of studies on land suitability for cultivation of essential oil crops in terms of the forest-steppe altitudinal belt of the Greater Caucasus are presented by the example of Anapa district of the Krasnodar Territory. For the purpose of type design of land massifs the cumulative assessment of land by soils, topography, degree of erosion, and cultural condition is necessary for cultivation of ether tracts in accordance with the requirements to growing conditions. The conducted studies determined the areas of land plots for growing the perennial essential-oil-bearing plant and placing essential oil crop rotations on the land plot selected for analysis.

1. Introduction

The development of the world market of essential oils, which is an important component of food, pharmaceutical, perfumery, cosmetic, paint and varnish, textile, leather, metallurgical, printing and other industries dictates the growing need for essential oil raw materials the production of which in terms of the industrial scale was ruined in 1990-2010. Domestic enterprises operate mainly on import deliveries estimated at not less than 700 million US dollars annually [1].

The variety of natural and climatic conditions in Russia makes it possible to cultivate various types of essential oil crops, providing not only their own needs for these raw materials, but also can successfully export natural essential oils to the world market. One of the favorable regions for the cultivation of essential oil crops is the Krasnodar Territory.

This paper presents studies on the types of land massifs for cultivation of essential oil crops in the conditions of forest-steppe zone of the Greater Caucasus (Anapa region).

2. Materials and methods

The altitudinal zonality allows cultivating a wide variety of crops, including oil-bearing ether due to different temperatures, humidity, soil composition, steepness and slope exposure. The key issue of industrial cultivation of essential oil crops is the requirement for soil fertility of land plot, its technological properties, i.e. contour, configuration, relief, rockiness, and energy intensity.

To determine the suitability of land for the cultivation of essential oil crops the following indicators were identified: soil, relief, cultural and technical condition (bushes, hillocks, contamination by stones,
etc.), and the degree of erosion.

The climate of the Anapa Region is of the Mediterranean type, moderately humid continental-steppe, which is a combination of three microclimates, i.e. steppe, mountain and sea foothill-steppe with a fairly steady barometric pressure. The prevailing winds in the territory are northeast in winter and southwest in summer. As a result of complex historical, geological transformations in the region, a relief was formed, represented by low mountains, ridge hills and lowland plains [2]. The soil composition of the Anapa Region is characterized as sod-calcareous shallow soil, from low to high stone, medium washed and strongly washed, weak and strongly eroded soil. The grain-size composition is marl clays, marl eluvium, talc heavy loam. The sandstone and fen clays are found. The relief is difficult with the slope steepness from 0° to 25°; the exposure is varied.

The above characteristics of climate, soil, terrain are suitable for essential oil crops, which have low requirements for soil fertility, and are capable of preventing the development of erosion processes on the land plots. On the other hand, any producer of essential oil raw materials takes into account the needs of the market. At present, lavender, rosemary, mint, wormwood, calendula, chamomile, and thyme oil are in great demand.

Taking into account the long-term experience of cultivation of these crops in Russia [3-6], as well as modern foreign experience [7-10] the most suitable for the conditions of the region are lavender, rosemary, and wormwood. For example, lavender is a perennial, cold-resistant, light-loving, drought-resistant plant that grows on many types of soil, carbonate, gravelly or stony-gravelly loams. The southern and southwestern slopes are especially favorable for its cultivation. Having strong, fibrous and branched root system lavender can grow on steep slopes (over 15 degrees), protecting them from soil erosion and as a honey plant. Rosemary is a perennial light- and heat-loving plant, drought-resistant, that prefers dry calcareous, permeable soils with good aeration. It also grows on dry sandy and rubbly soils. For their placement it is necessary to have sunny areas protected from prevailing winds. Wormwood is underdemanding to the conditions of growth; light-requiring and relatively thermophilic, frost hardy, when placing this plant, you must choose the southern exposure, a place protected from the winds. All of these crops are cultivated as perennial plantations. The wormwood can be cultivated in special medicinal crop rotations [1].

Figure 1. Topographic area scale plan 1:5,000.
The type design of land massifs was carried out on one of the land plots of the territory of the former collective farm Caucasus. The study was carried out by QGIS, the topographic terrain plan of 1:5,000 scale was used as a source material for the analysis of the terrain (Figure 1). Besides, planned and high-altitude survey of individual sections was created on the basis of which a digital model of the terrain using irregular triangulation network was developed (TIN). The soil characteristics of the land massifs were established on the basis of the 1990 soil map and the agrochemical soil survey of 2018.

3. Results
Let us consider the process of determining the suitability of land of Anapa Region in order to cultivate the essential oil crops mentioned above. To identify homogeneous land plots in terms of relief, a slope and slope exposure map was compiled based on the digital elevation model created (Figures 2, 3).

The slopes of the area are mainly southern, southwestern and southeastern exposure (Table 1); the slope is in the range from 0° to 20°, the largest share is made up of the areas with a steepness of 5° -15° (Table 2).

| Indicators          | North | Northeast | East | Southeast | South | Southwest | West | Northwest | Total   |
|---------------------|-------|-----------|------|-----------|-------|-----------|------|-----------|---------|
| Area (ha)           | 1.44  | 2.08      | 4.89 | 17.36     | 32.41 | 20.44     | 27.04| 15.88     | 121.54  |
| Specific weight (%) | 1.18  | 1.72      | 4.02 | 14.29     | 26.67 | 16.82     | 22.24| 13.07     | 100.00  |

The area is characterized as sod and calcareous with medium and shallow soil from weakly to heavily soils on hardly gentle slopes, i.e. 96.61 ha or 79% suitable for cultivation of essential oil crops.

1 The area does not account for the existing fruit-bearing vineyards.
According to the degree of erosion, steepness and exposure of slopes it is possible to establish the categories of erosion hazard of the lands of the studied area (Table 3). It can be seen from the Table that half of the land belongs to category IV and 40% belongs to VI, which requires the development of erosion control measures and the establishment of their rational placement carried out in the land management projects during cultivation of essential-oil-bearing plant.

Table 2. Characteristics of land on slope steepness

| Indicators       | 0-2.5 | 2.5-5 | 5.75 | 7.5-10 | 10-15 | 15-20 | >20 | Total |
|------------------|-------|-------|------|--------|-------|-------|-----|-------|
| Area (ha)        | 4.76  | 10.67 | 39.24| 19.75  | 41.06 | 5.82  | 0.23| 121.54|
| Specific weight (%)| 3.91  | 8.78  | 32.29| 16.25  | 33.79 | 4.78  | 0.19| 100.00|

Table 3. Characteristics of land on erosion hazard categories

| Indicators       | III   | IV    | V     | VI    | VII   | VIII  | Total |
|------------------|-------|-------|-------|-------|-------|-------|-------|
| Area (ha)        | 3.16  | 60.88 | 8.51  | 47.71 | -     | 1.27  | 121.54|
| Specific weight (%)| 2.60  | 50.09 | 7.00  | 39.26 | 1.04  | 100.00|

The characteristics of the studied land, including the establishment of its modern use and the degree of cultural state, are given in Table 4. As can be seen from the Table, most of the land is not currently used, which requires the carrying out of cultural and technical works on the uprooting, cleaning of stones, and primary tillage of soil (at current rates the cost of clearing from wood and grass vegetation will be 20.51 thousand rubles per 1 ha; from stones - 1.56 thousand rubles per 1 ha; primary tillage - 32.76 thousand rubles per 1 ha. The overall price will comprise 54.78 thousand rubles per 1 ha [11]).

Table 4. Characteristics of land

| Type of land     | Area (ha) | Degree of forest cover | Prevailing soil | Texture | Humus horizon width |
|------------------|-----------|------------------------|-----------------|---------|---------------------|
| Deposit          | 112.05    | Low                    | Medium sod-calcareous | Light clay | Medium              |
| Tilled soil      | 1.37      | -                      | medium stone     | Light clay | Medium              |
| Forest steppe    | 8.12      | High                   | medium washed   | -       | -                   |
| Total            | 121.54    |                        |                 |         |                     |

The studies show that the selected land has a complex topography and unfavorable soils for agricultural use due to heavy cobble content and increased dryness, as well as medium washed and hardened soil. However, for essential oil crops that are unpretentious for soils that have a good root system impeding the development of surface runoff, with a rational farming system these lands may be suitable for their cultivation due to favorable climatic conditions. Figure 4 and Table 5 show homogeneous lands suitable for plantations of perennial ether-carrying plants (lavender and rosemary), as well as lands suitable for medicinal crop rotation, where it is possible to cultivate wormwood, as well as other valuable essential oil crops, i.e. chamomile, calendula, etc.
4. Conclusion
The type design of land massifs for the cultivation of aromatic crops should be based on the analysis of the soil type, its grain sizes, degree of erosion, topography (slope, slope exposure), and cultural state of the land plot taking into account crop requirements for growing conditions, ability to protect the soil from erosion. The type design of land plots for the cultivation of ethers is an integral stage of land management projects (arrangement of territory).

References
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| Indicators                  | Area (ha) | Samples/land use                  |
|-----------------------------|-----------|-----------------------------------|
| Essential oil crop rotation| 47.89     | Wormwood, chamomile, calendula    |
| Perennial plantations       | 49.60     | Lavender, rosemary                |
| Other lands                 | 24.05     | Wild plants (hawthorn, dogrose)   |
| Total                       | 121.54    |                                   |

Figure 4. Type design of land massifs for cultivation of essential oil crops
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