The bioclimatic potential of the Crimea

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Abstract. The assessment of the bioclimatic potential of the Crimean Peninsula according to the Shashko method is given. The main indicators in this technique are the sum of temperatures above 10 °C and humidity deficiency. It was found that there are high indicators of bioclimatic potential on the territory of the peninsula, but certain patterns are observed due to the geographical location of the territory. It is noted that the urgent tasks of the agrotechnological industry of the Republic of Crimea today are the reorientation of crop production industries to the production of other crops, taking into account the bioclimatic potential of the territory and the state of soil resources.

1 Introduction

The study of agro-climatic resources in relation to a specific territory and taking into account various aspects of crop cultivation is a difficult task, since it requires to consider numerous components that affect the formation of the local climate, as well as the peculiarities of crop growth. For the Crimea, this direction is very topical in the current conditions, due to both natural causes – climate change, and due to changes in crop growing conditions after the cessation of the supply of Dnieper water through the North Crimean Canal which was the main source of water supply for fields and gardens in a significant part of the peninsula. After the Dnieper water supply was cut off in 2014, farmers faced a serious water shortage, which led to a decrease in the yield of some crops.

Therefore, the urgent tasks of the agrotechnological industry of the Republic of the Crimea today are, firstly, the reorientation of some branches of crop production to the production of other crops and secondly, taking into account the bioclimatic potential of the territory and the state of soil resources to ensure strategic objectives of agricultural reorientation.

The bioclimatic potential allows us to assess the availability of a wide range of crops with basic agro-climatic resources, heat and moisture, which makes it one of the main complex indicators, because these characteristics determine the possibilities of growing crops in a certain area. When developing the bioclimatic potential indicator (BCP), the algorithm proposed by D. I. Shashko was used [1]. The advantages of using BCP are primarily related to the versatility of this indicator: it can be used to assess the growing conditions of all major

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crops and it can be easily adapted to the characteristic conditions of the regions under consideration.

The purpose of the study is to assess the bioclimatic potential of the Crimea to determine the territorial patterns of growth of major crops.

2 Problem statement

At the initial stage of the study, an analysis of the climatic conditions of the region was carried out, including the study of the main climatic parameters. The basis of the actual information material for statistical analysis was the archival data of regular in-situ hydrometeorological observations of the Federal State Budgetary Institution "Crimean Directorate for Hydrometeorology and Environmental Monitoring" during the period of instrumental observations at meteorological stations of the Crimean Peninsula. In addition, weather data posted in the public domain was used [2].

3 Results and discussion

The main climate features of the Crimean Peninsula are determined by the physical and geographical location and relatively small size of the peninsula; the influx of solar radiation; atmospheric circulation; the influence of the Black and Azov Seas; the features of the underlying surface, as well as the presence of mountains in the south of the peninsula. The Crimea is characterized by a large number of sunshine hours, relatively mild winters, hot summers and a shortage of atmospheric moisture almost throughout the peninsula. The Crimea was one of the sunniest regions of Russia. The annual duration of sunshine here varies between 2180 – 2470 hours. The maximum duration is in July (320-360 hours) [3]. The average monthly air temperature mainly varies from north to south, with the exception of the Southern coast of the Crimea, where the change occurs to the east and west. The lowest average monthly air temperature in January – February to minus 4.0 °C is observed in mountainous areas, and the highest, about plus 5 °C, is on the Southern coast of the Crimea. The temperature reaches its highest values in the annual course in July, its average value is plus 23-24 °C in most of the territory, and plus 16 °C in the mountains. However, in 30-40% of the years, August is the warmest month. Due to the influence of the Black Sea, the air temperature in autumn is much higher than in spring, especially on the Southern coast of the Crimea. The Crimea is characterized by a very long frost–free period, reaching 240-260 days on the South Caucasus, 220-240 days on the West Coast and the Kerch Peninsula, 160-200 days in steppe and foothill areas, and only 150-160 days on the mountain tops [3]. The last 100 - 120 years, the air temperature in the Crimea has tended to rise. During this period, the average annual air temperature increased by approximately 1.0 °C [4, 5]. Due to the complex structure of the relief and the peculiarities of atmospheric circulation, precipitation is distributed very unevenly. The amount of precipitation per year varies over the territory from 250-300 mm in steppe areas to 1000 mm or more in the mountains, where specific humidification conditions are created. Most regions of the Crimea belong to the zone of insufficient moisture, especially the Western and Eastern sea coasts, where precipitation is 100-150 mm less than in the central regions of the steppe [3]. Thus, the combined influence of atmospheric circulation in the Crimean Mountains and on the Black Sea contributes to the formation of a subtropical climate zone on the Southern coast [5]. The lowest precipitation values are on the northwestern coast of the Black Sea and in the Prisivashye region, the highest are in the high–altitude zones.

The combined effect of heat and moisture supply on plant productivity is taken into account using the bioclimatic potential (BCP), the relative value of which is expressed by the equation of D.I. Shashko [1, 6]:

$$BCP=Kr\bullet\sum t>10^{\circ}C/1000\bullet Kpm, \quad (1)$$

where BCP – is the bioclimatic potential;

Kpm – is the transition coefficient;

$\sum t>10^{\circ}C$ – the sum of active temperatures during the growing season.

Kr – the growth coefficient according to the annual indicator of atmospheric humidification is calculated as;

$$Kp = 1.51g(20Md) – 0.24 + 0.36Md – Md \quad (2).$$

The growth coefficient of Kr is the ratio of crop yield in these conditions of moisture availability to maximum yield in conditions of optimal moisture. The Md coefficient in formula (2) is an indicator of atmospheric moisture, which is calculated using the formula:

$$Md = \sum P/\sum(E-e), \quad (3)$$

where $\sum$ P is the amount of precipitation per year (mm),

$\sum(E-e)$ – the sum of air humidity deficits for the year

As the soil cover of the Crimean Peninsula is characterized by significant diversity [7], the Kpm coefficient is introduced into the BCP formula, which is calculated using the formula:

$$Kpm = \sum Tp/\sum Tps, \quad (4)$$

where $\sum$Tp is the sum of the soil temperature at a depth of 10 cm (any kind);

$\sum$Tps is the sum of the soil temperature at a depth of 10 cm (medium loam) [6].

To calculate the sum of the temperature of the average loam at a depth of 10 cm, we used the author's model of the dependence of soil temperature (t) on the content of physical clay (f):

$$Tps= – 0.05\ Tp + 22.8 \quad (5)$$

When analyzing the territorial patterns of distribution of bioclimatic resources, it is almost impossible to assess the bioclimatic potential of the Mountainous Crimea, due to complex microclimatic processes and the lack of agro-climatic observations at weather stations located in the mountainous part of the peninsula. The results of the cartographic modeling of the BCP indicator are presented in Figure 1. This map as a whole allows you to see general patterns in the change of bioclimatic potential. Thus, the reverse inversion zonality is clearly visible when moving from north to south, which is due to the presence of the Crimean Mountains and the territorial patterns of temperature and precipitation distribution. There are differences in the BCP in the central and coastal regions, while in the western part of the peninsula, the potential of the BCP is significantly lower from 3.65 in the Black Sea to 3.72 in Razdolny than in the eastern part of the Crimea. On the Kerch Peninsula, its values range from 4.29 at the Vladislavovka weather station to 4.46 in Kerch. In the central part of the plain Crimea, the BCP varies from 3.79 in Klepinino to 4.02 in Yefpatoria, in the foothill Crimea from 3.62 in Belogorsk to 4.25 in Pochtovoe. The southern coast of the Crimea is characterized by the highest values of the biclimatic potential from 4.57 for the Nikitsky Gardens weather station to 5.05 in Yalta. In general, the territory of the Crimean Peninsula is characterized by high bioclimatic potential. The research data indicate that changes in the values of the BCP on the territory of the peninsula are most influenced by local and seasonal features of changes in temperature and precipitation.

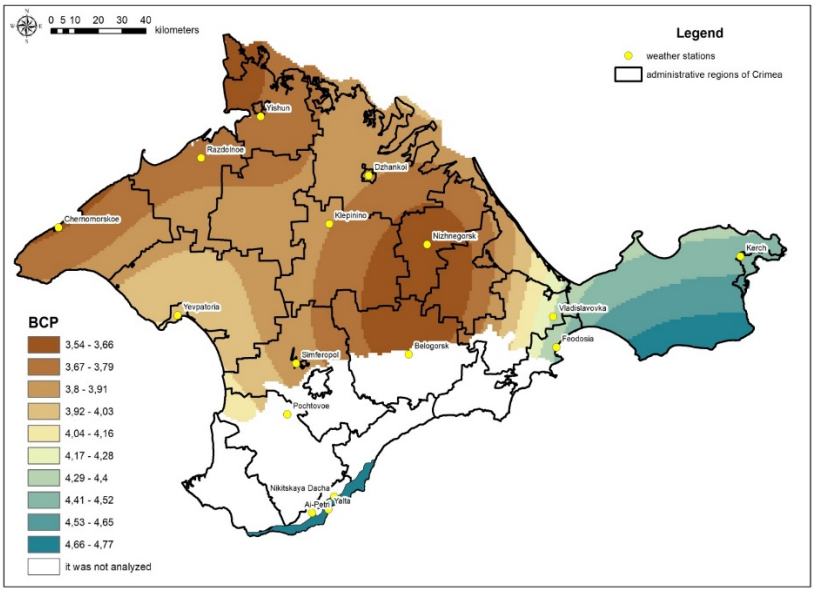

Fig. 1. Map of the bioclimatic potential of the Crimean Peninsula.

4 Conclusion

The main features of the climate of the Crimean Peninsula are determined by the physical and geographical location and size of the peninsula. The main climate–forming factors of the peninsula are the influx of solar radiation, atmospheric circulation, the influence of the Black and the Azov Seas, as well relief features. The Crimea is characterized by a large number of sunshine hours, relatively mild winters, hot summers and a shortage of atmospheric moisture almost throughout the peninsula. The agro-climatic conditions of the Crimea are characterized by high values of the sum of temperatures favorable for the growth of many crops, but low values of moisture availability. The assessment of the bioclimatic potential of the territory makes it possible to identify regions with favorable conditions for the growth of agricultural crops. This is especially important in modern conditions of climate dynamics and also during the transformation of crop cultivation conditions in post-irrigation conditions. The highest values of bioclimatic potential are characterized by the southern coast of Crimea. The central regions of the flat Crimea and the foothill areas of the main ridge of the Crimean Mountains have high potential. The lowest values of the bioclimatic potential are observed on the western and northwestern coasts of the lowland the Crimea. The study and assessment of bioclimatic potential in modern conditions is an important area of scientific research. Such work contributes to the development of sustainable and effective strategies for managing the natural resources of the region in a changing economic environment.

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