UDC: 551.583

DISTRIBUTION OF WINTER WHEAT WITH ACCOUNT OF GLOBAL WARMING

Meladze G.G., Meladze M.G.
Institute of Hydrometeorology at the Georgian Technical University, Tbilisi

The global climate change has become a very urgent problem in many countries of the world as a result of anthropogenic impact. Therefore, today, the relevant organizations realize the measures to limit the reasons causing the climate change, and unless they are accomplished, an essential change of the strategy of industrial and agricultural branches is not excluded. This is evidenced by frequent hydrometeorological natural disasters in the past decade causing significant economic losses.

The global climate change has affected the territory of Georgia, too. The studies prove [1, 2] that the air temperature in Georgia increased by 0.2-0.5°C on average. According to the most recent data [3], the air temperature in Western and Eastern Georgia has increased by 0.2°C and 0.4°C, respectively. As a result of such a trend, the temperature increase may reach 1-2°C or even more by 2040-2050. Therefore, depending on the mentioned air temperatures, it is necessary to consider the change of the agro-climatic zone of distribution of winter wheat and sums of active temperatures (above 10°C) being the major factor for the plant growth and development.

Following the above-mentioned trend of the temperature increase, we take 1°C increase for Western Georgia with less temperature increase compared with Eastern Georgia, and we take 2°C temperature increase for Eastern Georgia by considering the designed scenario. Therefore, we used the equations to calculate [4] the distribution of winter wheat and sums of active temperatures in Eastern and Western Georgia (Table 1).

Table 1. Regression Equations to Calculate the Dates of the Air Temperature Exceeding by 10°C and Sum of Active Temperatures

Calculation	Scenario, at 1°C temperature increase. Western Georgia	Scenario, at 2°C temperature increase. Eastern Georgia
Dates of temperature above 10°C	n=0.027h+51	n=0.036h+38
Sum of active temperatures	T=-16.711n-1.127h+5496	T=-44.254n-0.150h+6742

In the equations, T - is the active temperature sum above 10°C, n - is the dates of the air temperature exceeding by 10°C from February 1 (the number to of days from February 1 to the date when the temperature rises over 10°C), h - is altitude above sea level (in m).

Our aim is to distribute the winter wheat over the territory of Georgia by considering the global climate warming so that the temperature increase should not influence the plant growth or its productivity. Otherwise, the temperature increase may have a negative impact on the plant growth and its harvest.

In accordance with the above-mentioned scenarios, the sum of active temperatures (above 10°C) was calculated. For the regions with the potential to grow the given crops successfully, it turned out that in case of 1°C increase in air temperature according to the scenario, the sum of active temperatures will increase by 220-250°C on average, and it will increase by 440-480°C in case of a 2°C temperature increase. The work shows almost the same values [5].

An agro-climatic map of the possible areas of distribution of winter wheat by considering the gained temperatures sums is drafted (Fig. 1).

The demand for the sum of temperatures needed for the full ripeness of the given crop grains was considered in drafting the map. The demand is 2000-2200°C. Therefore, the upper limit of distribution of the winter wheat is marked by considering the said sums of temperatures. According to the said temperatures, the area of distribution of winter wheat in Western Georgia reaches up to 1450-1650 m altitude above sea level. The temperature of the lower limit of the area of distribution of winter wheat is 4000°C or more, with the area of distribution in Eastern Georgia reaching 1750-1800 m altitude above sea level or a little more.

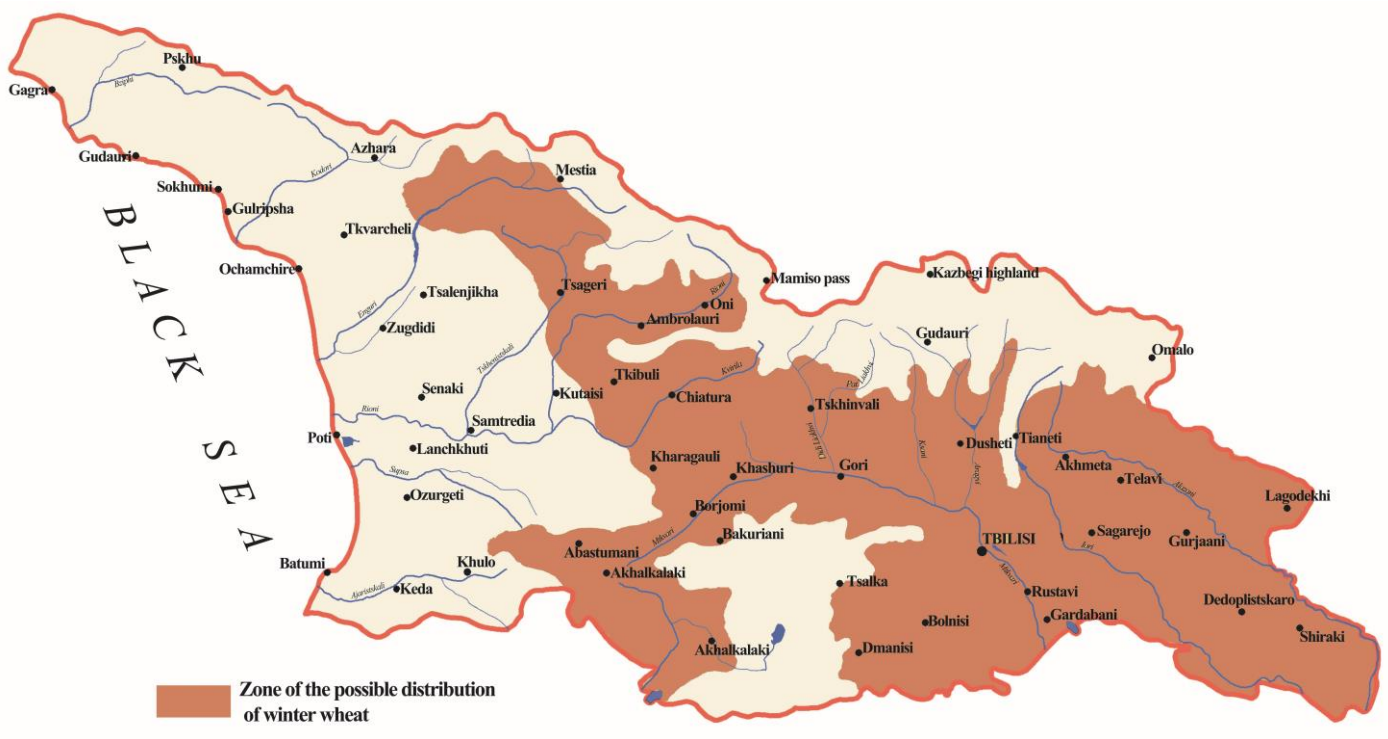

Fig. 1. Agro-climatic Map of the Possible Distribution of Winter Wheat

The map analysis evidences that the area of distribution of winter wheat has much expanded mostly at the expense of vertical zoning. The area of distribution of winter wheat in Western Georgia as compared to the basic (existing) area of distribution has risen by 170-200 m on average, and by 350-400 m in Eastern Georgia. It should be noted that the global warming, under the developed scenario, will not have any negative impact on winter wheat crops if the relevant agrarian techniques are used and will not hamper gaining the guaranteed harvest.

In connection to the global climate change, a regional model ECHAM4 and A2 future scenario is used to forecast the local climate change [3] by calculating the anticipated data of meteorological observations of the climatic parameters of the future (2020-2049). The average temperatures of the months of each year were used to calculate the sums of temperatures for four months after the dates the temperature is above 10°C. Close correlation was fixed between with above-mentioned the sum of temperatures and date of temperature above 10°C (r=0.90). Such a stable correlation was used to draft a forecast regression equation of the future (2020-2049):

$$T=12.12n+1611,$$

In the equations, T - is the active temperature sum above 10℃, n - is the dates of the air temperature exceeding by 10°C in spring (the number to of days from February 1 to the date when the temperature rises over 10℃). Deviation from the mean value is within the limits of admissible error Su±75.

The gained equation can be used to calculate the sum of anticipated temperatures of the future of any year, i.e. one can know to what extent the winter wheat crop is going to be supplied with the temperatures sum for four months (in the vegetation period) after the date the temperature exceeds 10°C in spring.

Following the global climate warming, we give increases and decreases (%) of the sums of atmospheric precipitations expected in the warm season over the areas of distribution of winter wheat [6]. For instance, a 5-10%-increase of the atmospheric precipitations is expected in Dedoplistskaro district in Eastern Georgia. Southern of this area and on the territories of Mtskheta, Tskhinvali, Khashuri, Gori and Borjomi up to 5% increase is expected. On the territory of Tkibuli in Western Georgia, a 5-10%-increase of the atmospheric precipitations is expected. A 5%-increase of the atmospheric precipitations is expected in Mestia and Kharagauli districts, and a 5%-decrease of the atmospheric precipitations is expected in other areas of winter wheat distribution (Oni, Tsageri, Tkvarcheli districtss).

Reduced atmospheric precipitations should be considered by agricultural workers and farmers, as the areas with anticipated reduction in the atmospheric precipitations will need additional irrigation (watering) at least once to grow winter wheat desirable in the earing phase.

Winter wheat is an important food product, and demand for it in our country can be met at 80% and more. Winter wheat is not much demanding to soil or climatic conditions. This allows expanding the area of its distribution

and gain a harvest of 2.5-3.0 t/ha on average; however, in individual areas, particularly in Kakheti (on Alazani valley) or Dedoplistskaro district a harvest of 3.5-4.0 t/ha or even more is also a reality if high-quality agrarian techniques are used.

The mentioned crop is sown on the plain, mountainous or high-mountainous zones in autumn. After successful wintering, it vegetates in spring. Development of the phonological phases of the plant (earing, ripening, etc.) coincides with the period of frequent atmospheric precipitations in spring in Eastern Georgia. In spring, unlike winter, from March through May, the atmospheric precipitations increase by 120-140% creating favorable conditions for winter wheat to develop and be highly productive. In this period, the atmospheric precipitations on Kolkheti Lowland in Western Georgia decrease by 30-40% limiting the area of distribution of the given crops.

For 1°C increase under the scenario, increase of the mean daily air temperature above 10°C starts 7 days earlier on average as compared with its basic (existing) value, and 10 days earlier in case of a 2°C increase. The duration of the mentioned days allows applying organic and mineral fertilizers (in relevant doses) to the soil 7 to 10 days earlier in spring (for wintered winter wheat grain field, if necessary).

We should note that in case of 1°C to 2°C increase in temperature over the area of distribution of the winter wheat under the scenario, the global climate change (before 2040-2050) will not affect the growth or vegetation of the given crop (winter wheat), unless the temperature increase exceeds the temperatures values fixed by the said scenario.

ლიტერატურა - REFERENCES - ЛИТЕРАТУРА

1. Tavartkiladze K., Elizbarashvili E., Mumladze D., Vachnadze J. The Empirical Model of Surface Temperature Field Change in Georgia. Tbilisi, 1999, p.106
2. Tavartkiladze K., Begalishvili N., Tsintsadze T., Kikava A. Influence of Global Warming on the Near-Surface Air Temperature Field in Georgia. Bulletin of The Georgian National Academy of Sciences, vol.6, № 3, 2012, pp.55-60
3. Georgia's Second National Communication to the UNFCCC. Ministry of Environmental Protection and Natural Researches - UNPP, Tbilisi, 2009, p.237
4. Meladze G., Tutarashvili M., Meladze M. Influence of Global Warming on Changes of Agroclimatic Zones. Transactions of the Institute of the Hydrometeorology, vol. 115, Tbilisi 2008, pp.97-104
5. Meladze G., Meladze M. Perspective Vine Propagation Zones in Georgia Considering Expected Global Climate Change. Bulletin of The Georgian Academy of Sciences, 172, № 2, 2005, pp.304-305
6. Elizbarashvili E., Papinashvili L., Kheladze T. National Informational Bulletin in Climate Change, №5, Tbilisi, 1997, p.14

უაკ: 551.583

გლობალური დათბობის გათვალისწინებით საშემოდგომო ხორბლის კულტურის გავრცელება./მელაძე გ.გ., მელაძე მ.გ./საქართველოს ტექნიკური უნივერსიტეტის ჰიდრომეტეოროლოგიის ინსტიტუტის შრომათა კრებული-2013.-ტ.119.-გვ.97-100-ინგლ., რეზ. ქართ., ინგლ., რუს.

განხილულია კლიმატის გლობალური ცვლილების ასპექტები. შემუშავებულია სცენარები ჰაერის ტემპერატურის 1 და 2°-ის მატებით (დასავლეთ და აღმოსავლეთ საქართველოსათვის, შესაბამისად). მოცემულია საშემოდგომო ხორბლის ტემპერატურათა ჯამით (>10°) უზრუნველყოფის მომავლის (2020-2049წწ) საპროგნოზო რეგრესიის განტოლება.

აქტიურ ტემპერატურათა (>10°) ჯამების განსაზღვრისათვის სცენარით, ტემპერატურის 1 და 2°-ის მატებით შედგენილია რეგრესიის განტოლებები, რომელთა მიხედვით გამოყოფილია (რუკაზე) საშემოდგომო ხორბლის გავრცელების ზონა.

არსებული (ფაქტიური) ტემპერატურების 1 და 2°-ის მატებით აქტიურ ტემპერატურათა ჯამები საშუალოდ იზრდება 220-250° და 440-480°-ით შესაბამისად. დასავლეთ საქართველოში საშემოდგომო ხორბალი ტემპერატურის 1°-ით მატებისას ვრცელდება 1450-1650 მ სიმაღლეზე ზღვის დონიდან, აღმოსავლეთ საქართველოში 2°-ით მატებისას 1750-1800 მ სიმაღლემდე.

UDC 551.583

DISTRIBUTION OF WINTER WHEAT WITH ACCOUNT OF GLOBAL WARMING /Meladze G.G., Meladze M.G./ Transactions of the Institute of Hydrometeorology, Georgian Technical University. -2013. -vol.119. -pp.97-100- Eng., Summ. Georg., Eng., Russ.

Aspects of global climate change are considered. According to the scenarios air temperature increase by 1 and 2º are developed (for Western and East Georgia, respectively). For definition of temperatures sums (>10°) under the scenarios increase by 1 and 2º the equation of regress is compiled. By the equation is defined and allocated zone of distribution of winter wheat.

At increase of existing temperatures by 1 and 2º the active temperature sums is raises on average by 220-250º and 440-480º (respectively).

In Western Georgia, upon the temperature increase by 1º winter wheat might spread up to 1450-1650 m above sea level, in Eastern Georgia up to 1750-1800 m.

УДК: 551.583

РАСПРОСТРАНЕНИЯ ОЗИМОЙ ПШЕНИЦЫ С УЧЁТОМ ГЛОБАЛЬНОГО ПОТЕПЛЕНИЯ /Меладзе Г.Г., Меладзе М.Г./Сб. Трудов Института Гидрометеорологии Грузинского Технического Университета Грузии. -2013.-т.119.-с.97-100 - Анг., Рез. Груз., Анг., Рус.

Даются аспекты глобального изменения климата. Разработаны сценарии с учётом повышения температуры воздуха на 1 и 2° (для Западной и Восточной Грузии, соответственно). Для определения сумм температур (>10°) по сценарию повышения на 1 и 2° составлено уравнение регрессии. Уравнением определена и выделена зона распространения озимой пшеницы. При повышении существующих температур на 1 и 2° суммы активных температур повышаются в среднем на 220-250° и 440-480° (соответственно).

В Западной Грузии озимая пшеница при увеличении температуры на 1° распространяется на высоте 1450-1650 м над уровнем моря, в Восточной Грузии до 1750-1800 м.