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Ecology

Distribution of Different Varieties of Vine with Account of Global Warming on the Territory of Georgia

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ABSTRACT. Climate change is one of the most important global problems. Atmosphere's self-cleaning capacity cannot maintain ecological balance of the climatic system due to strong anthropogenic loadings. Analysis of the global temperature regime confirmed that the climate changes sharply and tends to global warming. Tendency of global warming was observed on the territory of Georgia as well. Increase of the temperature in Eastern and Western Georgia is 0.4 and 0.2 °C, respectively. It is possible that it will reach 1-2 °C by 2030-2050. At the increase of temperature by 2 and 1°C active temperature sums (above 10 °C) increase by 440-480 °C and 220-250 °C in Eastern and Western Georgia. An agroclimatic map is compiled for vertical zonal distribution of different kinds of vine based on the above-mentioned data. Three agroecological zones are marked out in the map. Sums of increase and decrease (in %) of atmospheric precipitation (mm) are taken into consideration according to vine distribution areas. By the scenario worked out at the increase of temperature by 1°C the duration of the vegetation period (day) increases and amounts to 12 days on average, and at the temperature increase by 2 °C the duration amounts to 20 days. An extended vegetation period has positive effect on changes of terms of agrotechnical measures. Provision by temperature sums needed for complete ripening of grapes in the vegetation period is specified according to distribution zones of late vine varieties. By the database in Akhmeta (Eastern Georgia), the temperature sum is provided 8 times per 10 years, in Keda (Western Georgia) – 9 times per 10 years. According to the scenario it is supplied at the increase by 2 and 1°C each year. © *2013 Bull. Georg. Natl. Acad. Sci.*

Key words*: global warming, climate change, agroclimatic zone, active temperature sum, provision by active temperatures, atmospheric precipitation.*

Climate change is one of the important global problems of negative results caused by anthropogenic effect on the environment. Analysis of the temperature regime shows that sharp change of climate tends to global warming which means an increase of many-years average temperature on the Earth. The cause of this was definitively called sharp increase of greenhouse gas emission. It is revealed in activity of man, intensive use of natural resources (oil, coal, forests, etc.), which causes greenhouse effect in the atmosphere [1,2].

Over the past few years due to anthropogenic influence every year emission of carbon dioxide (CO_2) increases in the atmosphere. In the opinion of re-

searchers [3,4], its concentration will be twice more in 2030-2050 than it is at present. This will cause increase of temperature by 2-3 °C. It is evident that such increase of the temperature will change the climate, which, in turn, will affect many spheres of the national economy, especially agrarian sector.

At the beginning of the 21st century investigations carried out by the World Meteorological Organization (WMO) verified the existence of global warming, which has involved the entire territory of Georgia [5]. Proceeding from the complete relief Georgia is vulnerable to the natural catastrophes caused by climate global change. The country's relief, meteorological conditions and anthropogenic loading, causes development of natural disasters: drought, mudflows, erosion, etc. Nowadays it is urgent to work out adaptation and mitigation measures, such as improvement of irrigation methods for arable lands, selection of persistent varieties, etc.

In Eastern Georgia the increase of temperature amounts to 0.4 °C [6], in Western Georgia 0.2 °C [7]. If the trend of temperature increase continues it possibly will reach 1-2 °C and more in 2030-2050. Proceeding from this, in accordance with global warming, it is necessary to determine in advance the distribution area of different varieties of vine and make corresponding changes.

Our aim is, taking into consideration climate global change, to determine the possibilities of reasonable distribution and relocation on the territory of Georgia of different varieties of vine in such a way that the effect of temperature increase will be positive on its development and productivity. Otherwise, long-term variations of the temperature regime will have negative results in future. In connection with this, corresponding scenarios for temperature increase by 2 and 1 °C in Eastern and Western Georgia, respectively, are worked out. Differences in temperature increases in scenarios are caused by the fact that increase of air temperature is more in the eastern part of Georgia than in the western one.

According to the mentioned scenarios the sums of active temperatures are calculated (above 10 °C) for possible regions of production of different varieties of vine. It was determined that at the increase of temperature by 1 °C (according to the scenario) the sum of active temperatures increases by 220-250 °C on average, and at increase by 2 °C the sum increases by 440-480 °C and slightly more. Taking into consideration the sums of active temperatures obtained, an agroclimatic map of the distribution of different vine varieties is compiled, marking out 3 agroclimatic zones.

According to the map, in zone 1 the sum of effective temperatures (above 10 °C) totals 3500 °C and more. In this zone all varieties of vine may be produced. For complete maturity of late varieties of vine such as Rkatsiteli, Tsolikouri, Saperavi, Manavis mtsvane, Ckhaveri, Ojaleshi, Krakhuna and others the sum of 3400 °C is needed. The given sum fully provides production of high quality wine.

In zone I at the increase by 2 °C according to scenario in Eastern Georgia the late varieties of vine grow at 1150-1200 m above sea level, and in Western Georgia at the 1 °C increase – at 1000-1100 m a.s.l..

In zone II the temperature sum is 3000 °C and above. Here vines of medium ripening and early varieties are cultivated. Of medium varieties such as Goruli mtsvane, Chinuri, Tsitska, Usakhelouri, Aladasturi, Pinot Shavi and others need the sum 2900°C and slightly more for full ripening of fruit.

In the mentioned zone the given varieties at temperature increase by 2 °C in Eastern Georgia are spread at 1250-1300 m a.s.l., in Western Georgia at 1150-1200 m a.s.l. at the increase by 1 °C.

In zone III the sum of active temperatures is 2500 °C and above. In this zone varieties of early ripening can be grown: Aleksandrouli (Khvanchkara), Tsulukidzis Tetra, Dzvelshavi, Budeshuri, etc. varieties. Necessary temperature sum for full maturity of the mentioned varieties is 2400 °C and above. In this zone the vine varieties are distributed at 1350-1400 m a.s.l. in Eastern Georgia at 2 °C increase and at 1250-1300 m a.s.l. in Western Georgia at 1 °C.

Table. Provision by the temperature sums necessary for full maturity of grapes (above 10 °C)

District	Average temperature sums, °C	Provision by temperature sums, %						
		95	90	70	50	30	10	5
Akhmeta (basic)	3660	3300	3360	3520	3660	3780	3970	4060
Scenario, 2°C-increase	4160	3730	3820	4010	4160	4280	4520	4620
Keda (basic)	3870	3370	3460	3750	3870	4020	4310	4410
Scenario, 1°C-increase	4290	3790	3900	4140	4290	4460	4690	4710

For the warm season in vine distribution zones increase and decrease of atmospheric precipitation in percentage are calculated in [8] taking into account the climate global change. Using these data, the authors compiled a scheme of prediction of changes in the amount of atmospheric precipitation on the territory of Georgia. In particular, in the vine distribution zone I of Eastern Georgia, 5-10% -increase of precipitation is expected in the south and south-east part of the zone; decrease of atmospheric precipitation is assumed in the north (Telavi), in the west and east of the zone by 5%, and in the extreme west by 5-10%. In Western Georgia, in the same zone, increase of precipitation by 5% is expected in the east, in the north, in the middle part of the zone (Samtredia, Senaki, Lanchkhuti). In the west of zone I (Zugdidi) - increase of precipitation is expected by 5-10% and to the Black Sea shore by 10-15%. Decrease of precipitation by 5% is expected along the sea shore strip (Sokhumi).

In zone II of Eastern Georgia increase of precipitation is expected in the middle part of the zone (Tskhinvali, Dusheti) by 5% and in the east by 5-10%. Decrease is expected in the north by 5%, in the south (Bolnisi) and in the western narrow strip to the north (Kvareli) by 5-10%. In Western Georgia increase of precipitation is anticipated in the north (Ambrolauri) and in the west (Tsalenjikha) by 5%, in the south of the zone by 5-10%. Decrease is expected by 5% in the extreme south, in the east (Chiatura), in the north-west (Tkvarcheli); precipitation will decrease by 5-10% in the southern narrow strip of the zone.

In zone III of Eastern Georgia increase of atmospheric precipitation by 5% is expected in the south (Borjomi). Decrease of precipitates by 5% is expected in the middle of the zone, by 5-10% in the west and in the east (Dmanisi) and decrease by 10-15% in the east (Lagodekhi).

It is clear that decrease of precipitation by the values mentioned above will not affect the development of plant considerably. On the other hand, it is possible that in some years an expected intensive drought will affect harvest, especially in the zones of vine distribution in Eastern Georgia. Therefore in the active vegetation period (July-August) it will be necessary to provide the soil with moisture (irrigation or cultivation 1-2 times).

According to scenario at the temperature increase by 1 °C transition of temperature above 10 °C in spring would be advanced by 6 days in comparison with the basic (actual) term, and transition of temperature below 10 °C in autumn ends late and amounts to the same number of days. As a result the duration of the vegetation period increases by 12 days. At 2 °C temperature increase in spring the temperature transition above 10 °C starts 10 days earlier , and that below 10 °C in autumn ends also 10 days later , therefore the vegetation period continues 20 days. Additional 7-10 days in spring allow to fertilize and plough up the soil earlier. Extension period in autumn by 10 days allows to prepare the soil for agricultural works earlier in some regions, and so on. At 2 °C temperature increase, proceeding from the prolonged vegetation period, vine should be cut 10 days earlier in spring in comparison with the basic (actual) term.

The nomogram providing for active temperature sums in the zones of distribution of different vine varieties is compiled using the method adopted in agrometeorology and agroclimatology [9,10]. Determination of provision by temperature sums necessary

for full maturity of grape in the vegetation period in each 10 and more years is possible using the mentioned nomograms for any zone of vine distribution. As an example we give the Table for late varieties of grape: Rkatsiteli in Akhmeta district (Eastern Georgia) and Tsolikauri in Keda district (Western Georgia) at 2 °C and 1 °C temperature increase, respectively.

Indices given in the Table make it possible to estimate the percent of the provision of late vine varieties by the temperature sum. In particular, according to basic sums, vines are supported 8 times in Akhmeta, and 9 times in Keda (in each 10 years); according to scenario each year at 2 °C and 1 °C temperature increase.

ეკოლოგია

გლობალური დათბობის ფონზე ვაზის კულტურის სხვადასხვა ჯიშების გავრცელება საქართველოს ტერიტორიაზე

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** საქართველოს ტექნიკური უნივერსიტეტის ჰიდრომეტეოროლოგიის ინსტიტუტი, თბილისი*

(წარმოდგენილია აკადემიკოს ო. ნათიშვილის მიერ)

მოცემულია გლობალური დათბობის პირობებში თერმული რეჟიმის ცვალებადობის ანალიზი, რომლის შედეგად გამოვლენილია ტემპერატურის მატების ტენდენცია აღმოსავლეთ (2°C-ით) და დასავლეთ საქართველოს (1°C-ით) ტერიტორიებზე. აღმოსავლეთ საქართველოში დასავლეთ საქართველოსთან შედარებით, ტემპერატურის მეტი მატების ტენდენციიდან გამომდინარე, შემუშავებული სცენარების მიხედვით, აღმოსავლეთ საქართველოში ტემპერატურის 2°C-ით მატებისას აქტიურ ტემპერატურათა ჯამი (10°C-ის ზევით) იზრდება 440-480°C-ით, ხოლო დასავლეთ საქართველოში 1°C-ით მატებისას – 220-250°C-ით. აქტიურ ტემპერატურათა ჯამების მიხედვით, შედგენილია ვაზის სხვადასხვა ჯიშების ვერტიკალური ზონალობით გავრცელების რუკა, რომელიც გლობალური დათბობის გათვალისწინებით პირველადაა შესრულებული საქართველოს სოფლის მეურნეობისათვის. გლობალური დათბობის გათვალისწინებით ვაზის გავრცელების რაიონებისათვის მითითებულია სავეგეტაციო პერიოდში ატმოსფერული ნალექების ჯამების (მმ) მატება და კლება (%). დადგენილია, რომ გლობალური დათბობის ფონზე ტემპერატურის 1°C-ით მატებისას სავეგეტაციო პერიოდის ხანგრძლივობა მატულობს და შეადგენს საშუალოდ 12 დღეს, ხოლო 2°C-ით მატებისას - 20 დღეს. ვაზის საგვიანო ჯიშების გავრცელების ზონებში (სცენარით 2 და 1°C-ით მატება) განსაზღვრულია ნაყოფების სრული სიმწიფისათვის საჭირო ტემპერატურათა ჯამებით უზრუნველყოფა (%) ყოველ ათ წელიწადში.

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