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Effect of Bordeaux Mixture on the Origin of Hail

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ABSTRACT

The paper discusses the territorial unit most vulnerable to hail in Georgia, Kakheti, and its istorical and current hail-related situation. With the help of the views of famous scientists as well as surveys, the authors of the paper concluded that nature isn't the only reason for hailstorms. The cause can also be the chemical substances used in the grapevine care process.
Key words: *hail, Bordeaux mixture, Kakheti, coagulation, poisoning.*

Introduction

The problem of hail damage is one of the most important problems in Georgia, in particular in the Kakheti region. Vakhushti Bagrationi (1696-1737) wrote about the devastating actions of the hail in the Vere Gorge but did not mention the Kakheti region. Well-known scientists M. Kordzakhia and academician F. Davitaya were of the opinion that during the time of Vakhushti Bagrationi there was no hail in Kakheti because, in the presence of abundant forest cover, there was no upward flow of air, which is one of the prerequisites for hail [1]. However, it is difficult for us to agree with this opinion because, in those days, Kakheti was a densely populated region with a well-developed agriculture. Probably, the vegetation cover of the region did not differ much from the present one, and the conditions for the occurrence of hail damage should have been approximately the same; and the vegetation cover, according to the scientists mentioned, prevents the upward flow of air. The authors involved the study of V. Gigineishvili, who believes that hail in Eastern Georgia, in particular in Kakheti, is mainly associated with the influx of cold air masses in the warm seasons. However, these inflows cause intense hail damage only when local atmospheric conditions are favorable during this particular period [1].

Main part

And if the formation of hailstones depends on local natural conditions, then the question of what changes in the natural conditions of Kakheti could have taken place in the period from the 18th to the 20th centuries that caused intense hailstorms in the region is appropriate. The answer to this question is partially given in the scientific work [2], which considers the effect of Bordeaux mixture drops, as well as aerosols on an increase in the crystallization temperature from -40 degrees to -5 degrees Celsius. The answer to the question posed by us can be attracted by the fact that at the end of the XX century the 100th anniversary of the use of Bordeaux mixture was celebrated worldwide, i.e. during the time of Vakhushti, Batonishvili did not resort to spraying Bordeaux liquid. The hailstone is formed not only under the influence of Cu and SO_4 ions contained in the Bordeaux mixture drops. The table of Zenger and Prupahar also lists other aerosols containing Cu - ions [3], which act similarly to Bordeaux drops and increase the freezing point of drops to -5 degrees Celsius. Among them is also a silver-iodine reagent. It is this reagent that is used today in an anti-hail rocket. The reagent at a height of 2.5 - 4.5 km dissipates in the clouds within 30-35 seconds. Research in the 1980s showed that during the spraying of vineyards in the settlements of Kakheti, the air contained Cu and SO_4 ions

in large quantities. And this means that in the conditions of an ascending air flow, they fall into the zone of city formation. This is confirmed by the fact that hail falls mainly in the interval from 2 to 5 hours. It is during this period of time that the number of droplets accumulated during spraying reaches its maximum in the atmosphere [1]. It is known that drops in clouds have different sizes and are often so supercooled that their temperature can be equal to -40 degrees Celsius [4]. At this moment, the drop is in a metastable state, and if a crystallization center enters it [5], the drop instantly turns into an ice crystal (hailstone). Therefore, the ingress of crystallization centers both naturally and artificially into such clouds, where drops of various sizes have already been formed, is especially dangerous, since this can lead to hail. It should also be noted that the drop expands in the process of turning into a hailstone, and, accordingly, its density decreases by about 9% compared to the density of water; in parallel, coagulation occurs and supercooled small water drops are attached to the hailstones, which quickly freeze and as a result turn not into smooth streamlined balls, but into rough hailstones of various shapes. Between the hail and the air, the coefficient of friction increases, and therefore the upward flow of air easily lifts the hailstone high into the colder layers. It increases significantly there, which is clearly seen from the Stokes formula [6]:

$$F = C\rho U^2 L^2 \quad (1)$$

where:

F - force of air resistance;

C is the drag coefficient;

ρ - air density;

U - hail speed;

L^2 - hailstone cross-sectional area;

The drag coefficient - C from the formula for streamlined bodies varies from 0.03 to 0.05, and for non-streamlined bodies - C = 1.0 to 1.5.

With an upward flow, the air expands adiabatically and, accordingly, cools, which leads to the formation of a hailstone crystal. In the process of crystal formation, heat is released, and a temperature difference is formed between the hailstone crystal and the surrounding air, which in turn forms a micro updraft around the hailstone. The ascending air flow carries the hail to higher layers of the atmosphere, which contributes to the growth of the hailstone crystal. It is also important that the longer the hail is in the clouds, the more the hail crystals, when colliding with each other, emit fragments, which, in turn, turn into crystallization centers. Crystal hailstones drift, begin to move randomly in different directions, since some of these crystals contain both positive and negative ions and they are affected by the electronic forces formed in the clouds, the Earth's magnetic field, the force of attraction and the Coriolis force. Clouds move together with hail, and the area of hail damage significantly increases [2]. The degree of coagulation also increases.

According to our research, spraying vineyards against hail damage is not a painless process. Apparently, therefore, economically developed European countries have abandoned the method of introducing crystallization centers into clouds using rockets to protect vineyards from hail, despite the fact that at one time they were the pioneers of its application.

Hailstorms did not take place in the Pankisi Gorge, since vineyards were not planted there; and after the 1980s, when vineyards appeared in the gorge like other regions, hailstorming became an intense phenomenon. But in contrast to the Pankisi Gorge, in regions where instead of vines they began to breed another agricultural crop that does not require spraying, hailstorming has ceased. For example, on the territory of Enamta, on the agricultural land of the Dedoplistskharo municipality, vineyards were planted on an area of 300 hectares. In Soviet times, they were sprayed with chemicals (Bordeaux liquid), while using heavy equipment. Over the past 20 years, the area of vineyards has decreased to 2 hectares, sprayed by hand, which minimizes the level of bardo liquid in the atmosphere. After the decrease in the area of vineyards in Enamta, no hail was recorded.

During spraying, it is necessary to take into account the ecological state of both air and water, since the sprayed substance eventually enters the water, and then the human body. Copper is a heavy metal and poison, as is S4, which, when exposed to water, forms sulfuric acid - H_2SO_4 .

On Fig. 1 we see the spraying process and a large amount of Bordeaux liquid that has entered the air with a large dispersion, the main part of which is carried by the ascending flow to the clouds. There, the liquid trapped in the clouds begins to act as a center of condensation as well as crystallization [1]. Therefore, the fight against hailstorms primarily involves the search for spraying methods that reduce the aimless spraying of $CuSO_4$ Bordeaux mixture in the air.

Fig.1. Spraying the vineyard with Bordeaux mixture

We consider it necessary to note that hail damage occurs not only during the spraying of vineyards, but also during the grape harvest. This is explained by the fact that when picking grapes, people come into intensive contact with the vines, and the $CuSO_4$ dust remaining on the branches of the vine after the evaporation of the Bordeaux mixture enters the high layers of the atmosphere, which can cause hail.

This assumption is confirmed by the fact that, as it turned out, aerosol pollution of the atmosphere, including radioactive, has a significant impact on thunderstorm, hail processes and precipitation [7-12]. Bordeaux mixture, as part of the general aerosol pollution of the atmosphere, especially in Kakheti, can contribute to this influence.

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ბორდოს ხსნარის გავლენა სეტყვის წარმოშობაზე

შ. მესტვირიშვილი, მ. კოდუა, მ. ბენაშვილი

რეზიუმე

განხილულია საქართველოს სეტყვისგან ყველაზე მოწყვლადი ტერიტორიული ერთეული კახეთი და ამ რეგიონში სეტყვასთან დაკავშირებული როგორც ისტორიული, ასევე დღევანდელი მდგომარეობა. მოყვანილია ცნობილი მეცნიერების ნაშრომებში დადასტურებული შეხედულებები, ასევე მოსახლეობის გამოკითხვებიც, რომელთა შედეგადაც ნაშრომის ავტორები მივიდნენ იმ დასკვნამდე, რომ სეტყვის მოსვლის ინიცირებას მარტო ბუნება კი არა, ადამიანებიც ახდენენ ვაზის მოვლის პროცედურით და იმ ქიმიური ნივთიერებებით,რომელიც გამოყენებულია ვაზის მოვლის პროცესში.

საკვანძო სიტყვები: სეტყვა, ბორდოს ხსნარი, კახეთი, კოაგულაცია, შეწამვლა

Влияние бордосской жидкости на происхождение града

Ш.А. Мествиришвили, М.А. Кодуа, М.О. Бенашвили

Резюме

Рассмотрен вопрос градобития и нанесенный им ущерб на территориальной единице Грузии – Кахети, а также состояние в регионе с точки зрения градобития и в прошлом и в настоящем времени. Привлечены мнения известных ученых, опрос местного населения по проблеме, все это и позволило авторам заключит, что градобитие инициировано не только природой, но и процедурой ухода за виноградниками и использованными в процессе ухода человеком химическими веществами.

Ключевые слова: – град, бордоская жидкость, Кахети, коагуляция, опрыскивание.