THE INFLUENCE OF SOME CULTURAL PRACTICES ON CHEMICAL COMPOSITION OF GRAPES, IN THE VIEW OF THEIR USE AS MEASURES OF VITICULTURE ADAPTATION TO CLIMATE CHANGE

INFLUENȚA UNOR INTERVENȚII TEHNOLOGICE ASUPRA COMPOZIȚIEI CHIMICE A STRUGURILOR, ÎN VEDEREA UTILIZĂRII LOR CA MĂSURI DE ADAPTARE A VITICULTURII LA SCHIMBAREA CLIMATICĂ

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Abstract: *Climate change influences viticulture by changing the topoclimate of the vineyards, the phenology of grapevine and the chemical composition of the grapes. Areas unsuitable for viticulture have started to acquire viticultural potential, while others are negatively affected. Research to date indicates that Cotnari vineyard is among the regions favored by climate change: the vineyard's potential has changed in terms of increasing areas favorable for the production of quality white wines and the creation of conditions for red wine production. This researchaims to establish the influence of some cultural practices on the chemical composition of grapes for the Tămâioasă românească variety, aiming to use them asadaptation measures to climate change. The evolution of the grapes ripening was studied for three different experimental variants: defoliation applied at the base of the shoots; the defoliation of the middle third of the shoots; and shading vine leaves by bentonite film. The results indicate taht: the lowest accumulations of sugars is registered in the control variant, no de-leafing measure applied (173.8 g / L) while the largest is found in grapes where the shoots were stripped free of leaves at their base (216.0 g / L); an effect of reducing the sugar content when shading with bentonite film at a concentration of 6% (206.8 g / L), increasing the pH (3.91) and decreasing the titratable acidity (5.0 g / L ac. tartaric) was registered . The values obtained provide indications of the effect of different interventions on the composition of grapes and their suitability as measures to adapt to climate change, and experiences will be continued and diversified in the coming years.*
Key words: climate change, phenology, grapevine, Tămâioasă românească, grape ripening, bentonite film, total acidity, sugar

Rezumat. *Schimbarea climatică influențează viticultura prin modificarea topoclimatului podgoriilor, fenologiei viței de vie și a compoziției chimice a strugurilor. Zone improprii pentru viticultură până înprezent, dobândesc potențial viticol, în timp ce unele regiuni viticoleconsacrate sunt influențate negativ. Cercetările efectuate până în prezent indică faptul că podgoria Cotnari este printre regiunile viticole favorizate de schimbarea climatică: potențialul viticol al podgoriei s-a*

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modificat în sensul creşterii suprafeței favorabile producției vinurilor albe de calitate şi apariței condițiilor propice producției vinurilor roşii. Cercetarea de față a avut ca scop stabilirea influenței unor intervenții tehnologice asupra compoziției chimice a strugurilor la soiul Tămâioasă românească, în perspectiva utilizării lor ca măsuri de adaptare a culturii viței de vie la schimbarea climatică. S-a studiat evoluția procesului de maturare a strugurilor în condițiile desfrunzirii bazei lăstarilor; a desfrunzirii treimii mediane a lăstarilor; şi a umbririi prin film de bentonită a strugurilor. Rezultatele cercetării relevă influența acestor intervenții asupra compoziției chimice a strugurilor: cele mai mici acumulări de zaharuri (173,8 g/L) s-au înregistrat la varianta martor, nedesfrunzit, iar cele mai mari (216,0 g/L)la desfrunzitul bazei lăstarilor. Umbrirea cu film de bentonită în concentrație de 6% a limitat acumularea zaharurilor (206,8 g/L), a determinat creşterea pH-ului (3,91) şi a redus aciditatea titrabilă (5,0 g/L ac. tartric). Valorile obținute oferă indicii privind efectul măsurilor experimentate asupra compoziției strugurilor şi a pretabilității lor ca măsuri de adaptare a culturii viței de vie la schimbare aclimatică, experiențele urmând a fi continuate şi diversificate anii următori.

Cuvinte cheie: Schimbarea climatică, fenologia, viță de vie, Tămâioasă românească, maturarea strugurilor, film de bentonită, aciditate totală, zaharuri

INTRODUCTION

Climate factors, in particular temperature, influence the intensity of the physiological processes underlying the quality of the grapes and implicitly of the wine (Kliewer and Leader 1970; Coombe, 1987; Irimia *et al.,* 2012; Irimia *et al.*, 2014; Irimia *et al.,* 2019). The regional climate, specific and quite stable over time, has led to the establishment of the variety of local wine varieties and specific types of wine. Climate change is considered a major challenge for viticulture as it threatens the established relationship between the local climate, local grape varieties and the representative wines of the vineyards.

The main manifestation of climate change, important for vineyards, is the increase in their heliothermic resources (Duchêne and Schneider, 2005; Ramos *et al.,* 2008; Webb *et al.,* 2012; Irimia *et al.,* 2017). This led to an increase in the alcoholic potential of the must and a decrease in total acidity (Jones and Davis, 2000), a possibility of less forecasting the size and quality of grape production (Schultz, 2000; Fraga *et al.,* 2016), earlier ripening of grapes, with changes in their color and flavor (Lacey *et al.,* 1991, Keller, 2010).

Due to the impact on renowned vineyards, climate change is the subject of numerous researches around the world. Climate change affects viticulture worldwide and therefore new methods of intervention on the bush are being studied in order to preserve the varieties of the varieties of the vineyards, the quality, quantity and typicality of the grape and wine production they produce.

In this paper are presented the results of a study on the reaction of the wine and the evolution of the quality of the grapes under the conditions of total foliage in the grape, the leafing of the upper third of the shoots and the protection of the leaves with a film from bentonite solution, at different concentrations.

MATERIAL AND METHOD

The wine-growing area studied has an area of about 1600 ha and is located in the Cotnari vineyard, with altitudes between 120 m (at Magura and Juleşti) and 260 m (Catalina Hill). The experimental field is organized in the Tămâioasă românească plantation at an altitude of 199 meters and has an exhibition S-E.

Tămâioasă românească is a variety well adapted to the pedoclimatic conditions of the Cotnari vineyard, due to the long and sunny autumns that benefit the vineyard. Under the conditions of the Cotnari vineyard, this variety reaches high accumulations of sugars at full maturity (200-210 g/L) and varietal-specific aromas. From the point of view of biological resistances, the Tămâioasă româneascăis a pretentious variety, sensitive to frost (-18...-20 ^{o}C), to drought and excess moisture, is strongly attacked by diseases, grape moths and wasps. The cultivation of the variety requires well-defined areas, because of its low ecological plasticity.

The experimental field is represented by a plantation of Tămâioasă româneascăof the year 5, and comprises 5 experimental variants and a control variant. Each experimental variant is represented by 30 normally developed hubs. The experimental variants are as follows:

V0 – control variant, with leaves and without treatment with bentonite;
V1 –de-leafing next to grapes;
V2 – de-leafing in the middle;
V3 – treatment with 1% bentonite solution;
V4 –treatment with bentonite solution 3%;
V5 –treated with 6% bentonite solution.

Between 3.08 and 9.09.2020, nine samples were taken (tab. 1 and tab. 2). In each experimental variant, 2 samples of grapes were collected, one on the sunny side and one on the shaded side, each represented by 400 grains (approximately 500 g). From each sample was extracted the must on which the following analyses were carried out, according to the OIV methodology: sugar content (g/L); total acidity (g/L tartaric acid); pH; density. (Țârdea, 2007) The evolution of the chemical composition of the grapes in each variant was followed and the results compared with those of the control variant.

RESULTS AND DISCUSSIONS

1. Evolution of temperatures during maturation

Figure 1 highlights the evolution of temperatures (Min – Max) during maturation (01.08.2020-30.09.2020), which was recorded with the Tinytag Talk 2 TK 4014 field sensors, placed one at a time, at the level of the foliar apparatus (1.5 m high) and which record the temperature every one hour.

During maturation, the sugar content continuously increases and the acidity decreases until full maturity is reached. The intensity of the evolution of the content of sugars and acids is directly influenced by recorded temperatures. The reduction of acidity is influenced by temperature, especially by the type of acid used as a respiratory substrate. At daily temperatures between 30-37 ^{o}C, the vine uses malic acid as a respiratory substrate, which makes it easier to obtain more velvety wines. According to the data shown in Figure 1, the temperatures recorded during maturation show two highlights in the periods 06.08 – 08.08 and 29.08 – 01.09, when temperatures above 32 °C were revealed. Photosynthesis in the case of temperatures above 32 °C is slowed and at more than 35°C is blocked. The highest temperature (35.5 °C), of the maturation period, is recorded on the last day of August (fig. 1).

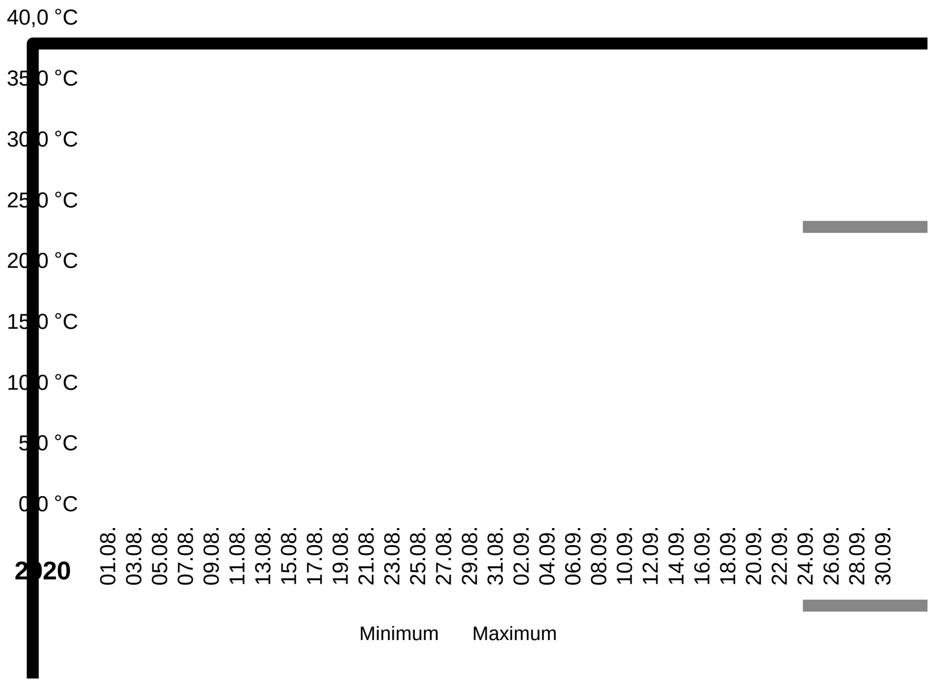

Fig. 1 Evolution of temperatures

2. Evolution of sugars according to technological interventions

In full maturity, there were significant differences in the composition of the grains between the control variant and the leafy variant next to the grapes. The leafy version next to V1 grapes has the highest accumulations of sugars throughout the ripening. At the last sampling (12 September), it was found that the control sample reached a significantly lower concentration of sugars (V0 = 173.8 g/L*) compared to the deleafed variant next to grapes (V1 = 216 g/L*) (tab. 1). Each experimental variant also recorded a significant difference between the accumulations of sugars on the sunny and shaded sides of the row. The biggest differences are large in the leafy version next to grapes (V1 = 11.4 g/L**) and the control variant (V0 = 18 g/L**); the most balanced experimental variant is the one for which 6 % concentration bentonite film (V5 = 2.2 g/L**) was used, as shown in table 1. The largest difference was between the deleafed version next to the grapes, on the shaded side (210.3 g/L) and the control sample on the same side (164.8 g/L).

*average on the experimental version, on the last day of sampling

**the difference between the sunny and the shaded sides on the last day of sampling

Table 1

Evolution of sugar content (g/L) during maturation of the Tămâioasă românească variety in different experimental situations

Variant***	03.08.2020	07.08.2020	11.08.2020	15.08.2020	19.08.2020	26.08.2020	01.09.2020	06.09.2020	12.09.2020	Average during maturation	**Average by experimental factor**
V_0 i	68.88	103.6	107.9	122.9	149.2	155.9	173.6	171.5	182.8	137.36	**132.96**
V_0 u	68.88	90.8	105.7	120.8	131.6	138.2	167	169.3	164.8	128.56	
V_1 i	80.36	84.5	122.9	144.8	155.9	144.8	191.9	212.5	221.7	151.04	**147.03**
V_1 u	80.36	84.5	122.9	125.1	149.2	147	185.1	182.8	210.3	143.03	
V_2 i	77.08	88.6	107.9	129.5	155.9	162.6	194.2	201.1	212.5	147.71	**144.45**
V_2 u	77.08	88.6	107.9	129.5	155.9	151.5	158.1	194.2	207.9	141.19	
V_3 i	59.04	99.3	110	131.6	160.4	164.8	194.2	191.1	210.3	146.75	**142.8**
V_3 u	59.04	99.3	110	125.1	158.1	142.6	164.8	182.8	207.9	138.85	
V_4 i	75.44	95	114.3	125.1	162.6	164.8	191.9	180.5	205.7	146.15	**142.51**
V_4 u	75.44	95	114.3	122.9	151.5	153.7	167	173.6	196.5	138.88	
V_5 i	68.88	88.6	114.3	125.1	151.5	158.1	187.4	205.7	207.9	145.28	**140.29**
V_5 u	68.88	88.6	114.3	116.5	138.2	149.2	158.1	178.3	205.7	135.31	

***V0 i= control sample, sunny part; V0 u = control sample, shaded part; V1 i = the deleafed version next to the grapes, the sunny part; V1 u = the deleafed version next to the grapes, the shaded part; V2 i = the deleafed version in the upper third of the shoots, the sunny part; V2 u = the deleafed version in the upper third of the shoots, the shaded part; V3 i = protected version with bentonite film (1%), sunny side; V3 u = protected version with bentonite film (1%), shaded part; V4 i = protected version with bentonite film (3%), sunny side; V4 u = protected version with bentonite film (3%), shaded part; V5 i = protected version with bentonite film (6%), sunny side; V5 u = protected version with bentonite film (6%), shaded part;

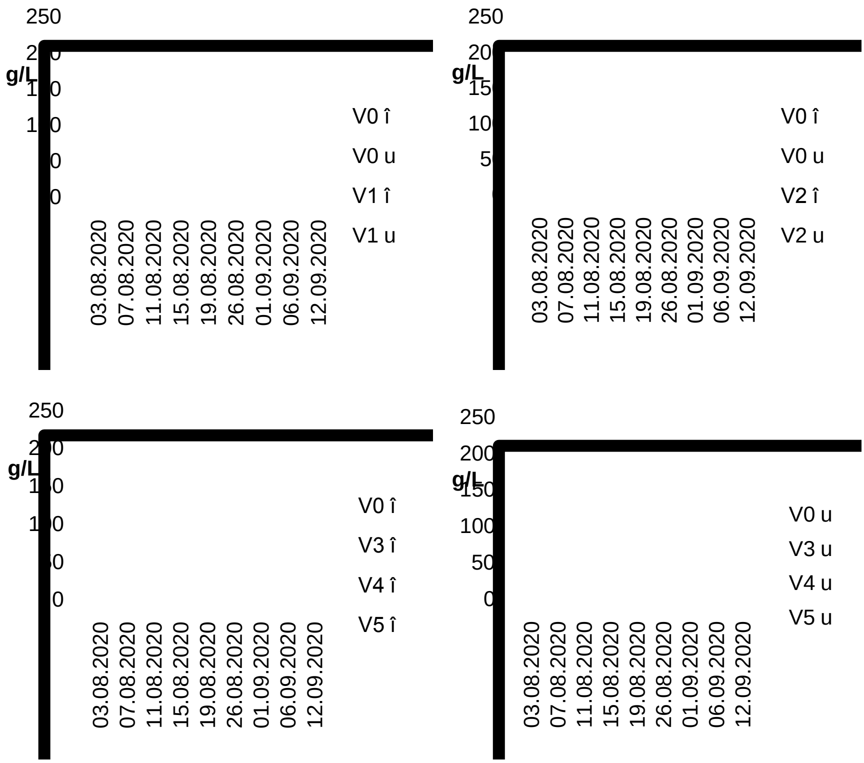

Fig. 2 Evolution of sugar content during maturation

A difference in the accumulation of sugars is observed throughout the maturation period, between the sunny and the shaded sides, in all experimental variants. In general, grapes on the sunny side have accumulated higher amounts of sugars than those on the shaded side (fig. 2). A reduction effect of sugar content is observed and on shading with bentonite film in a concentration of 6 % (206.8 g/L).

3. Evolution of acidity according to technological interventions

The data in Table 2 indicate that on the sunny side of the row, the highest acidity is recorded in the control variant (V0) with 5.4 g/L tartaric acid and the lowest in the deleafed variants (V1 and V2) with 3.8 g/L tartaric acid. On the shaded side the highest value is obtained in the control variant (V0) with 6.1 g/L tartaric acid, and the lowest value at the deleafed variant next to the grapes (3.1 g/L tartaric acid). It is also noted that the acidity is higher on the shaded side in the case of the solar-protected variant with 6 % bentonite film (V5 = 5.4 g/L tartaric acid) and in the unchanged variant (V0 = 6.1 g/L tartaric acid), as shown in table 2.

Table 2

Evolution of the total acidity of grapes (g/L) during maturation of the Tămâioasă românească variety in different experimental situations

Variant***	03.08.2020	07.08.2020	11.08.2020	15.08.2020	19.08.2020	26.08.2020	01.09.2020	06.09.2020	12.09.2020	Absolute average	**Average by experimental factor**
V_0 î	33.66	19.9	16.8	12.2	9.2	6.9	5.4	3.1	5.4	12.51	**13.27**
V_0 u	33.66	23	18.4	13.8	10.7	9.2	6.1	5.4	6.1	14.04	
V_1 î	28.30	27.54	13.8	10.7	8.7	8.4	4.6	3.1	3.8	12.10	**12.56**
V_1 u	28.30	27.54	13.8	13.8	9.2	8.4	5.4	5.4	5.4	13.03	
V_2 î	27.54	26.01	18.4	12.2	9.9	7.7	5.4	3.1	3.8	12.67	**13.01**
V_2 u	27.54	26.01	18.4	13.8	9.9	8.4	8.4	4.6	3.1	13.35	
V_3 î	32.13	24.48	16.8	13.8	9.2	8.4	5.4	3.8	2.3	12.92	**13.42**
V_3 u	32.13	24.48	16.8	15.3	9.9	9.2	7.7	6.1	3.8	13.93	
V_4 î	29.07	23.71	16.1	15.3	8.4	7.7	5.4	3.8	3.8	12.59	**12.89**
V_4 u	29.07	23.71	16.1	16.1	9.2	8.4	6.1	5.4	4.6	13.19	
V_5 i	29.83	26.01	16.83	12.2	12.2	7.7	6.1	4.6	4.6	13.34	**13.73**
V_5 u	29.83	26.01	16.83	13.8	13.8	9.2	6.1	6.1	5.4	14.12	

*** V0 i= control sample, sunny part; V0 u = control sample, shaded part; V1 i = the deleafed version next to the grapes, the sunny part; V1 u = the deleafed version next to the grapes, the shaded part; V2 i = the deleafed version in the upper third of the shoots, the sunny part; V2 u = the deleafed version in the upper third of the shoots, the shaded part; V3 i = protected version with bentonite film (1%), sunny side; V3 u = protected version with bentonite film (1%), shaded part; V4 i = protected version with bentonite film (3%), sunny side; V4 u = protected version with bentonite film (3%), shaded part; V5 i = protected version with bentonite film (6%), sunny side; V5 u = protected version with bentonite film (6%), shaded part;

The acidity of the grapes, according to the data of the last day of sampling, is lower for each experimental variant. Of all variants, the protected one with 6% bentonite film, best retained acidity (tab. 2). On the sunny side, compared to the control variant (5.4 g/L tartaric acid) it is observed that the variant treated with 1 % concentration bentonite solution maintained a lower acid content (2.3 g/L tartaric acid). On the other hand, on the shaded side the control variant has the highest acidity (6.1 g/L tartaric acid) and the lowest is observed in the deleafed variant in the upper third of the shoots (3.1 g/L tartaric acid) (fig. 3).

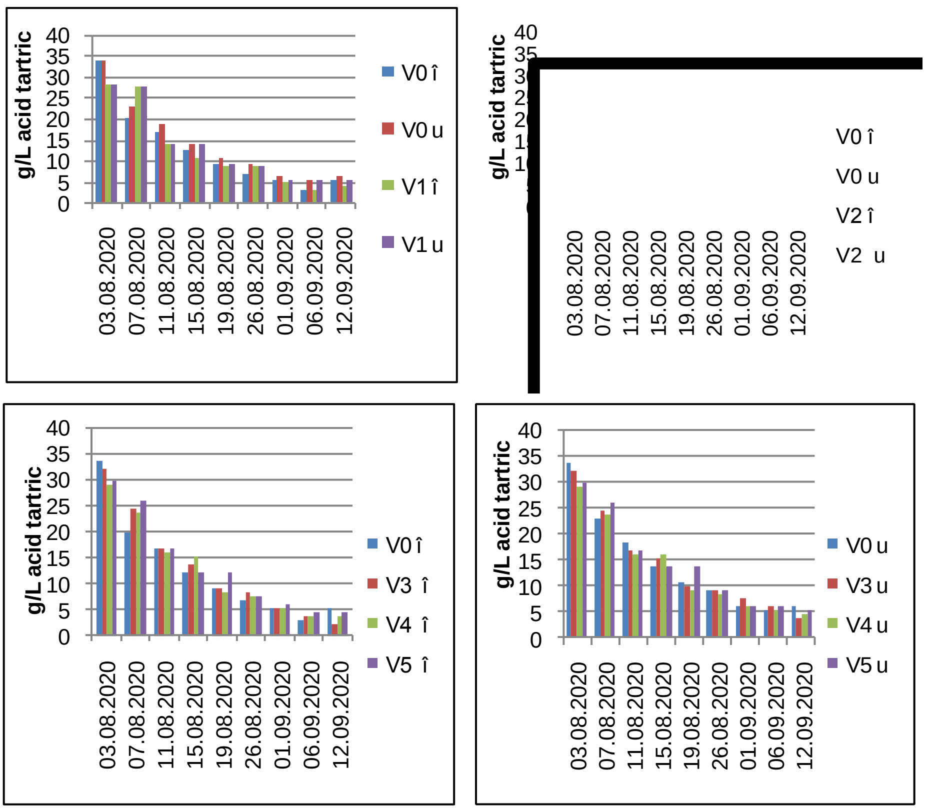

Fig. 3 Evolution of titrable acidity during maturation

4. Correlations between the evolution of acidity and that of sugars

The highest acidity was recorded in the control variant (5.75 g/L tartaric acid*), but the accumulation of sugars (173.8 g/L*) is unsatisfactory for obtaining a quality wine. The deleafed variants have accumulated sufficient sugars, but have acidity deficiency and the resulting wines would be lacking freshness. In the case of variants protected with bentonite film, the most balanced and suitable composition is the protected variant with 6 % bentonite film (sugars = 206.8 g/L*; acidity = 5 g/L tartaric acid*). This variant can be considered for the purpose of obtaining a quality wine due to the balance between acidity and sugars (tab. 1 and tab. 2).

*average on experimental variant

CONCLUSIONS

The experimental phytotechnical interventions have influenced the chemical composition of the grapes, with the smallest accumulation of sugars recorded in the control (182.8 g/L on the sunny side and 164.8 g/L on the shaded side) and the highest in the deleafed version at the base of the shoots (221.7 g/L on the sunny side and 210.3 g/L on the shaded side).

Treatment with bentonite film at a concentration of 6 % limits the accumulation of sugars (207.9 g/L on the sunny side and 205.7 g/L on the shaded side) and maintains the titratable acidity of the musts (4.6 g/L tartaric acid and 5.4 g/L tartaric acid the practical effect that is actually sought in the context of climate change and the high temperatures that characterize it. Bentonite film is only effective at higher concentrations. In this study the influence on the composition of the grapes only applied the 6% solution, while the lower 3% and 1% concentrations did not influence the chemical composition of the grapes in relation to the control. The concentration of 6 % has maintained the balance between sugars and acidity, which is of interest in a more detailed study of higher concentrations.

The deleafing of the grapes has caused higher sugar accumulations, but also a reduction in the titratable acidity of the grapes, this intervention being suitable for the cool vineyards, from the northern limit of vineyard cultivation, where the resources of heliothermal energy are more limited.

The results of the study indicate that the microclimate exercises a dominant influence on the chemical composition of the grapes, the information obtained from the observations being used to assess the effectiveness of technological interventions.

For more conclusive results, comments will continue for a longer period of time to demonstrate the usefulness of climate change adaptation measures. These measures should be checked technically but also economically so as not to significantly increase production costs. The variants which have been defoliated require a high volume of labor and thus higher costs.

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