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РЕГИОНАЛЕН ИСТОРИЧЕСКИ МУЗЕЙ – ПЛЕВЕН

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СЪДЪРЖАНИЕ

ОБЩИНА ПЛЕВЕН – ДЕСТИНАЦИЯ ЗА ВИНЕН И КУЛИНАРЕН ТУРИЗЪМ.....	7
<i>Гл. ас. д-р Владимир Димитров, доц. д-р инж. Емил Цветанов</i>	
ПРЕВРЪЩАНЕ НА ДУАЛНАТА ВРЪЗКА „ТУРИЗЪМ-ВИНО“ В АТРАКТИВЕН АКЦЕНТ НА ПРОДУКТОВОТО ПОРТФОЛИО НА ДЕСТИНАЦИЯ БЪЛГАРИЯ.....	25
<i>Проф. д-р Светла Ракаджийска</i>	
ВИНОТО – ГЕНЕЗИС И САКРАЛНОСТ.....	39
<i>Доц. д-р Борис Борисов</i>	
МЕДОВИНАТА – ДРЕВНА НАПИТКА С ПРИЛОЖЕНИЕ ВЪВ ВИНАРСТВОТО И ТУРИЗМА.....	48
<i>Доц. дн Любомир Д. Любенов, гл. ас. д-р Владимир Димитров</i>	
СЕКТОРНА ПОЛИТИКА И ФИНАНСОВИ МЕХАНИЗМИ ЗА СТИМУЛИРАНЕ НА ДЕЙНОСТТА В ЛОЗАРО-ВИНАРСКИЯ СЕКТОР.....	59
<i>Гл. ас. д-р Даниела Димитрова</i>	
АЛКОХОЛ И ДАНЪЦИ.....	75
<i>Д-р Мирослав Ганчев</i>	
АМПЕЛОГРАФСКА ХАРАКТЕРИСТИКА НА НАЙ-РАЗПРОСТРАНЕНИТЕ В БЪЛГАРИЯ АВТОХТОННИ СОРТОВЕ ЛОЗИ.....	82
<i>Доц. д-р Илиян Симеонов, гл. ас. д-р Йорданка Белберова</i>	
АМПЕЛОГРАФСКА ИСТОРИЯ НА СОРТ МАВРУД.....	106
<i>Маргарита Христова, проф. д-р Венелин Ройчев, доц. д-р Ангел Иванов</i>	
МОНИТОРИНГ НА БОЛЕСТИ И НЕПРИЯТЕЛИ ПО ЛОЗАТА.....	117
<i>Доц. д-р Николай Генов, ас. Катина Иванова, ас. Денислав Иванов</i>	
DIFFERENT APPLICATION METHOD OF GA₃ AS AN AGROTECHNICAL TOOL INFLUENCING THE FRUIT QUALITY OF FLAME SEEDLESS GRAPE VARIETY (VITIS VINIFERA L.).....	138
<i>Rajchin Viktor, Nedelkovski Dushko, Gjoshcheva Kovachevikj Marija, Popovska Stojanov Despina</i>	
ТЪРГОВИЯТА С ВИНО В БЪЛГАРИЯ: ГЕОГРАФСКИ АСПЕКТИ.....	145
<i>Проф. д-р Милен Пенерлиев</i>	

**ЛОЗАРСТВОТО В КЮСТЕНДИЛСКИ РАЙОН –
МИНАЛО, НАСТОЯЩЕ И ПЕРСПЕКТИВИ.....153**

Доц. д-р Симеон Крумов

**ПИЯНСТВОТО КАТО СОЦИОКУЛТУРЕН ПРОБЛЕМ.
ТЪЛКУВАТЕЛЕН ПРОЧИТ НА СТАТИЯТА „НЯКОЛКО
ДУМИ ПРОТИВ ПИЯНСТВОТО“ НА ХРИСТО Г. ДАНОВ.....167**

Кристина Минчева

**ЛОЗАРСТВОТО И ПРОИЗВОДСТВОТО НА ВИНО
В ЛОВЕЧ ОТ КРАЯ НА XIX ДО 60-ТЕ ГОДИНИ НА XX В.....177**

Елена Георгиева

**ЛОЗЯТА, ГРОЗДЕТО И ВИНОТО НА
ГРАД ОМУРТАГ И ТОЗЛУКА. БЕЛЕЖКИ И МАТЕРИАЛИ.....196**

Мирослав Тошев

**ЛОЗАРСТВОТО И ВИНОДЕЛИЕТО
В ГРАД АНХИАЛО (ПОМОРИЕ) ОТ
ОСВОБОЖДЕНИЕТО ДО КРАЯ НА 40-ТЕ ГОДИНИ НА XX В.....217**

Любка Николова

**ЗА НАЧАЛОТО И ДЕЙНОСТТА НА ЛОЗАРО-ВИНАРСКА
ПРОИЗВОДИТЕЛНА КООПЕРАЦИЯ „ПЛЕВЕНСКА ГЪМЗА“.....235**

Десислава Близнашка-Георгиева

**ВИНОТО КАТО ЕДИН ОТ ДАРОВЕТЕ НА
ИСУС – „ЧУДОТО НА СВАТБА В КАНА“ ОТ ДАРИО ФО.....243**

Докторант Елена Минчева

**ЛОЗАТА, ВИНОТО И ХОРАТА, ИЗОБРАЗЕНИ ВЪВ
ВРЕМЕТО ВЪРХУ БЪЛГАРСКИТЕ ПОЩЕНСКИ МАРКИ.....254**

Доц. д-р Пело Михайлов

**„ЛОЗАТА В БИТИЕТО НА БЪЛГАРИНА“ –
ЗА ЕДНА ИЗЛОЖБА И СВЪРЗАНИТЕ С НЕЯ ПРОУЧВАНИЯ....270**

Д-р Тоня Любенова

**ВЪЗМОЖНОСТИ ЗА РАЗВИВАНЕ НА ТУРИСТИЧЕСКА
ДЕСТИНАЦИЯ ХАСКОВО ЧРЕЗ ВИНЕН ТУРИЗЪМ.....291**

Доц. д-р Юлия Джабарова

**ТЕРИТОРИАЛЕН ОБХВАТ НА СТАНЦИИ
ПАЗАРДЖИК, ПЛОВДИВ, САДОВО И ЧИРПАН
ЗА ОПРЕДЕЛЯНЕ НА АГРОКЛИМАТИЧНИТЕ
УСЛОВИЯ ЗА РАЗВИТИЕ НА ЛОЗАРСТВОТО.....305**

Проф. д-р Пламен Маринов Лаков, проф. д-р Красимир Левков

TABLE OF CONTENTS

MUNICIPALITY OF PLEVEN – A DESTINATION FOR WINE AND CULINARY TOURISM.....	7
<i>Chief assistant Vladimir Dimitrov, PhD, Assoc. Prof., Eng. Emil Tsvetanov, PhD</i>	
CONVERT THE DUAL LINK „TOURISM-WINE“ IN ATTRACTIVE ACCENT OF BULGARIA DESTINATION’S PRODUCT PORTFOLIO.....	25
<i>Prof. Svetla Rakadzhiyska, PhD</i>	
WINE – GENESIS AND SACREDNESS.....	39
<i>Assoc. Prof., Boris Borisov, PhD</i>	
MEAD – AN ANCIENT BEVERAGE WITH APPLICATIONS IN WINEMAKING AND TOURISM.....	48
<i>Assoc. Prof. Lyubomir Lyubenov, PhD, Chief assistant Vladimir Dimitrov, PhD</i>	
SECTORAL POLICY AND FINANCIAL MECHANISMS FOR STIMULATING ACTIVITY IN VITICULTURE AND WINE SECTOR.....	59
<i>Chief assistant Daniela Dimitrova, PhD</i>	
ALCOHOL AND TAXES.....	75
<i>Miroslav Ganchev, PhD</i>	
AMPELOGRAPHIC CHARACTERISTICS OF THE MOST WIDESPREAD IN BULGARIA AUTOCHTHONOUS /LOCAL/ GRAPEVINE VARIETIES.....	82
<i>Assoc. Prof. Iliyan Simeonov, PhD, Chief assistant Yordanka Belberova, PhD</i>	
AMPELOGRAPHIC HISTORY OF THE MAVRUD CULTIVAR.....	106
<i>Margarita Hristova, Prof. Venelin Roychev, PhD, Assoc. Prof. Angel Ivanov, PhD</i>	
MONITORING OF GRAPEVINE DISEASES AND PESTS.....	117
<i>Assoc. Prof. Nikolay Genov PhD, Asst. Katina Ivanova, Asst. Denislav Ivanov</i>	
DIFFERENT APPLICATION METHOD OF GA₃ AS AN AGROTECHNICAL TOOL INFLUENCING THE FRUIT QUALITY OF FLAME SEEDLESS GRAPE VARIETY (VITIS VINIFERA L.).....	138
<i>Rajchin Viktor, Nedelkovski Dushko, Gjosheva Kovachevikj Marija, Popovska Stojanov Despina</i>	
WINE TRADE IN BULGARIA: GEOGRAPHICAL ASPECTS.....	145
<i>Prof. Milen Penerliev, PhD</i>	

VITICULTURE IN THE KYUSTENDIL REGION – PAST, PRESENT AND PROSPECTS.....	153
<i>Assoc. Prof. Simeon Krumov, PhD</i>	
DRUNKENNESS AS A SOCIOCULTURAL PROBLEM. INTERPRETIVE READING OF HRISTO'S ARTICLE „A FEW WORDS AGAINST DRUNKENNESS“. D. DANOV.....	167
<i>Kristina Mincheva</i>	
VITICULTURE AND WINE PRODUCTION IN LOVECH FROM THE LATE 19TH CENTURY TO THE 1960s.....	177
<i>Elena Georgieva</i>	
FOR THE VINEYARDS, GRAPES, AND WINE OF THE TOWN OF OMURTAG AND THE TOZLUKA REGION. NOTES AND MATERIALS.....	196
<i>Miroslav Toshev</i>	
VITICULTURE AND WINEMAKING IN THE TOWN OF ANCHIALO/POMORIE FROM THE LIBERATION TO THE END OF THE 1940S.....	217
<i>Lubka Nikolova</i>	
ON THE ESTABLISHMENT AND ACTIVITIES OF THE VITICULTURE AND WINEMAKING COOPERATIVE „PLEVENSKA GAMZA“.....	235
<i>Desislava Bliznashka-Georgieva</i>	
WINE AS ONE OF THE GIFTS OF JESUS: THE MIRACLE OF A WEDDING AT CANA BY DARIO FO.....	243
<i>Elena Mincheva</i>	
VINE, WINE AND PEOPLE DEPICTED ON THE BULGARIAN POST STAMPS OVER THE YEARS.....	254
<i>Assoc. Prof. Pelo Mihaylov, PhD</i>	
„THE VINE IN THE LIFE OF A BULGARIAN“ – FOR AN EXHIBITION AND RELATED STUDIES.....	270
<i>Tonya Lubenova, PhD</i>	
OPPORTUNITIES FOR DEVELOPING THE HASKOVO TOURIST DESTINATION THROUGH WINE TOURISM.....	291
<i>Assoc. Prof. Yulia Dzhabarova, PhD</i>	
TERRITORIAL SCOPE OF PAZARDZHIK, PLOVDIV, SADOVO AND CHIRPAN STATIONS FOR DETERMINING AGROCLIMATIC CONDITIONS FOR THE DEVELOPMENT OF VITICULTURE.....	305
<i>Prof. Plamen Lakov, PhD, Prof. Krasimir Levkov, PhD</i>	

DIFFERENT APPLICATION METHOD OF GA₃ AS AN AGROTEHNICAL TOOL INFLUENCING THE FRUIT QUALITY OF FLAME SEEDLESS GRAPE VARIETY (VITIS VINIFERA L.)

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Abstract: Gibberellic acid (GA₃) treatment of Flame Seedless grapes inhibits larger berry size, reduces fruit set, and bunch uniformity. It can also cause changes in ripening of the grapes, resulting in longer shelf life and consistency across different growing conditions. However, there is limited knowledge and research on the difference in effectiveness of the methods of gibberellic acid applications—such as spraying or plunging, on improving berry quality without changing the concentration of GA₃ solution. This study evaluated the spraying (T1) and plunging (T2) methods to determine the impact of gibberellic acid (GA₃) application on Flame Seedless grape quality. The main objective of the research was to evaluate the influence of GA application methods, to see differences in: enhancing berry size, its weight, bunch dimension, berry firmness improvement, resistance to pressure during transport, optimizing sugar content and pH for improved flavor and ripeness. Methods used to study this are: measuring berry size, weight, firmness, bunch dimensions, skin harness, pulp to skin ratio, pH and sugar levels. In comparison to the control, berry weight, size, and bunch mass increased significantly with both treatments. While plunging raised acidity and decreased sugar content, spraying boosted bunch weight and berry size. Both treatments improved berry uniformity without changing the shape of the berries, which is advantageous for table grape production. GA₃ application, particularly spraying, can significantly improve the quality of Flame Seedless grapes by enhancing berry weight and size without altering shape, offering

benefits for commercial table grape production. These findings suggest that the spraying method is a practical, scalable option for improving grape quality in large vineyards, with potential economic benefits.

Keywords: flame seedless, gibberellic acid, grapes

Introduction:

Gibberellic acid (GA₃) is a plant growth regulator that enhances fruit size and quality by stimulating cell division, elongation, and the accumulation of sugars and dry matter (Li, X. et al., 2024).

J. H. Weinberger and F. N. Harmon developed Flame Seedless, an early maturing red seedless table grape (*Vitis vinifera* L.), realeced in 1973. The pedigree of Flame Seedless is a complicated crossbreeding program comprising [(Cardinal × Thompson Seedless) × (Red Malaga × Tifafihi Ahmer)] × (Muscat of Alexandria × Thompson Seedless) as shown in the figure 1. It is well-known for having firm, spherical berries that are averaging 16 –18mm in diameter. Gibberellin treatments help to increase the size of the berries, which form medium-sized, conical clusters with evenly spaced fruit (Weinberger, J. H., et al. 1974).

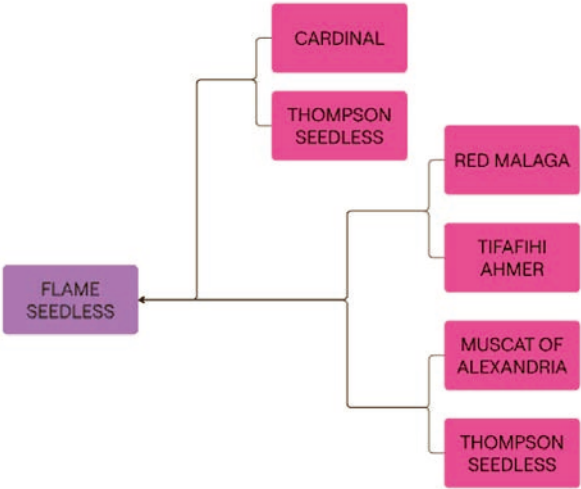


Figure 1. Pedigree of Flame Seedless' grape (Weinberger, J. H., et al. 1974).

Application of GA₃ has become a crucial practice in modern viticulture for improving the quality of seedless grapes variety such as Flame Seedless (*Vitis vinifera* L.). These varieties are highly valued in the global market for their aesthetic appeal, but even so, uniform berry size and desirable bunch structure are tough to accomplish. These problems have been successfully resolved by using gibberellic acid, a plant growth regulator that promotes cell elongation and

cell division. Usage of GA₃ application is particularly critical in seedless cultivars, which naturally lack the endogenous gibberellins found in seedless varieties, a deficiency that often leads to smaller berry size (Weaver, 1976). The way GA₃ is applied greatly influences how it affects quality and yield. Researchers have explored various approaches to maximize its effectiveness. Van Der Vyver in 2016 demonstrated that the plunging method in GA₃ makes grape bunches more homogeneous (Van Der Vyver, 2016). On the other hand, Fallahi et al. in 1995 highlighted foliar spraying as a convenient and scalable option for larger vineyards. Similarly, spraying is commonly preferred due to its efficiency in large vineyards, although the plunging method has been shown to guarantee uniform distribution of gibberellic acid across bunches (Van Der Vyver, 2016). This research explores how quality of Flame Seedless grapes grown in N. Macedonia climate conditions are affected by two GA₃ application techniques: spraying and plunging. In terms of providing evidence-based suggestions for optimizing GA₃ treatments in table grape production, the study compares important parameters like berry size, bunch morphology, and chemical composition.

Materials and Methods

The experiments were conducted in a private vineyard located in Skopje, Macedonia. The grapevines used in this study were of the Flame Seedless variety, grafted onto Kober 5BB rootstock. The vines were 7 years old, planted at a spacing of 1 meter between vines and 2,3 meters between rows. They are trained using the T-system, and each vine was pruned to 20 – 22 buds annually.

The experiments were carried out over a 1-year period in 2023. A total of two types of treatments were applied, alongside a control group: spraying (T1), and plunging (T2) and control (C), all using gibberellic acid (GA₃) at a concentration of 20 ppm. The first treatment was applied when the berries reached pea size, and the second treatment was applied one week later. For the spraying treatment, a hand-held 10l sprayer was used to ensure thorough coverage of the grape bunches and vine leaf area, while the plunging treatment was carried out manually with a cup filled with GA₃ solution.

Grape bunches were harvested at full maturity in the autumn of 2023. A total of 21 bunches from 30 vines were collected for each treatment group and transported to the laboratory for analysis immediately after harvest. The following parameters were measured to assess the impact of GA₃ treatment on grape quality: pH value (OIV-MA-AS313-15) (determined using a calibrated pH meter), sugar content (OIV-MA-AS2-02) (measured using a refractometer), titratable acidity (OIV-MAAS313-01)(measured by potentiometric titration), and bunch and berry according to Божиновиќ (2010).

The One-Way ANOVA (Analysis of Variance) is used to determine if there are

statistically significant differences between the means of three groups (control, spraying and plunging). The Tukey test is used for post-hoc pairwise comparisons of all groups, determining statistically significant differences between them.

Results and Discussion

In Table 1 is shown the impact of two different GA₃ applications (spraying and plunging) on the physical characteristics of grape bunches and berries of the grape variety Flame Seedless. Consistent with the findings of Dimovska et al. 2014; Fallahi et al. 1995, the application of gibberellic acid significantly influenced bunch weight, berry size, and other mechanical traits. Among the treatments, T1 (spraying) resulted in the highest bunch weight (621 g), representing a 29% increase over the control (480 g). This indicates that spraying GA₃ may enhance the overall bunch mass more effectively than plunging.

The distinctions between treatments is less noticeable in terms of berry width and length. Similar berry lengths (22,4 cm and 22,2 cm, respectively) is noticed by T1 and C (control), indicating that the application technique has no significant effect on this parameter. In comparison to the elongated profile seen in the control, the L/W ratio was slightly lower in T2 (plunging), suggesting a more rounded berry form.

In comparison to the control (257 berries), the amount of berries per bunch is significantly lower in treated vines, especially in T2 (209 berries) and T1 (219 berries). This indicates that use of gibberellic acid reduce the berry development at the expense of the quantity of berries in the bunch. This pattern is further supported by the berry index readings, which showed that T1 and T2 had lower values of 85 and 81, respectively, while the control maintained an index of 100.

Taken all together, these results highlight that GA₃ applications enhance specific quality attributes, like bunch weight, berry homogeneity, and that the technique of application effect the ratio of berry size to quantity. Especially in commercial table grape cultivation, spraying seems to be a useful, most economical and efficient way to improve fruit quality.

Table 1. *Influence of gibberellic acid on the weight, dimension, number of berries of bunches*

GA ₃	Weight (g)	Index	Length (cm)	Wight (cm)	L/W	No. berries	Index
T1	621±224.02a	129	22.4±2.90a	14.9±2.66a	1.50	219±82.87a	85
T2	590±149.15a	122	21.6±3.12a	16.1±3.48a	1.34	209±67.76a	81
C	480±139.65a	100	22.2±3.67a	14.2±2.15a	1.56	257±81.57a	100

Following GA₃ treatment, the weight, size, and shape measurements of Flame Seedless grape berries are displayed in **Table 2**. In comparison to the C, both treatments (T1 and T2) in this research show a significant increase in overall berry characteristic (such as weight, length, wight and diameter). T1 and T2 achieved weights of 2,77 g and 2,75 g, respectively, while the control's weight was 1,83 g. The significant effect of GA₃ on berry development is confirmed by the average 51% increase in berry weight.

Berry dimensions also showed significant improvements. T2 berries exhibited the largest dimensions, with lengths of 17,9 cm and widths of 18,2 cm, while T1 berries were slightly smaller but still significantly larger than the control which corresponds with the results given by Sangeetha et al., 2015, which is an indicator that GA₃ has a positive impact for berry growth in combination with the plunging method for the best results for berry size (Sangeetha, J, et all., 2015). There were no noticeable differences in the length-to-width (L/W) ratio between treatments. Even after GA₃ treatments, the berries kept their distinctive oval form, which is typical of the Flame Seedless type. This suggests that while the berry expanded, the treatments had no effect on the basic shape.

In treated samples, the average berry diameter also increased noticeably. T1 and T2 berries displayed diameters of 17,1 mm and 18,1 mm, respectively, while control berries had a diameter of 15,9 mm. Although the data varied, no statistically significant distinctions between the treatments and the control were found. Skin hardness is 0,79 kg/cm² for T1 and 1,29 kg/cm² for T2, while 0,70 kg/cm² is measured for the control (C).

All in all, GA₃ treatments significantly increase berry weight and size without changing its distinctive shape, proving that it is a useful agrotechnical tool for table grape production.

Table 2. *Influence of gibberellic acid on the weight, size, pressure and form of berry*

GA ₃	Weight (g)	Index	Length (cm)	Wight (cm)	L/W	Average diameter	Pressure skin hardness (Kg/cm ²)	Index
T1	2.77a	151	16.8±1.46b	17.3±2.84ab	0.97	17.1	0.79±0.19a	112
T2	2.75a	148	17.9±1.57a	18.2±1.12a	0.98	18.1	1.29±1.88a	184
C	1.83b	100	15.6±1.31c	16.2±0.99b	0.96	15.9	0.70±0.11a	100

The impact of GA₃ application techniques on Flame Seedless grapes' sugar

content, pH, and Titratable acidity are shown in **Table 3**. These chemical parameters showed different results from the C.

The sugar content of the treated grapes was lower than that of the control. At 211 g/L (index 100), C had the highest sugar level. The sugar content dropped to 208 g/L (index 98) in T1, but more significantly to 177 g/L (index 83) in T2.

The grapes' overall acidity increased after GA₃ treatments. T2 had the highest acidity, measuring 5,7 g/L (index 109), while T1 produced an acidity of 5,4 g/L (index 103). By contrast, the total acidity of the control was 5,2 g/L (index 100).

There was little difference in the pH values between treatments. The pH values of T1 and C were almost the same at 4,15 and 4,12, respectively (both with index 100). In line with its increased acidity, T2 displayed a minor decline to 4,00 (index 97).

The results from Table 3 indicate that while GA₃ applications do not drastically impact the pH level, they reduce sugar content and increase the total acidity in treated grapes. T1 maintains chemical traits closer to the control, while T2 has a more pronounced effect on reducing sugar and increasing acidity, potentially delaying the harvest date.

Table 3. *Influence of gibberellic acid on the content of sugar, total acids and pH in the must*

GA ₃	Weight (g)	Index	Length (cm)	Wight (cm)	L/W	No. berries	Index
T1	621±224.02a	129	22.4±2.90a	14.9±2.66a	1.50	219±82.87a	85
T2	590±149.15a	122	21.6±3.12a	16.1±3.48a	1.34	209±67.76a	81
C	480±139.65a	100	22.2±3.67a	14.2±2.15a	1.56	257±81.57a	100

Conclusion

Gibberellic acid (GA₃) application greatly improves Flame Seedless grapes' physical attributes, especially berry and bunch weight. In comparison to the control, berry mass and size rose in treatments that included T1 and T2, with T1 showing better outcomes in terms of bunch weight and berry uniformity. However, neither treatment changed the berries' unique oval form, preserving the Flame Seedless variety's characteristics. Statistical results revealed that there were no significant differences in bunch perimeters among the three groups. However, the analysis of berry dimensions and width showed significant differences between the treatments and the control, which imply

better uniformity of the bunch grape and higher grape market value. The chemical analysis showed that GA₃ treatments resulted in a decrease in sugar content and an increase in total acidity, especially in T2, where plunging caused a more noticeable reduction in sugar and an increase in acidity. This can point to a possible postponement of harvest maturity. In conclusion, T1 is the most practical and efficient technique, balancing the preservation of chemical traits closer to the control with the enhancement of physical qualities, even if both application methods improve grape quality measures. These results highlight GA₃'s value as an agrotechnical instrument for maximizing table grape yield.

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