



EFFECT OF GIBBERELIC ACID ON QUANTITY AND QUALITY OF KESHMISHI GRAPES

Najihullah SAIQ^{1*}, Ghulam Rasoul SAMADI²


¹Kabul University, Faculty of Agriculture, Department of Horticulture, 1001, Kabul, Afghanistan


Abstract: Table grapes are one of the most commercially significant non-climacteric fruits globally. In Afghanistan, grapes and raisins represent the most valuable perennial fruit crop, with annual production exceeding 1.1 million tons. However, seedless varieties like Keshmishi often produce small berries, limiting their market value. Gibberellic acid (GA₃), a widely available plant growth regulator, is commonly used to enhance berry size, but improper application can negatively affect grape quality and yield. This study investigated the optimal concentration and timing of GA₃ application to improve the quality and yield of Keshmishi grapes in a commercial vineyard in Esfandeh village, Ghazni province. Six treatments were tested, including different concentrations (20–60 ppm) applied at various phenological stages. Results showed that a 30 ppm GA₃ application after flowering significantly increased yield to 36.75 MT/ha—an improvement of 11.5 MT or 45.5% over the untreated control. This treatment also produced larger, well-compacted bunches with minimal adverse effects. Applications at other stages or higher concentrations did not yield significant benefits. The study recommends post-flowering application of 30 ppm GA₃ for optimal results. Further research across different cultivars and economic analysis of treatment costs is advised to support broader application in commercial viticulture.

Keywords: Gibberellic acid, Keshmishi grape, Yield, Fruit quality, Cluster compactness

*Corresponding author: Kabul University, Faculty of Agriculture, Department of Horticulture, 1001, Kabul, Afghanistan

E mail: najihullah.saiq@gmail.com (N. SAIQ)

Najihullah SAIQ  <https://orcid.org/0009-0009-0080-1629>

Ghulam Rasoul SAMADI  <https://orcid.org/0009-0008-5551-710X>

Received: September 23, 2025

Accepted: March 19, 2026

Published: May 15, 2026

Cite as: Saiq, N., & Samadi, G. R. (2026). Effect of gibberellic acid on quantity and quality of Keshmishi grapes. *Black Sea Journal of Agriculture*, 9(3): 353-359.

1. Introduction

Grapes (*Vitis vinifera* L.), among the oldest domesticated fruit crops, are cultivated globally for their versatility in fresh consumption and processing into raisins, juices, wines, and other value-added products (Shirzad and Samadi, 2018). As a crop with significant economic value, grapes are grown in diverse agro-climatic zones, including temperate, tropical, and subtropical regions (Shirzad and Samadi, 2018). In Afghanistan, grape cultivation plays a pivotal role in the rural economy, with production reaching over 1.1 million tons in 2020 (MAIL, 2020). The country's viticultural industry is primarily oriented around two sectors: fresh table grape production and raisin processing (Shirzad and Samadi, 2018).

Despite favorable agro-ecological conditions such as warm summers, full sunshine, and long growing seasons, Afghan grape production remains largely traditional and under-optimized. One major limitation is the inconsistent and often incorrect use of plant growth regulators (PGRs), particularly gibberellic acid (GA₃), which negatively impacts fruit quality, especially for seedless varieties like Keshmishi grapes (MAIL, 2020). Keshmishi grapes are widely cultivated for raisin production, but their marketability is hindered by small berry size and compact clusters resulting from inadequate GA₃

application (Shirzad and Samadi, 2018).

Since the 19th century, cultural practices such as girdling, pruning, and berry thinning, along with PGR applications, have been adopted to improve grape quality and yield (May, 2004). Among these, the use of GA₃ has gained prominence for enhancing parameters such as berry size, bunch weight, sugar content, and acidity (Dokoozlian, 1996; Srivastava and Handa, 2005). Research across several grape cultivars, including 'Thompson Seedless', 'Flame Seedless', and 'Italia', has shown that GA₃ significantly improves both vegetative and fruiting characteristics when applied at optimal concentrations and developmental stages (Shaaban et al., 1989).

In Afghanistan, however, there is a lack of standardized knowledge and implementation practices regarding GA₃ use. Farmers, particularly in provinces like Ghazni, often apply gibberellin at inappropriate times or in excessive doses, leading to undesirable outcomes such as tight clusters, increased fungal susceptibility, delayed ripening, and reduced bud fertility (Shirzad and Samadi, 2018). As a result, the quality and yield of Keshmishi grapes are adversely affected, reducing their value in both fresh and raisin markets.

Gibberellins are naturally occurring plant hormones that regulate multiple physiological processes, including seed germination, shoot elongation, flowering, and fruit



development, and GA₃, in particular, promotes berry expansion by stimulating cell division and elongation in the pericarp tissue. When applied at the correct phenological stage, GA₃ can improve fruit set, increase berry and cluster size, and enhance overall fruit quality. However, the effectiveness of GA₃ depends on various factors, such as grape variety, dosage, method of application, plant age, and environmental conditions.

Recognizing these challenges, this study focused on optimizing the application of GA₃ in Keshmishi grapes grown in Ghazni province. The primary aim is to identify the most effective timing and concentration of GA₃ that maximizes yield and fruit quality without inducing negative side effects. Given that grape cultivation is a high-income, labor-intensive agricultural sector in Afghanistan, improving the scientific basis for GA₃ use will benefit not only farmers but also traders, horticultural students, and the broader agricultural economy (Shirzad and Samadi, 2018).

The central issue addressed in this study is the suboptimal use of GA₃ in Keshmishi grape production, particularly the incorrect timing and overdosage, leading to quality deterioration. Inadequate berry sizing, tight clusters, and lower yields are common consequences of these practices. Therefore, this research aims to:

- Evaluate the effects of different concentrations of GA₃ on the quality characteristics of Keshmishi grapes.
- Determine the optimal timing and dosage of GA₃ application that positively influences yield and marketable fruit traits.

By addressing these objectives, the study seeks to offer practical recommendations for improving raisin grape production practices in Afghanistan and to contribute to the broader body of knowledge on viticulture in developing regions.

2. Materials and Methods

2.1. Study Area

The experiment was conducted from May to September 2024 in a commercial vineyard located in Isfanda village, Ghazni Province, in the central region of Afghanistan (33°28'13" N latitude, 68°24'20" E longitude, 2136.94 m above sea level). The site lies within the central dry zone of Ghazni, characterized by arid climatic conditions suitable for grape cultivation. The study focused on the local Keshmishi variety of grapevine to evaluate the effect of gibberellic acid (GA₃) applications on growth, yield, quality, and benefit–cost ratio.

2.2. Experimental Design and Layout

The experiment followed a completely randomized block design (CRBD) with six treatments and five replications, comprising a total of 30 experimental units (one vine per unit). The vines were arranged in five rows, each containing six experimental units. All field observations were recorded from the experimental units.

T₁: 20 ppm GA₃ applied before flowering

T₂: 30 ppm GA₃ applied after flowering

T₃: 40 ppm GA₃ applied at berry size 4 mm

T₄: 50 ppm GA₃ applied at berry size 4 mm

T₅: 60 ppm GA₃ applied at berry size 4 mm

T₆: Control (no GA₃ application)

2.3. Plant Material

The study utilized 20–25-year-old vines of the Keshmishi cultivar, the predominant grape variety in Ghazni Province. The vines were spaced 3.0 m × 2.5 m apart, traditionally trained as runner shrubs on earthen mounds. Pruning was performed on 31 October 2023 prior to the experimental season. The Keshmishi variety is a widely cultivated Afghan landrace used for fresh consumption, raisin production, and vinegar making (URL1).

2.4. Preparation of GA₃ Solutions

Commercially available TOCAA tablets containing 10% GA₃ were used. Solutions of 20, 30, 40, 50, and 60 ppm concentrations were prepared by dissolving the required quantity of GA₃ in distilled water. For example, 80 mg of GA₃ powder was dissolved in 4 L of water to prepare a 20 ppm solution. A total of 4 L of solution was required per application to treat six vines. Prepared solutions were applied as foliar sprays to bunches and berries until fully soaked.

2.5. Application Schedule

Sprays were applied at different phenological stages of vine development:

T₁ (20 ppm): applied on 2 June 2024, before flowering, T₂

(30 ppm): applied on 22 June 2024, after flowering, T₃

(40 ppm), T₄ (50 ppm), T₅ (60 ppm): applied on 6 July

2024, at berry size 4 mm, T₆: untreated control

2.6. Harvesting and Data Collection

Bunches were harvested at full ripening from each vine per treatment. Observations were recorded on growth, yield, quality, and sensory attributes as follows:

2.7. Growth Parameters

Bunch length (cm): measured from peduncle to distal end using scale markings. Bunch weight (g): average weight of three bunches per treatment using an electronic balance. Bunch volume (cm³): determined by water displacement in a volumetric beaker. Bunch compactness: ratio of bunch weight to bunch volume.

Berry dimensions (mm): length and diameter measured with a digital vernier caliper. Berry weight (g): average weight of randomly selected berries using an electronic balance.

2.8. Quality Parameters

Total soluble solids (°Brix): determined using a digital refractometer from juice of ripe berries. Titratable acidity (%): estimated by titration with NaOH using phenolphthalein as indicator.

2.9. Yield Parameters

Yield per vine was recorded in kilograms and converted to metric tons per hectare (MT ha⁻¹).

2.10. Statistical Analysis

Data were analyzed using ANOVA in STAR statistical software (v. 2.0.1). Treatment means were compared using the Least Significant Difference (LSD) test at 1%

and 5% levels of significance. Data organization and visualization were performed in Microsoft Excel 2021.

3. Results

The application of different concentrations of gibberellic acid (GA₃) significantly influenced the growth parameters of Keshmishi grapes, including bunch and berry characteristics, as shown in Table 1.

Among the treatments, maximum bunch length (26.68 cm) was recorded in vines treated with 30 ppm GA₃ applied after the flowering stage. This was significantly higher than the control (22.52 cm) and as well from the treatment 5, which was the 60-ppm treatment (21.46 cm), while other treatments (20, 40, and 50 ppm) produced intermediate lengths (24.12–24.65 cm) that were not significantly different from the control.

Bunch weight also showed highly significant differences among treatments. The highest bunch weight was observed in the 30 ppm treatment (735.02 g), followed by the 40 ppm treatment (515.12 g). The lowest weight was recorded in the 20 ppm treatment (344.56 g), with control and other treatments showing intermediate values (453.92–460.22 g).

Bunch volume varied significantly among treatments, with the maximum volume recorded in the 30 ppm GA₃ treatment (670 cm³), followed by the 40 ppm treatment (544 cm³). The control recorded 421.6 cm³, while the 20, 50, and 60 ppm treatments produced lower volumes (262–404 cm³). Bunch appearance, evaluated as the ratio of weight to volume, differed significantly, with the most compact clusters observed in the control (1.46 g/mL) and 20 ppm treatment (1.32 g/mL), while the 30 and 40 ppm treatments produced the loosest compact clusters (1.00–1.03 g/mL).

Significant differences were also observed in berry characteristics. Berry length was highest in the 30 ppm treatment (21.57 mm), followed by the 40 and 60 ppm treatments (17.18, 17.51 mm), while the control and 20 ppm treatments produced shorter berries (14.22 and 15.50 mm). Similarly, berry diameter was greatest in the 30 ppm treatment (16.03 mm), and the 40, 50, and 60 ppm treatments produced smaller berry diameters (14.99 to 15.20 mm), and the control and 20 ppm treatments yielded the smallest berries (12.75 and 13.50 mm).

Table 1. Shows Growth parameters (bunch length, bunch weight, bunch volume , bunch compact/ loose, berry length, berry diameter, weight of 50 berries) in seedless (Keshmishi) grapes as influenced by different concentrations of gibberellic acid treatment

Treatment	Bunch length(cm)	Bunch weight (g)	Bunch volume (cm ³)	Bunch Compact/ Loose	Berry length (mm)	Berry diameter (mm)	Weight of 50 Berries (gr)
T1 (20 ppm)	24.40 ^{ab}	344.56 ^b	262.00 ^d	1.32 ^{ab}	14.22 ^c	12.75 ^b	15.59 ^c
T2 (30 ppm)	26.68 ^a	735.02 ^a	670.00 ^a	1.03 ^b	21.57 ^a	16.03 ^a	34.40 ^a
T3 (40 ppm)	24.65 ^{ab}	515.12 ^{ab}	544.00 ^{ab}	1.00 ^b	17.51 ^b	15.20 ^a	26.57 ^b
T4 (50 ppm)	24.12 ^{ab}	460.22 ^b	404.00 ^{bcd}	1.16 ^{ab}	17.20 ^b	14.99 ^a	25.05 ^b
T5 (60 ppm)	21.46 ^b	401.26 ^b	351.00 ^{cd}	1.13 ^{ab}	17.18 ^b	14.99 ^a	26.08 ^b
T6 (control)	22.52 ^b	453.92 ^b	421.60 ^{bc}	1.46 ^a	15.50 ^{bc}	13.50 ^b	18.58 ^c
F-test	*	**	**	*	**	**	**
LSD 5% & 1%	3.019	170.89	141.46	0.27	1.91	1.17	5.46
CV %	9.54	19.57	17.78	17.21	6.19	4.48	12.45
SEm±	1.45	60.06	49.72	0.12	0.67	0.41	0.19

Means with the same letter are not different at 5% or at 1% level of significance.

Table 2. Shows quality parameters (total soluble solid, acidity, pH) in seedless (Keshmishi) grapes as influenced by different concentrations of gibberellic acid treatment

Treatment	Total soluble solid (TSS)	Acidity of berry juice (%)	pH of Berry Juice
T1 (20 ppm)	19.73 ^{ab}	0.70	2.80
T2 (30 ppm)	21.22 ^a	0.66	3.00
T3 (40 ppm)	18.47 ^{bc}	0.72	2.58
T4 (50 ppm)	17.56 ^c	0.76	2.76
T5 (60 ppm)	18.62 ^{bc}	0.68	2.84
T6 (control)	19.35 ^{bc}	0.66	2.76
F-test	*	NS	NS
LSD 5% & 1%	1.86	-	-
CV %	7.37	18.92	7.58
SEm±	0.89	0.08	0.13

Means with the same letter are not different at 5% or at 1% level of significance.

Table 3. Shows total yield and organoleptic parameters (berry appearance, colour, texture, flavour, and overall acceptability) in seedless (Keshmishi) grapes as influenced by different concentrations of gibberellic acid treatment

Treatment	Total Yield (MT/Hectare)	Berry Appearance	Colour	Texture	Flavour	Overall Acceptability
T1 (20 ppm)	29.15 ^{ab}	2.60 ^b	2.60 ^b	2.80 ^b	2.60 ^{bc}	2.80 ^b
T2 (30 ppm)	36.75 ^a	4.00 ^a	3.60 ^a	3.80 ^a	4.00 ^a	3.60 ^a
T3 (40 ppm)	33.25 ^{ab}	2.60 ^b	2.60 ^b	2.80 ^b	3.20 ^b	2.60 ^b
T4 (50 ppm)	28.8 ^{ab}	2.40 ^b	2.60 ^b	2.80 ^b	3.00 ^{bc}	3.00 ^{ab}
T5 (60 ppm)	25.35 ^b	2.60 ^b	2.60 ^b	2.20 ^b	2.40 ^c	2.60 ^b
T6 (control)	25.25 ^b	2.40 ^b	2.80 ^b	2.80 ^b	2.80 ^{bc}	2.60 ^b
F-test	*	**	*	**	**	*
LSD 5% & 1%	6.0582	0.62	0.63	0.63	0.63	0.64
CV %	20.57	17.08	17.25	16.85	16.10	17.09
SEm±	2.90	0.29	0.30	0.30	0.30	0.30

Means with the same letter are not different at 5% or at 1% level of significance.

The weight of 50 berries was significantly affected by GA₃ concentration and timing. The highest weight was recorded in the 30 ppm treatment applied after flowering (171.98 g), followed by the 40 and 60 ppm treatments (125.24 and 132.83 g). The lowest weight was observed in the 20 ppm treatment before the flowering stage (77.95 g) and control (92.91 g).

Overall, vines treated with 30 ppm GA₃ after flowering consistently showed superior growth parameters, producing the largest, heaviest, and most voluminous bunches and berries, as well as the proper compact clusters, compared to other treatments and the untreated control. Treatments with 40 and 50 ppm GA₃ applied during the berry growth stage yielded moderate improvements, while 20 and 60 ppm applications were less effective or produced smaller, and denser clusters.

3.1. Quality Parameters

As shown in Table 2, the total soluble solids (TSS) content of Keshmishi grape berry juice varied significantly among the gibberellic acid (GA₃) treatments. The highest TSS was recorded in grapes treated with 30 ppm GA₃ applied after flowering (21.22 °B), followed by the 20 ppm treatment before flowering (19.73 °B) and the untreated control (19.35 °B). Moderate values were observed for the 40 and 60 ppm treatments (18.47–18.62 °B), while the lowest TSS was recorded in the 50 ppm treatment applied during the 4 mm berry stage (17.56 °B). These results indicate that both the concentration and timing of GA₃ application significantly influence sugar accumulation in Keshmishi grapes.

In contrast, the acidity of berry juice was not significantly affected by GA₃ treatments (F-test, NS). Values ranged from 0.66% to 0.76% across all treatments, with no statistically meaningful differences between the control and the treated vines. Similarly, juice pH was not significantly influenced by the GA₃ applications (F-test, NS), although the highest pH (3.00) was observed in the 30 ppm treatment after flowering. Other treatments, including 20, 40, 50, and 60 ppm applications, as well as the control, showed minor variations in pH (2.58–2.84) that were not statistically significant.

These results suggest that while GA₃ application can enhance sugar content in Keshmishi grapes, it does not significantly affect juice acidity or pH under the conditions of this study.

3.2. Yield and Organoleptic Evaluation

The total yield of Keshmishi grapes was significantly influenced by gibberellic acid (GA₃) treatments. The highest yield was recorded in vines treated with 30 ppm GA₃ after flowering (36.75 MT per ha), representing a 45.5% increase over the untreated control (25.25 MT per ha). The 40 ppm treatment during the 4 mm berry stage produced the next highest yield (33.25 MT per ha), followed by 20 ppm before flowering (29.15 MT per ha), 50 ppm during the 4 mm stage (28.8 MT per ha), and 60 ppm during the 4 mm stage (25.35 MT per ha). These results indicate that both the concentration and timing of GA₃ application strongly affect overall productivity.

Organoleptic evaluation of the grapes, assessed by a panel of 5 persons, also showed significant differences among treatments. The highest scores for berry appearance, colour, texture, flavour, and overall acceptability were consistently observed in the 30 ppm GA₃ treatment after flowering. Specifically, appearance and texture received scores of 4.0 and 3.8, colour 3.6, flavour 4.0, and overall acceptability 3.6, compared to the other treatments that received lower scores: Treatments 1, 3, and 5 generally scored 2.6 for appearance and texture, while Treatment 4 and the control scored 2.4 for appearance. Colour ratings were highest in Treatment 2 (3.6), followed by the control (2.8), with the lowest score in Treatment 1 (2.6). Flavour scores ranged from 2.4 in Treatment 5 to 4.0 in Treatment 2, and overall acceptability varied from 2.4 to 3.6, mirroring trends in other sensory attributes.

These results suggest that application of 30 ppm GA₃ after flowering not only maximizes yield but also improves the sensory quality of Keshmishi grapes, highlighting the importance of optimized concentration and timing for both quantitative and qualitative traits.

4. Discussion

The application of growth regulators, particularly Gibberellic Acid (GA₃), has consistently been shown to enhance grape yield and quality across diverse grape-growing regions worldwide. Earlier studies by Weaver and McCune (1960) and Randhawa and Pal (1968) demonstrated the effectiveness of GA₃ and GA-like substances in improving both fruit size and quality. Similarly, (Chaitakhob et al., 2011) reported that plant growth-promoting substances significantly influence fruit set, berry size, bunch size, yield, and other quality parameters of grapes. Among these substances, GA₃ has been particularly effective in improving berry and bunch characteristics, as confirmed by Meena et al. (2012), El-Razek et al. (2015), and Harrell and William (1987). Based on this evidence, the present study investigated the effect of different GA₃ doses on the quantity and quality of Keshmishi grapes in Ghazni province, Afghanistan.

The results of this study revealed that grapes treated with 30 ppm GA₃ after flowering (Trt-2) consistently showed superior growth and yield parameters compared to other treatments. Bunch length, weight, and volume were significantly higher in this treatment, likely due to enhanced cell elongation in the rachis and optimal nutrient allocation, which allowed the development of elongated and heavier bunches. These findings align with those of Ahmad (2005) in Perlette grapes, Mohammed Farooq and Hulamani (2000) in Arkavati grapes, and Dimovska et al. (2014) in Flame Seedless grapes, confirming that post-flowering GA₃ application optimizes bunch elongation across different varieties.

The study also observed that GA₃ application reduced cluster compactness in seedless grapes, with Trt-2 showing moderately loose clusters. This reduction in compactness is attributed to GA₃'s effect on lowering fruit set and promoting berry thinning, a phenomenon previously reported in Thompson Seedless and Crimson Seedless grapes (Patil, 2017). By reducing the number of berries per bunch, GA₃ allows the remaining berries to receive more nutrients, which contributes to increased berry length, diameter, and weight. The highest individual berry size and 50-berry weight were recorded in Trt-2, reflecting the combined effect of enhanced cell division and subsequent cell expansion in the mesocarp and pericarp tissues. Similar observations were made in Thompson Seedless grapes (Elgendy et al., 2012) and Crimson Seedless grapes (Patil, 2017).

Quality parameters were also positively influenced by GA₃ application. Total soluble solids (TSS) were highest in Trt-2 grapes, indicating enhanced sugar accumulation, while acidity and pH were not significantly affected. These results are consistent with previous studies in Red Globe grapes (Avenant, 2013) and indicate that GA₃ primarily accelerates sugar accumulation rather than affecting acidity or juice pH (Gupta and Chakrabarty, 2013). The findings suggest that GA₃ improves grape taste and ripening without compromising acidity balance.

Yield per vine and per hectare was also maximized in Trt-2, reflecting the combined effects of improved bunch length, berry size, and cluster thinning. GA₃ treatment, when applied post-flowering, effectively promotes berry enlargement and optimizes yield, as reported in Thompson Seedless (Kumar and Sharma, 2016) and Einset Seedless grapes (Magdalena et al., 2017). These results emphasize the importance of timing and dosage, as higher GA₃ concentrations or applications at earlier stages did not produce comparable benefits.

Organoleptic evaluation further confirmed the superior quality of Trt-2 grapes. Panelists consistently rated Trt-2 highest in berry appearance, color, texture, flavor, and overall acceptability. This improvement is likely due to GA₃'s thinning effect, which reduces fruit set and enhances berry development, contributing to better shape, color uniformity, taste, and texture. Similar effects have been reported by Habibi (2009) and Kashyap et al. (1989).

Overall, this study demonstrates that 30 ppm GA₃ applied after flowering is the most effective treatment for enhancing both the quantity and quality of Keshmishi grapes. Excessive GA₃ doses or premature applications were less effective, highlighting the critical role of timing and concentration in optimizing grape growth and yield. These findings answer the key research questions of the study: GA₃ effectively enhances grape yield and quality, and the post-flowering application at 30 ppm provides optimal results for Keshmishi grapes. Moreover, the results are consistent with global research on seedless grape varieties, confirming that GA₃ promotes cell elongation, berry enlargement, and cluster thinning, thereby improving both quantitative and qualitative traits. The findings provide practical recommendations for grape growers in Afghanistan and similar agro-climatic regions to maximize grape productivity and marketability.

5. Conclusion

A field experiment conducted from May to September 2024 in Isfanda village, Ghazni province, evaluated the effects of different concentrations and application timings of gibberellic acid (GA₃) on Keshmishi (seedless) grapes. Six treatments significantly influenced bunch growth, berry size, yield, quality, and organoleptic characteristics. Among them, the application of GA₃ at 30 ppm after flowering (Treatment 2) proved superior to all other treatments. This treatment produced better clusters, improved berry development, and enhanced quality parameters. Notably, yield increased to 36.75 MT/ha, representing an 11.5 MT (45.5%) increase compared to the control (25.25 MT/ha), demonstrating the critical importance of proper GA₃ timing and concentration.

Further research is needed to standardize growth regulators for different seedless grape varieties to improve productivity and fruit quality in varying agroclimatic conditions. Future studies should

investigate the link between gibberellic acid concentrations and biochemical parameters like starch and sugar content to enhance grape quality. These points inform the study's final recommendations:

Gibberellin spray application with the concentration of 30 ppm after flowering to the bunches of grapes until the bunches were soaked, as it had the highest yield 36.75MT per ha, and the yield was increased by 11.5MT or 45.5% per ha compared to the control, with the largest berries, properly compact bunches, large clusters, and the highest percentage of normal berries. Additionally, it requires an optimum concentration of GA3 and has the possibility of very low negative side effects.

Author Contributions

The percentages of the authors' contributions are presented below. All authors reviewed and approved the final version of the manuscript.

	N.S.	G.R.S.
C	80	20
D	70	30
S	10	90
DCP	100	
DAI	100	
L	100	
W	100	
CR	70	30
SR	80	20
PM	80	20
FA	100	

C= Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

Acknowledgments

The authors sincerely acknowledge the support and guidance provided by Prof. G. R. Samadi, Faculty of Agricultural Sciences, Kabul University, for his valuable supervision and academic advice throughout the study. The authors also appreciate the support of their families during the completion of this research work.

References

Ahmad, M. (2005). Effect of girdling, thinning and g a3 on fruit growth, yield, quality and shelf life of grapes (*Vitis vinifera* L.) cv. *Perlette* (Doctoral dissertation, Kashmir University).
 Avenant, J. H. (2013). Effect of gibberellic acid, CPPU and harvest time on browning of *Vitis vinifera* L.'Regal Seedless'. In *IX*

International Symposium on Grapevine Physiology and Biotechnology 1157 (pp. 357-366).
 Chaitakhob, N., Janchean, B., Pilap, N., & Methaneekorncchai, S. (2011). Influence of gibberellic acid and n6-benzyladenine on the development of seed and berry quality in 'Perlette' seedless grape. In *International Symposium on Tropical and Subtropical Fruits 1024* (pp. 197-203).
 Dimovska, V., Ivanova, V., Salamovska, A., & Ilieva, F. (2014). Flame Seedless grape variety (*Vitis vinifera* L.) and different concentration of gibberellic acid (GA3). *Bulgarian Journal of Agricultural Science*, *20*(1), 137-142.
 Dokoozlian, N. K. (1996). Gibberellic acid application timing influences the bud viability and fruitfulness of seedless table grape cultivars. *HortScience*, *31*(4), 598c-598.
 Elgendy, R. S. S., Shaker, G. S., & Ahmed, O. A. (2012). Effect of foliar spraying with gibberellic acid and/or sitofex on bud behavior, vegetative growth, yield and cluster quality of Thompson Seedless grapevines. *The Journal of American Science*, *8*(5), 21-34.
 El-Razek, E. A., Yousef, A. R. M., & Abdel-Hamed, N. (2015). Effect of chelated Fe, zn and mn soil application with spraying GA3 and ascorbic acid on growth, yield and fruit quality of flame seedless grapevines under calcareous soil conditions. *International Journal of ChemTech Research*, *8*(6), 441-451.
 Gupta, R., & Chakrabarty, S. K. (2013). Gibberellic acid in plant: still a mystery unresolved. *Plant Signaling & bBehavior*, *8*(9), e25504. <https://doi.org/10.4161/psb.25504>
 Habibi, H. K. (2009). Effect of gibberellic acid and brassinosteroid on bunch and berry characters, yield and quality of Bangalore blue grapes (MSc thesis, GKVK).
 Harrell, D. C., & Williams, L. E. (1987). The influence of girdling and gibberellic acid application at fruitset on Ruby Seedless and Thompson Seedless grapes. *American Journal of Enology and Viticulture*, *38*(2), 83-88.
 Kashyap, A. S., Ananda, S. A., Jindal, K. K., & Negi, T. C. P. (1989). Effect of gibberellic acid on the productivity and quality of Thompson Seedless grapes grown under dry temperate conditions. *Progressive Horticulture*, *21*(3-4), 317-321.
 Kumar, K. T., & Sharma, M. K. (2016). Effect of GA₃ in combination with urea phosphate and BA on yield and physical quality parameters of grape cv. Thompson Seedless. *Progressive Horticulture*, *49*(2), 133-137.
 Magdalena, K., Agnieszka, N., Piotr, B., & Kamila, K. (2017). Effect of gibberellic acid concentration and number of treatments on yield components of "Einset Seedless" grapevine cultivar. *Horticultural Science*, *44*(4), 195-200.
 MAIL. (2020). *Agriculture annual report: Cumulative products and yields per hectare of land disaggregated by provinces, Afghanistan*. Ministry of Agriculture, Irrigation and Livestock.
 May, P. (2004). *Flowering and fruit set in grapevines*. Phylloxera and Grape Industry Board of South Australia in association with Lythrum Press.
 Meena, V. S., Nambi, V. E., Vishwakarma, R. K., Gupta, R. K., & Nangare, D. D. (2012). Effect of gibberellic acid on fruit quality and storability of grape in semi-arid region of Punjab. *Agricultural Science Digest*, *32*(4), 344-347.
 Mohammed Farooq, M. F., & Hulamani, N. C. (2000). Effect of growth regulators and boric acid and their stage of treatment on bunch characters of Arkavati grapes (*Vitis vinifera* L.). *Karnataka Journal of Agricultural Sciences*, *13*(4), 1049-1053.
 Patil, S. (2017). Standardization of growth regulators for rachis elongation in crimson seedless and berry and flower thinning in red globe grapes (*Vitis vinifera* L.) (MSc Thesis, College of Horticulture Venkataramannagudem).
 Randhawa, G. S., & Pal, N. C. (1968). Further studies on seed

- germination and subsequent seedling growth in grape (*Vitis* spp.). *Indian Journal of Horticulture*, 25(3/4), 149-158.
- Shaaban, E. A., El-Tanaby, M. M., & Nageib, M. M. (1989). Effect of GA3 and Vapor-Gard on yield and fruit quality of 'Thompson Seedless' grape-vine. *Assiut Journal of Agricultural Sciences*, 20(1), 3-14.
- Shirzad, B. M., & Samadi, G. R. (2018). *Deciduous fruits of Afghanistan*. Said Hsibullah.
- Srivastava, A., & Handa, A. K. (2005). Hormonal Regulation of Tomato Fruit Development: A Molecular Perspective: A. Srivastava and AK Handa. *Journal of plant growth regulation*, 24(2), 67-82. <https://doi.org/10.1007/s00344-005-0015-0>
- URL1. Kishmishi grape. <https://www.fondazioneslowfood.com/en/ark-of-taste-slow-food/kishmishi-grape> (accessed on 17 June 2025).
- Weaver, R. J., & McCune, S. B. (1960). Further studies with gibberellin on *Vitis vinifera* grapes. *Botanical Gazette*, 121(3), 155-162.