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Effects of gibberellic acid (GA₃) on quality and yield in grapes

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Abstract

Grape (*Vitis vinifera* L.) is one in every of the most precious fruit plants of temperate regions, but it is successfully grown in tropical and sub-tropical agro-climatic situations. This review is undertaken to evaluate the effects of gibberellic acid on the Quality and yield of grapes. The plant hormones are extraordinarily essential agents inside the integration of developmental activities. GA₃ is also called gibberellic acid, but the term gibberellic is often used in describing all gibberellins. Active gibberellins show many physiological effects, each depending on the type of gibberellin present in the grape plant. This review Results suggest foliar sprays of only gibberellic acid (combine with different chemicals) with various concentrations at the different developmental stages, increases both quality and yield in grapes.

Keywords: Gibberellic acid (GA₃), quality, yield, grapes

Introduction

Grape (*Vitis vinifera* L.) is the most precious fruit plants of the temperate region which has acclimatized to tropical and sub-tropical agro-climatic situations. It belongs to the Vitaceae family, originated in Western Asia and Europe. It was introduced to India in 1300 A. D by the Persian invaders. Grape is a famous and economically valuable fruit [Ruel JJ & Walker MA (2006)]^[34] around the globe Grapes production became calculated about 74.5 million tons from the growing area of 7.12 million hectares [FAO (2014)]^[16]. China, Italy, USA, Spain, France, Turkey, Argentina, India, and Iran [FAO (2017)]^[17] is the leading producer of the grapes in India grape is cultivated in an area of 45,200 ha with an annual production of 10.57 lakh tones (Mani, 2014)^[33].

Grapes is a non-climacteric fruit that grows at deciduous woody and the perennial climbing vine. Grapes is a cross-pollinated vine with easy, lobed, cut, or toothed leaves (seldom compound) with racemes of greenish plants, the fruit along with the watery or fleshy pulp, stones, and skin, four-seeded. Grape is a fairly appropriate supply of minerals like calcium, phosphorous, iron, and nutrients like B1 and B2. Fresh and dried culmination has numerous uses in Ayurvedic and Unani medicinal drugs.

PGR is usually applied in order to improve the berry size and quality of grapevine (Rusjan, 2010)^[44]. Gibberellic acid (GA₃) is used widely for improving yield and fruit quality. GA₃ is applied to grape cultivars during the fruit set to increase berry size (Peacock and Beede, 2004) studies have established that bioactive GAs are involved in key aspects of plant development, like seed germination, flower induction, fruit and seed development [Hedden P & Kamiya Y (1997)]^[24]. Berry quality is influenced by both exogenous (e.g., temperature, light, and water availability) and endogenous factors (e.g., nutritional and hormonal factors) [Ollat *et al.* (2002)]^[41]. Seediness is controlled by endogenous growth promoters [May P (2000)]^[36]. The presence of berry is significantly correlated with endogenous gibberellins [Gokturk N & Harmankaya N (2005)]^[21] and growth retardants. Substances such as 2-chloroethyl trimethylammonium chloride (CCC) increase fruit set but reduce berry size and sugar accumulation by inhibiting gibberellin synthesis [Looney NE (1981)]^[31]. These substances did not harm the plant and environment. The influence of Gibberellins (GA₃) is observed in tomato and other vegetables for parthenocarpic fruit induction through the exogenous application. GA₃ induce fruit development in unfertilized ovaries. GA₃ also overcome the suspended growth of dormant pollinated ovaries [Magdalena *et al.* (2017)]^[32]

Structure of Gibberellic acid (GA₃)

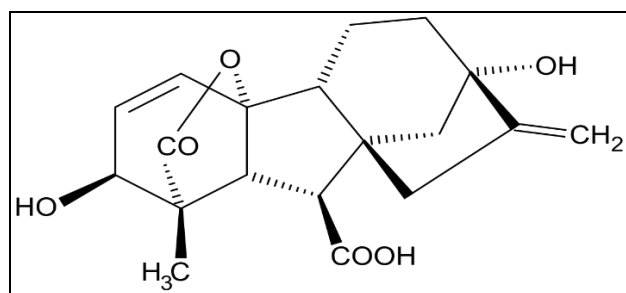


Fig 1: Effects of Gibberellic acid (GA₃) on quality and yield in grapes

Anjum *et al.* (2020) [5] observed that foliar applications were applied to get to and normalize the ideal portion of GA₃ 100 mg/L, 200mg/L, and 300mg/L dosages alongside control. It was seen that the use of GA₃@300mg/L essentially improved berry weight, berry size, and cluster weight but quantities of berries per bunch were decreased. While total soluble solids (TSS) were essentially increased with application 200 mg/L of GA₃ while titratable causticity (TA) was diminished in gibberellin treatment when contrasted with control. Gadissa *et al.* (2020) [19] evaluated that the experiment included ten treatments developed via a factorial combination of five levels of GA₃ and two levels of the canopy. These treatments were complete based on a randomized block design with three replications. GA₃ was sprayed when the cluster length 8-10 cm before flowering and after fruit set plus canopy management (first- hedging and leaf base thinning was done at the height of 45% length of shoots from the arm after flowering and the second was done by removing lateral growth one month after the first Hedging. The results revealed that significantly gibberellic acid increased berry length, berry size, berry weight and Hedging, and leaf base thinning affect the total number of berry per cluster. But exogenous application 90 mg GA₃/cluster showed better economic return without canopy management.

Gao *et al.* (2020) [20] found that the application of 50-100mg/L GA₃ prior to grape vine, showed elongation of inflorescences and bunches and eased cluster compactness in Cabernet Franc (CF) and Cabernet Sauvignon (CS), while no negative effects were observed on the yield and seed number. Ali *et al.* (2019) observed that among all treatments (control, 1ppm GA₃, 1ppm GA₃+5000ppm Low-biuret Urea, 2ppm GA₃, and 5000ppm Low-biuret Urea), the results showed that 1ppm GA₃+5000ppm Low-biuret Urea treatment improved growth and high-quality clusters of Red globe table grape. Mohamed *et al.* (2019) [38] evaluated that exogenous application of Abscisic Acid (ABA), Gibberellic Acid (GA₃) on three important grape cultivars (Flame Seedless, Ruby Seedless, and Thompson Seedless), the result revealed that all individual abscisic acid treatments at two hundred, four hundred and six hundred ppm and ABA at 400 ppm mixed with GA₃ at 10 ppm remarkable increased in yield weight (kg/vine) comparing with the control treatment.

Eleonora *et al.* (2018) [15] determined that gibberellic acid treatments and girdling influenced by the climate in the growing season and ripening stage increased the average cluster weight and berry dimensions and Quality of *Vitis vinifera* L. cv. Victoria and Italia table. Da Silva *et al.* (2018) [13] evaluated the impact of various doses of gibberellic acid (GA₃) on rot incidence of 'Pinor Noir' grapevine. The treatments of GA₃ doses i.e., 0, 2, 4, 6 and 8 mg L⁻¹ applied at

the developed inflorescence on 14-year-old plants, the results showed the utility of GA₃ doses of 4, 6 and 8 mg L⁻¹, confirmed higher cluster length, rachis length and also decreased clusters rotting compared to the control. Athani *et al.* (2018) [6] determined that the test changed into carried out to look at the impact of gibberellic acid on different grape varieties. Two exclusive schedules of gibberellic acid treatment viz., schedule-1 [10 ppm GA₃ at parrot green stage as spray+ 20 ppm GA₃ during 1 week of 1st spray as spray + 30 ppm GA₃ at 3-4 mm berry size stage as bunch dipping + 40 ppm GA₃ at 8-10 mm berry size stage as bunch dipping + 50 ppm GA₃ as bunch dipping during 1 week after 4th treatment] and schedule-2 [20 ppm GA₃ at anthesis stage as dipping + 50 ppm GA₃ at berry set stage as dipping] were applied to four exclusive styles of grape viz., Thompson seedless, Manik Chaman, KR White, and 2-A Clone, The effects revealed that most berry duration, berry diameter, berry weight, pulp weight, peel weight and pulp: peel ratio, berry firmness and minimal weight reduction for 12 days, the minimal range of rotten berries had been recorded within the grapes treated with a schedule-1 set of gibberellic acid as compared to that of the schedule-2 set of gibberellic acid treatment.

Noori *et al.* (2018) [41] evaluated the effect of phosphorus and gibberellic acid on the boom and yield of grape (*Vitis vinifera* L.). The first thing on this experiment changed into P2O5 with three levels (0, 5, and 10 g/l) supplied through phosphatic fertilizer containing 46% phosphorus, and the second one factor becomes gibberellic acid with three concentrations (0, 100 and 200 ml/l). The outcomes of this observe confirmed good-sized consequences of phosphorus and gibberellic acid on leaf vicinity, chlorophyll content material, carbohydrates, cluster-wide variety, cluster weight, wide fruit variety, juice intensity, total soluble solids, and overall acidity of the grape. Magdalena *et al.* (2017) [32] evaluated yield and Quality after one, two, or three spray applications of GA₃ (7, 14 and 21 days after full bloom) at 100, 200 and 300 mg/l, three times spray showed higher yields, cluster weight and berry weight than treatments performed once or twice. Alrashdi *et al.* (2017) determined that pre-harvest application of gibberellin and salicylic acid on 'El-Bayadi' table grapes, showed GA₃ spray increased berry size (weight, length, and width), Vitamin C, Peroxidase (POD) polyphenol oxidase (PPO), polygalacturonase (PG) and xylanase activities as compared to salicylic acid. This results revealed GA₃ increased overall Quality of 'El-Bayadi' table grapes.

Kumar *et al.* (2017) [19] evaluated the effect of GA₃ in mixture with Urea Phosphate and BA on yield and exceptional parameters of grape cv. Thompson Seedless. Ten concentration of GA₃ in aggregate with Urea Phosphate and BA and control (water spray) had been implemented at ranges that have been pre-bloom and berry set. Among all of the combined applications, both GA₃ and BA at distinctive concentrations (30 ppm, 40 ppm GA₃, and 10 ppm BA) at stages (pre-bloom and berry set) improved fruit parameters like berry size, width, weight, and the number of grapes per bunches. Nanjappanavar *et al.* (2017) [40] evaluated Quality and yield of grapes cv. Manik Chaman by application of five treatments of gibberellic acid i.e., T1-Gibberellic acid 0.001% L 120 ml/ac, T2-Gibberellic acid 0.001% L 180 ml/ac, T3-Gibberellic acid 0.001% L 240 ml/ac, T4-Gibberellic acid 0.001% L 180 ml/ac (Standard check) T5-Control. Among the treatments, T2-Gibberellic acid 0.001% L @ 180 ml/ac bunch dipping at 30 days after forwarding pruning and at match head

stage, out of all treatments T2-Gibberellic acid 0.001% L @ 180 ml/ac revealed higher bunch weight, yield per vine and yield per ha and also found superior quality parameters. Filimon *et al.* (2016) evaluated that test becomes performed by using spraying the inflorescences with 25 ppm, 50 ppm, and 100 ppm GA₃. The end result found out that GA₃ @25 ppm confirmed better yield, and high-quality with equilibrated sugar/acid ratio, a higher accumulation of anthocyanins and phenolic compounds in berries, improving the economic factor of grapes by way of increasing coloration intensity and uniformity.

Camcı (2016) [8] Evaluated that the test was based on results of applications on grape yield and quality characteristics of Cluster via Tipping (CT), Girdling (G), CT+G, GA₃+CT, GA₃+G, GA₃+G+CT, the consequences confirmed all packages had widespread outcomes on grape yield, cluster weight, cluster width, berry period, berry width, berry duration/berry width, soluble solids and titratable acidity in Superior Seedless but this study, recommended GA₃+G the most suitable application for growing Superior Seedless table grape variety. Sangeetha *et al.* (2015) [47] Saw that the use of GA₃ by showering with plunging strategy recorded the most noteworthy berry weight, berry width, heaviest packs, and best return per vine and further more recorded high absolute solvent solids, pH and lower titratable acid compare to control. Shamim-ul-Subtain Shah *et al.* (2015) [49] discovered that Different concentrations of GA₃ (15ppm, 20ppm, and 25ppm) had been carried out to grape CV. Perlet as Bloom treatment in two splits doses. The first spray became applied at 70-80% bloom and accompanied with the aid of the second spray as the post-bloom treatment, just after fruit set, they noticed Maximum berry weight, length berry width, and TSS had been recorded at 25ppm. Mohsen *et al.* (2015) [39] evaluated result of this study revealed that spraying GA₃ at 0.5 mg/l at full bloom was the optimum treatment for Crimson Seedless berry thinning, this treatment showed improved bunch and berry physical and chemical characteristics, in addition to the packable yield of tested table grape cv. Without a better reduction in a number of berries/ bunch, as well as yield and bunch weights as compared with the alternative tested GA₃ concentrations and control.

Samra *et al.* (2015) [46] evaluated that impact of spraying "Flame Seedless" grapes with gibberellic acid (GA₃) and ethephon at 250 ppm while berry length was about 10, 12 and 14 mm on berry color and Quality, consequences found out that combined spray of ethephon at 250 ppm with GA₃ when berry length was approximately 14 mm considerably expanded cluster weight, berry weight, and yield/ vine than the single treatment of ethephon and GA₃. Abu-Zinada (2015) found that test based on sprayed with GA₃ at 10 (G1), 15 (G2), 20 (G3), 30 (G4) or 40ppm (G5) on 'Parletta' cultivar of grape whilst the cluster changed into the 7-12cm length (S1), at full bloom (S2) or while berry became 2-4mm (S3). He concluded that Spraying with GA₃ at 15 ppm when cluster 7-12mm increased berry size and quality. Tian (2014) [51] observed that the experiment based on the effect of GA₃ application on content and antioxidant activity of phenolic compounds in different tissues of Muscat grapevine (*Vitis vinifera* L. 'Muscat'), the study showed application GA₃ 100 mg L⁻¹ induced seedless grape berries, enhanced berry size and accelerated the development of berries, resulting in earlier ripening of seedless berries and also increased total phenolics and flavonoids, and antioxidant activity of leaves, stem, and tendrils.

Kukali *et al.* (2014) [28] studied the effect of GA₃ at various concentration (75-100-125 mg /L) on grapes to evaluate the Production and Quality Improvements, Results confirmed that all treatments showed an acceleration of the flowering, maturation and also increased berry size, weight and sugar content in fruit. Coțovanu-Filimon *et al.* (2013) [12] evaluated that the anthocyanin content variant underneath the has an effect on of treatments with gibberellic acid (GA₃) at a few table grape varieties (*Vitis vinifera* L.), the results discovered the application of gibberellic acid extended productivity & quality, and also accelerated anthocyanin in some varieties i.e., Coarna Neagra. He *et al.* (2013) [23] studied on effects of different concentrations of gibberellic acid treatment on berry quality and sugar metabolism during the grape berries development, and the study showed that application GA₃ increased average fruit weight, total soluble content and also increased in Ca²⁺-ATPase activity. Ozer *et al.* (2012) evaluated that effects of gibberellin (GA₃) on yield and fruit quality of Reçel Uzumu table grapes, by treatment of GA₃ (40 ppm) was applied at the 3-5 mm berry size stage. The study showed GA₃ was the main factor for the increase in berry size, berry and cluster weight, and yield and also delayed fruit maturity. Juan *et al.* (2012) [25] observed that treatments with GA₃ and 6-BA on of 5-years-old Red Globe, the results showed treatment with 50 mg/kg GA₃ + 20 mg/kg 6-BA promoted more growth and development of grape berry, and increase the yield than the individual treatment with 50 mg/kg GA₃. Meena *et al.* (2012) [37] observed that application of Gibberellic acid (GA₃) with different concentration @ 20, 25, and 50 ppm on fruit developmental stage, concentration 25 ppm spray showed maximum yield and reduced decay percentage (0.16%) up to the third week of storage of grape. Dimovska *et al.* (2011) [14] studied that the application of three concentration levels of gibberellic acid @ 5, 10 and 20 mg/L on three different periods of the vine growing: before blooming, after blooming and before veraison, this test showed that the concentration of GA₃ had an effect on the physiological characteristics of the berries in all grape-growing periods and gibberellic acid at a dose of twenty mg/L increased the cluster and berry weight of two seedless varieties i.e., Thompson and Belgrade. Kaplan (2011) [26] studied on yield quality of 'Einset Seedless' grape after the application of gibberellic acid (GA₃) with concentration 100 mg×L⁻¹ at full flowering (70-80% of open flowers) and 50 mg×L⁻¹ applied twice: at the beginning of flowering (20% of open flowers), and the second time at the end of flowering (80% of faded flowers) and combined application of 50 mg×L⁻¹ GA₃ + 0.2% NOA at full flowering; and single treatment of NOA @ 0.2% at full flowering stage. The results showed that treatments had a favourable effect on berry weight as well as on the number of berries per cluster. Chaitakhob *et al.* (2011) [10] evaluated that the experiment was conducted on 7-year-old 'Perlette' grape trained on T-trellis system, to investigate the effect of bunch dipping with GA₃ and N6-benzyl adenine (BA), the results revealed that bunch dipping with 30 μl L⁻¹ GA₃ (at 50% of full bloom) and 10 μl L⁻¹ BA (at pea size) significantly reduced the seed formation and improved the yield and quality in 'Perlette' grape. Rusjan (2010) [44] studied on impacts of the gibberellin (GA₃) application on grapevine (*Vitis vinifera* L.) varieties 'Cardinal' and 'Michele Palieri,' on grape quality and their storage potential, the treatment with GA₃ @50ppm showed highest total sugar concentration & CIRG indices and the quality of table grape responded differently to GA₃ applications, especially the different impacts were observed

according to varieties. Satidawat (2009) [48] evaluated that effects of berry thinning period and GA₃ software to berry size and best of Beauty Seedless grapes. The result revealed that GA₃ application @ 25 and 50 ppm to 14 and 21 days after full-bloom collectively with berry thinning earlier than or after GA₃ utility was considerably increasing the berries length and tended to increase boom cluster size & weight. Lamjaroenphong (2009) [30] Studied on the effect of berry thinning period and gibberellic acid (GA₃) application at 14 days and 21 days after full bloom to determined berry size and quality of 'Perlette, the study showed that GA₃ at a concentration of 25 ppm at 14 days after full-bloom with berry thinning before or after GA₃ application gave berry size more than GA₃ at a concentration of 50 ppm and also know GA₃ at concentrations of 25 and 50 ppm at 14 and 21 days after full-bloom tended to increase total soluble solids than the untreated. Khan *et al.* (2009) [27] observed that sprayed with GA₃ at the concentrations of 15ppm, 20pp, and 25ppm at 80% blooming, and a week later fruit set on the flame seedless grape cultivar, It was seen that the use of GA₃@25 ppm showed Maximum berry weight, width, length, TSS and cluster weight.

Warusavitharana *et al.* (2008) [53] evaluated that effect of Cytokinins and Brassinosteroid with Gibberellic acid on Yield and Quality of Thompson Seedless Grapes, and the results showed application of GA₃ at 10 ppm at before blooming stage, 15 ppm at after flowering initiation, 25 ppm mixed with brassinosteroid @ 1 ppm, and benzyl adenine @ 10 ppm at 3 to 4 mm berry diameter stage in twice at 4 leaves and berry setting stage and found maximum berry diameter, berry length, berry weight, number of berries per bunch, number of bunches per vine, bunch weight and yield with the attractive grayish-yellow color of berries. Casanova *et al.* (2007) Located that application of Gibberellic acid @80 mg /L at fruit set to 21 days afterward on 'Emperatriz' seedless grape, showed berry weight accelerated by 50%-90% and the impact befell via larger berry growth rate, early glucose, fructose, and sucrose uptake, growth of absolute glucose & fructose content (mg berry⁻¹) of seedless berries and growth of absolute berry water content material. Wassel *et al.* (2007) [54] found that combined application of micronutrients(Zn, Fe, and Mn) at 0.2%, gibberellic acid at 25 ppm, and ascorbic acid at 500 ppm on white Banaty seedless grapevines, the results showed the maximum weight of clusters and number of clusters per vine that indicated remarkable promotion on yield.

Tecchio *et al.* (2006) [50] observed that dipping clusters into aqueous solutions of CPPU @ 0, 15, 30, 45, 60, 75 and 90 mg/litre and GA₃ @ 0, 30, 60, 90, 120, 150 and 180 mg/litre, showed both growth regulators treatments increased weight, length and width of fruits. Chen *et al.* (2005) [11] observed that experiments had been conducted on Red Globe grape cultivar for analyzing the influence of girdling and gibberellic acid utility at the berry weight, cluster weight, seed variety consistent with berry, the consequences showed that trunk girdling conducted while the berry diameter grew up to fifteen-sixteen mm extended the berry weight with the aid of 10%, and that dipping cluster with GA₃ 40-60 mg/L expanded the berry weight and cluster weight substantially. Usha *et al.* (2005) [52] Studied on the experiment was conducted on a 3-year-antique grape CV. Perlette educated on pergolas, to research the impact of bunching dipping with GA₃ and N6-benzyl adenine (BA) on lowering the problem of shot berries and enhancing the productiveness of grapevines, the take a look at discovered that bunch dipping with 30 µL/L GA₃ (at 50% of complete bloom) and 10µL/L BA (at pea size)

considerably decreased the trouble of shot berries, and improved the yield and first-rate in grape cv. Palette.

Avenant & Avenant (2005) [7] Effect of gibberellic acid and CPPU on colour and berry size of 'redglobe' grapes. The combined applications of 20 mg L⁻¹ GA₃ plus 5 mg L⁻¹ CPPU plus 1.5% seaweed at 12mm berry size, 16 mm berry size and véraison stage, results showed highest yield with a desirable colour. Gowda *et al.* (2005) [22] Studied at the influence of the utility of GA₃ on the increase and development of bunches and berries of 'Thompson Seedless grapes (*Vitis vinifera* L.), the results discovered that utility of GA₃ at 20, 25, 30 and 40 mg L⁻¹ at 45, 50, 55 and 65 days after October pruning was observed to be higher yield and good quality of 'Thompson Seedless grapes below Bangalore situations.

Conclusion

This review is undertaken to evaluate the effects of gibberellic acid on the quality and yield of grapes. Significance application of GA₃ at different developmental stage (flowers and fruits) was increase yield and maintained the quality of grapes as compare to control. This review shows exogenous application of different concentrations of GA₃ is beneficial for quality and yield of various cultivars of grapes.

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