Agro Bali : Agricultural Journal
Vol. 6 No. 1: 40-46, March 2023
e-ISSN 2655-853X
https://doi.org/10.37637/ab.v6i1.1217

The Effects of GA3 Application on the Quality of 'Kediri Kuning' Variety of Grape (*Vitis vinifera* L.)

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Article history: submitted: February 8, 2023; accepted: March 21, 2023; available online: March 31, 2023

Abstract. 'Kediri Kuning' is one of the superior varietiy in Indonesia. Fruit quality is an important thing that must be considered. This research reports the effects of GA3 on the quality of 'Kediri Kuning' variety of grape. This experiment employed a randomized block design, five treatments, and seven replications. Meanwhile, the treatments employed GA3 concentrations of 0, 25, 50, 75, and 100 ppm. The GA3 was applied by spraying GA3 in inflorescence twice before anthesis, namely on days 14 and 28 after production pruning. Data was analyzed using analysis of variance and the differences between treatment means were analyzed using Least Significant Difference (LSD). This study revealed that GA3 25-100 ppm could more significantly increase fruit sugar content at harvest, fruit length, and fruit diameter than the control group. Seed weight at a concentration of 100 ppm is lower and more statistically significant than that at other treatments. However, all treatments could not induce seedless because the seed remains in the fruit.
Keywords: fruit quality; inflorescence; seedless

INTRODUCTION

'Kediri Kuning' is one of the leading grape varieties in Indonesia. It was released by the Minister of Agriculture of the Republic of Indonesia in 2004 through Minister of Agriculture Decree No. 361/Kpts/LB.240/6/2004 on 2 June 2004 (Balitjestro, 2012). The decree states that this variety is an introduced variety from Belgium and BS 88 (Banjar Sari 88) and grows well in the lowlands of 20-300 m above sea level. The harvest age of the 'Kediri Kuning' grape variety is 105-110 days after the production is pruned and the flesh turns yellow with a greenish-yellow skin color (Indonesia, 2004). Other characteristics of the 'Kediri Kuning' variety are thin leaves, hairless undersides, medium fruit size with a fruit length of 1.9 cm and diameter of 1.7 cm, greenish-yellow fruit with yellowish flesh, and 65 fruits per bunch (Ferdiatik, 2014).

'Kediri Kuning' variety is generally used as table fruit and is consumed fresh; therefore, the quality is an important factor that should be considered. Several factors that determine the quality of grapes are sweetness, fruit size, and seedlessness. Grape is classified into non-climacteric fruit (Chervin et al., 2004; Pahi et al., 2020) and cannot be ripe after being harvested; thus, its fruit sugar content is similar to that in the harvest time. Such a condition suggests that harvest should be done on time so that the fruit still has a sweet taste with optimal sugar content when reaching consumers.

Gibberellin (GA3) is a growth regulator widely used in agriculture, including in the process of seed germination, shoot elongation, flowering, fruit development, breaking dormancy, enzyme synthesis, dwarf reversal, parthenocarpy in fruit, and inhibition of wilt (Boğa et al., 2009; Hamman et al., 2003). Moreover, the number of axillary shoots in garlic bulbs can increase when soaked with GA3 (Liu et al., 2020). Galimba et al. (2019) have also found that gibberellin acid ZPT can induce seedlessness in apples and reduce the sour taste. The application of GA3 can also stimulate plant growth and improve the fruit quality of blueberries (Zang et al., 2016) and the el-bayadi grape variety (Alrashdi et al., 2017). Meanwhile, Cheng et al. (2013) investigate how seedlessness occurs and when the formed seeds are aborted in two seed grape varieties, namely kyoho and red globe. To increase fruit sweetness, Casanova et al. (2009) apply 160 ppm GA3 in two varieties, namely an Emperatriz seedless grape variety and an Aledo seed grape variety, when the fruits are formed and begin to enlarge on day 21 after fruit set. They have discovered that

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v6i1.1217

GA3 increases the absolute content of glucose and fructose in Emperatiz and Aledo. In addition, the application of GA3 combined with CPPU (N-(2-chloro-4-pyridyl)-N'-phenylurea) could reduce russet in the skin of the Shine Muscat grape variety (Xu et al., 2019).

Administering GA3 to grapes before anthesis can lengthen the bunches, reduce the number of seeds, and increase the sweet taste (Astawa et al., 2015). Meanwhile, Galimba et al. (2019) have discovered that the growth regulator of gibberellic acid induces seedlessness in apples and reduces sour taste. Several studies report that the application of GA 3 stimulates plant growth and improves the quality of blueberries (Zang et al., 2016), el-bayadi grape cultivar (Alrashdi et al., 2017), and the red globe cultivar of table grapes (Mohsen & Ali, 2019). The application of GA 3 could also break dormancy and induce early germination in tea plants (Cheng et al., 2013) and promote axillary bud development in garlic (Allium sativum L.) when the seed cloves are soaked in gibberellic acid (GA 3) solutions (Liu et al., 2020). Moreover, GA 3 could improve the quality of grapes by reducing russet (brown spots appearing on the surfaces of some fruits), elongating bunches (Xu et al., 2019), affecting berry thinning and berry sizes (Vyver, 2016), and inducing seedlessness in seeded cultivars (Cheng et al., 2013).

This study observes the effects of GA3 applied before anthesis on the ‘Kediri Kuning’ seed grape variety. This study aims to determine the effects of GA3 on the quality of grapes, including sugar content, fruit sizes, and seedlessness.

METHODS

The research was conducted during a planting season from May to November 2021. The GA3 treatment was conducted twice: when the inflorescence aged 14 days after pruning (DAP) and aged 28 DAP.

The experimental design of this study was a randomized block design, with five treatments, and seven replications. The treatments included T0 = Control (without GA3), T1 = 25 ppm GA3, T2 = 50 ppm GA3, T3 = 75 ppm GA3, and T4 = 100 ppm GA3. The treatment was replicated seven times. Each experimental unit consisted of one inflorescence. GA3 was applied by directly spraying on the inflorescence. The inflorescence was observed at the age of 100 days after production pruning. Meanwhile, the data were analyzed using ANOVA, and the mean difference between treatments was analyzed using Duncan's multiple range test (DMRT). The observed variables were sugar content, fruit length, fruit diameter, number of seeds per fruit, and weight of seeds per fruit.

RESULTS AND DISCUSSION

Sugar content (%Brix) and fruit length increase along with the increase in GA3 concentration, but the GA3 concentration treatment does not affect the weight of 10 fruits (Table 1). An increase in sugar content indicates that the ripening process accelerates because harvesting is done at the same time.

Poudel et al. (2022) assert that the application of GA3 in the field increases the degree Brix in Himrod grape varieties. Spraying is usually done when the grape's size is as big as a corn seed (4-5 mm). However, in this research, spraying was done when the flowers had not bloomed or were in the inflorescence phase. Similarly, Casanova et al. (2009) report that glucose and fructose in grapes absolutely increase due to GA3 treatment when the fruit is formed or aged 21 days after the fruit set. These findings conclude that the application of GA3 in the field, either when the fruit is formed or before anthesis, can increase sugar content or accelerate ripening.

The ‘Kediri Kuning’ variety constitutes a green grape variety so that the effect of accelerated ripening due to GA3 application is not visually visible. However, this result looks more noticeable on colored grape varieties. For example, the red prabu bestari grape variety has stadia veraison (the formation of color in the fruit), which is

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v6i1.1217

formed on day 60 after the pruning due to the GA3 application and before the anthesis. Meanwhile, in the control group, the grapes are still green (data has not been published). The increase in sugar content due to GA3 administration in this study is also reported by Al-Atrushy (2016). He states that the total sugar (%) and total soluble solids (%) in grapes of the zark variety increase significantly along with the increase in GA3 concentrations of 0, 10, 20, and 30 ppm. In contrast, El Masri et al. (2018) apply the GA3 treatments with concentrations of 20 and 40 ppm in seedless variety grapes twice: when the flowers bloom and when the fruit diameter is 4-7mm. Such treatment delays fruit ripening. The application of GA3 to grape quality is determined by many factors, such as grape variety (seeded or seedless), GA3 concentration, and application time. This study concludes that, unlike the control treatment, the application of GA3 with concentrations of 25, 50, 75, and 100 ppm on the seeded variety applied before the flowers bloom could increase the sugar content of the fruit (oBrix) at the harvest age of 100 days after pruning. However, the result of each concentration is not significantly different. Khandaker et al. (2015) also report that the effect of oBrix fruit with GA3 concentrations of 20, 50, and 100 ppm in apples (waxed apples) is not significantly different; in contrast, the effect is significantly different in the control.

Fruit length of GA3 treatments increased more significantly than that of the control group (Table 1). The most significant visual increase is found in the 100 ppm treatment because the grape's shape becomes more oval due to the increase in fruit length (Figure 1). The increase in fruit length due to the application of GA3 is also reported by Casanova et al. (2009). This fruit elongation is closely related to the effect of external GA3 on plant cell division and elongation, which are assumed to be closely related to gene expression. Heuvel et al. (2008) have proven that the external application of GA3 to mutant tomato plants is associated with gene expression. Meanwhile, the northern blot analysis in this study has revealed that the application of GA3 increases gene expression, which is correlated with DNA replication (h1 and h2b histones) and cell elongation (expansion and -tubulin). Thus, the fruit shapes of grapes are influenced by environmental factors, namely external hormone treatment that causes genes to turn on and off.

Table 1. Effects of GA3 application on sugar content, fruit length, and fruit diameter

Treatment	Observed Variables		
	Sugar Content (% Brix)	Fruit Length (cm)	Fruit Diameter
K0	13.37 b	1.71 b	1.45 b
K1	14.63 a	1.73 a	1.55 a
K2	14.64 a	1.77 a	1.50 a
K3	15.37 a	1.82 a	1.51 a
K4	16.06 a	1.83 a	1.53 a

Description: Numbers followed by the same letters show no significant difference based on Duncan's test level of 5%.

The application of GA3 significantly affects fruit diameter; this result is significantly different from that of the control but not significantly different among the GA3 concentrations (Table 1). The increase in fruit size due to the application of GA3 is also reported by Vyver (2016) and Nampila et al. (2010). Vyver (2016) applies GA3 twice: when the fruit's full bloom is 80-100% by spraying and when its size is 7-8 mm by soaking its bunches. Meanwhile, Nampila et al. (2010) combine GA3 with CPPU by spraying. An increase in fruit size also occurs in the application of GA3 during the fruit set

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v6i1.1217

(Peacock & Beede, 2004). The results of this study are in line with those of the previous studies although this study applied GA3 at different times, namely before the flowers bloom. The effects of GA3 treatment on the observed variables are presented in Table 1 and 2.

Table 2. Effects of GA3 application on number and weight of seeds per fruit

Treatment	Observed Variables	
	Number of Seeds per Fruit	Seed Weight per Fruit
K0	2.76 a	2.07 a
K1	2.72 a	1.89 a
K2	2.67 a	1.88 a
K3	2.47 a	1.78 a
K4	2.52 a	1.45b

Description: Numbers followed by the same letters show no significant difference based on Duncan's test level of 5%.

Figure 1. The effect of GA3 treatment on the Fruit length of the 'Kediri Kuning' grapes. Control with an average fruit length of 1.71 cm (left); Treatment of 100 ppm GA3 with an average fruit length of 1.83 cm (right)

The seedlessness has not been able to be induced by external application of GA3 (Table 2) because all GA3 treatments still show the presence of seeds. However, in the GA3 treatment with a concentration of 100 ppm, the seed weight decreases; this result is statistically and significantly different from that of other treatments. A significantly reduced number of seeds is a characteristic that is highly desired by grape consumers (Dimovska et al., 2014; Varoquaux et al., 2000). Thus, various efforts should be made to remove seeds in the fruit, especially for seeded grape varieties. This result agrees with

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v6i1.1217

those of Gao et al. (2020) who have revealed that the application of GA3 before anthesis in cabernet franc and cabernet sauvignon grape varieties does not affect the number of seeds.

CONCLUSION

The application of GA3 25-100 ppm to the bunches before the flowers bloom could increase the fruit's sugar content at harvest, diameter, and length. However, this application could not induce seedlessness in the seeded grape variety, namely 'Kediri Kuning'.

ACKNOWLEDGMENT

This research was funded by PNBP funds of Universitas Udayana for the 2022 fiscal year. We convey our gratitude to the Research Institutions and Community Services of Universitas Udayana, which has facilitated the research activities from the proposal review to the funding.

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