The Journal of Agricultural Sciences - Sri Lanka
Vol. 21 No 2, May 2026. pp 421-432
https://doi.org/10.4038/jas.v21i2.11724

RESEARCH

Effect of Gibberellic Acid on Berry-Cluster Yield and Return Fruitfulness of Grapevine cv. *Poloskei Muskotaly*

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Received: 16th May 2025 / Accepted: 10th March 2026

ABSTRACT

Purpose: *Gibberellic Acid (GA_3) is generally applied to increase the size of berries for a better yield. Therefore, this study aimed to assess the effect of GA_3 doses and time of application on berry yield and return of fruitfulness in the next season in table grape cv. Poloskei Muskotaly during the years 2023 to 2024 in a commercial vineyard, Dhading, Nepal.*

Research Method: *: Studies were carried out in two factorial randomized complete block design using four concentrations of GA_3 (0, 5, 10 and 20 ppm) at post-flowering, 4-5 mm berry size and both post-flowering and 4-5 mm berry size stages, and inflorescences per vine were also counted to assess the vine fruitfulness.*

Findings and Values: *Application of 20 ppm GA_3 at 4-5 mm berry size increased berry weight by 26.91% and cluster weight by 41.17%. There was a distinct relationship between berry diameter and berry weight that showed about 55.22% and 55.12% variation in berry weight, which was explained by berry transversal and longitudinal diameter, respectively. GA_3 concentrations and stages of application in the previous season of 2024 did not show any significant effect on return fruitfulness in the following season of 2025. Sizing spray of GA_3 after berry set is effective for improving yield in Poloskei Muskotaly and has the potential to enhance commercial grape production in Nepal.*

Keywords: *Berry size, Cluster size, Inflorescences per vine, Post-flowering*

INTRODUCTION

Grapes (*Vitis vinifera* L.), belonging to descendants of the wild progenitor (*Vitis vinifera* spp. *sylvestris*), were domesticated around 8,000 years ago. Evolving into one of the world's most valuable horticultural crops, grapes are serving as a vital source of food and wine (Lin *et al.* 2019). Selected germplasms of temperate fruits and grapevines were officially introduced and maintained in *Kirtipur, Jumla* and *Mustang* in Nepal during the Hill Agriculture Project (FAO) 1976 to 1979 and Horticulture Development Project, 1985 (Shrestha *et al.* 2017). Small size vineyards on government research stations as well as farms were established in temperate and warm temperate areas in 1968 for preliminary studies (Dahal *et al.* 2017). No systematic research has been carried out in Nepal so far to improve the production and productivity of the berries. There was no commercial table grape production in Nepal. The production of grape has been started in private farms in the mid hills of Nepal.

The increasing demand of both fresh and dried grape is increasing every year. Nepal imported large quantities of dried and fresh grapes worth of 2373.80 million NPR (million US$ 17.30) in 2024 (Acharya *et al.* 2025). This trade value shows the scope of grape cultivation in Nepal as the native production is negligible

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(*Acharya et al.* 2023). There is a need to increase area and production of quality grapes both, to fulfil the national demand and substitute the import.

Heavy rainfall coinciding with the grapes harvest period, poor yield and early monsoon are documented as the major problems of grape cultivation in Nepal (Dahal *et al.* 2017). A private farm has introduced some promising grape varieties from Europe and initiated cultivation in *Dhading* district at 650 meter above mean sea level (masl).

Poloskei Muskotaly is considered as promising one among other tested cultivars and was introduced in 2020. It is a very productive cultivar of table grape originated from Hungary, known for its sweet muscat flavor (Wein-Plus 2025). It is popular for fresh consumption, wine and juices. Highly resistance character to fungal diseases of this cultivar makes it a popular choice for both commercial growers and amateur cultivation both (Vitifera 2025).

GA_3 is mostly applied to seedless table grape cultivars at post-flowering or after berry set to enlarge the size of berries (diameter and length) and cluster (bunch) attributes (Casanova *et al.* 2009, Zoffoli *et al.* 2009, Elgendy *et al.* 2012, Ozer *et al.* 2012, Raban *et al.* 2013). Dokoozlian & Peacock (2001) concluded that the use of GA is common in table grape viticulture (either seeded or seedless grapes) and more limited in their application for wine grape cultivars.

Hed *et al.* (2011), Molitor *et al.* (2012), *Van Der Merwe* (2014) reported that the doses and frequency of GA_3 applications are very specific to the variety as the seed content in berries varies with cultivars. Exogenous GA_3 is applied at pre-bloom stage or bloom stage for cluster (bunch) elongation (Hed *et al.* 2011).

Application of GA_3 in grapevine to improve the yield has yet to be explored in Nepalese viticulture. This study was carried out to assess the effect of GA_3 concentrations and identify the suitable berry growth stage for its application in table grapevine cv. *Poloskei Muskotaly*.

MATERIALS AND METHODS

Field experiments were conducted from December 2022 to March 2025 in the *Kewalpur* Agro Farm (27.75°N, 85.11°E) of the *Patleban Vineyard* and Winery at the altitude of 650 masl *Dhading*, Nepal. Four treatments of GA_3 concentrations (combine control/S0/0, 5, 10 and 20 ppm) were imposed at post-flowering stage (S1), 4–5 mm berry size stage (S2), and both stages (S3) (post-flowering and 4–5 mm berry) applications in table grape cv. *Poloskei Muskotaly* to compare in two factorial randomized complete block design (RCBD) with three replications.

Growth stages were monitored following the modified grapevine growth stages. The first application of GA_3 at its post-flowering stage (23 modified E-L stage i.e. $>50\%$ capfall stage as described by Coombe & Dry 2004) was carried out on 8th April 2023 and 2nd April 2024, and the second application at approximately 4 to 5 mm berry size (29 modified E-L stage i.e. berries peppercorn size stage) was done on 15th April 2023 and 15th April 2024. A knapsack sprayer having a fine nozzle was used to spray GA_3 at the selected cluster during evening hours.

Ten berries were randomly picked from each cluster in a ratio of 4:4:2 (top shoulder, middle part and bottom) representing a cluster as adopted by Dahal (2019) (Fig. 1). The average 10 berry weight (g) by using a digital weighing balance, the average berry transversal and longitudinal diameter (mm) by using a digital caliper, and the total number of berries were recorded. Likewise, by using a digital caliper, cluster length and cluster width (mm) were recorded and the weight (g) of cluster was also measured using a digital balance (Huazhi, model-HZT-B6000, Huazhi Scientific Instrument Company Ltd., China).

Return fruitfulness in the season of 2025 following the GA_3 application in 2024 was assessed by counting inflorescences per vine. It was conducted after 5–6 weeks of budburst in 2025. The collected data were managed by using MS Excel. Statistical analysis of all data was done by using GenStat 18 (VSN International

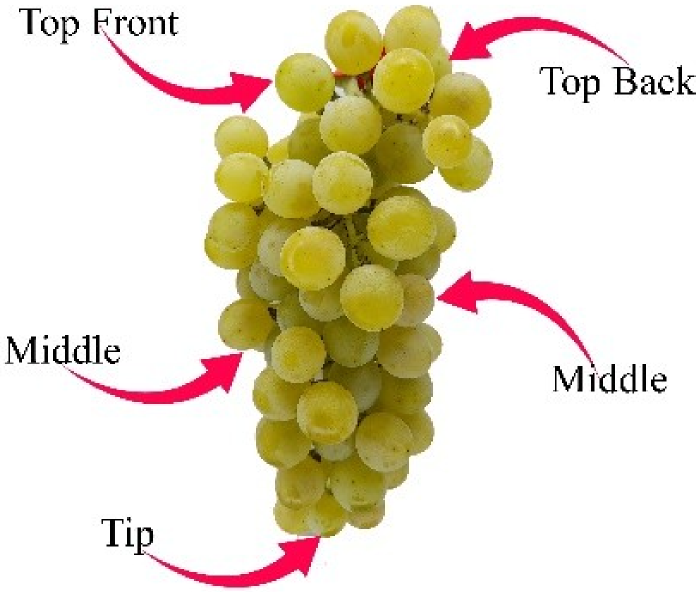

Figure 1. Berry sampling procedure adopted during the study.

Limited, UK) for ANOVA preparation as per the given instruction for RCBD.

RESULTS AND DISCUSSION

Doses and stages of GA_3 application on berry yield

The cluster treated with 20 ppm GA_3 had the highest berry transversal diameter (16.64 mm) in average data of 2023 and 2024 (Table 1.). The highest berry longitudinal diameter (18.18 mm) and 10-berry weight (29.33 g) were found with the application of 20 ppm GA_3. With respect to the stages of GA_3 application (Table 1.), the highest total berries per cluster (49.77) were found when GA_3 was applied at 4–5 mm berry size. While GA_3 applied at both i.e. post-flowering and 4–5 mm berry size stage had similar effect on the total berries per cluster (48.53).

Berry weight was increased by GA_3 application. GA_3 20 ppm applied at the 4–5 mm berry size stage increased berry weight by 26.91% over control, followed by 21.07% and 16.66% with 10 and 5 ppm GA_3 application, respectively. Dimovska *et al.* (2011) applied 5, 10 and 20 ppm GA_3 to the cv. *Thompson* and *cv. Belgrade* (having rudimentary seed), the 20 ppm was found better to improve the berry and cluster weight. Enhanced cell division and cell expansion by GA_3 application is considered responsible for the increased berry weight in grapes (Dimovska *et al.* 2014, Fortes *et al.* 2015). Additionally, GA_3 might improve the plasticity of the cell wall, and the quantity and rate of assimilates drawn into the grape berries leading to their increased size and weight of berries (Fortes *et al.* 2015). Casanova *et al.* (2009) reported that increase in berry size by GA_3 application is mediated by: a) a faster berry growth rate; b) earlier glucose, fructose, and sucrose uptake; c) an increase in absolute glucose and fructose content (mg/berry) and d) an increase in absolute berry water content.

Anjum *et al.* (2020) found that the berry weight increased in GA_3 treated grapes in cv. *Sultanina*. Likewise, Shah *et al.* (2015) concluded that GA_3 (15, 20 and 25 ppm) applied to grape cv. *Perlette*, berry weight improved at 25 ppm. There were no treatment effects on berries per cluster as reported by Dimovska *et al.* (2014). Satisha *et al.* (2021) also reported non-significant effect of 5–10 ppm GA_3 on the number of berries per cluster in cv. *Crimson Seedless*.

The interaction effect of both GA_3 doses and stages of application in Table 2 shows that the highest berry longitudinal diameter was with the 20 ppm GA_3 applied at 4–5 mm berry size

Table 1. Effect of GA_3 (stages and doses) application on berry attributes (Mean ± SE) of grapevine cv. *Poloskei Muskotaly* in mid-hill condition of Nepal (average of 2023 & 2024).

Factors	Treatments	Berry transversal diameter (mm)	Berry longitudinal diameter (mm)	Berry number	10-Berry weight (g)
Combine control	S0: No GA_3 application	15.68±0.19	17.07±0.17	37.07±2.42	23.11±1.20
Factor A: Stages (S)	S1: Post flowering	16.13±0.25	17.69±0.28	41.56±3.83	27.35±0.96
	S2: 4–5 mm berry	16.40±0.20	17.92±0.27	49.77±4.67	28.24±0.82
	S3: both S1 and S2	16.32±0.25	17.80±0.34	48.53±3.72	28.68±1.12
Factor B: GA_3 Doses (D)	D0: 0 ppm	15.68 ± 0.19^{b}	17.07 ± 0.17^{c}	37.07±2.42	23.11 ± 1.2^{c}
	D1: 5 ppm	16.00 ± 0.20^{b}	17.44 ± 0.26^{bc}	41.32±2.66	26.96 ± 0.81^{b}
	D2: 10 ppm	16.21 ± 0.23^{b}	17.80 ± 0.31^{ab}	46.65±4.30	27.98 ± 1.08^{ab}
	D3: 20 ppm	16.64 ± 0.23^{a}	18.18 ± 0.27^{a}	51.89±4.77	29.33 ± 0.90^{a}
F-test	S	ns	ns	*	ns
	D	*	*	**	*
	D × S	ns	ns	**	ns

Symbol 'ns' indicates non-significant ($P > 0.05$) between doses and stages; symbol '*' indicates significant ($P < 0.05$); and symbol '**' indicates significant ($P < 0.01$).

stage (19.19 mm), however, GA_3 10 ppm applied at both post-flowering and 4–5 mm berry size stage (19.07 mm) had the similar berry diameter. Similarly, the interaction effect of both GA_3 doses and stages of application on total berry number per cluster in 2024 (Table 2) and in average data of two years 2023 and 2024 (Fig. 2) showed that the highest total berry number was with the application of 20 ppm GA_3 applied at 4–5 mm berry size stage (67.47 and 63.68, respectively).

Cai *et al.* (2024) reported that the GA_3 treatments increased the longitudinal diameter of the berry, but there was no significant difference in the transverse diameter in *Shine Muscat-seedless*. They mentioned that the berry of seedless cultivar treated with 25 ppm GA_3 on May 24 and expanding 50 ppm GA_3 on June 7 had significant effect on the longitudinal diameter of berry. Indeed, the GA_3 treated berries had 12.2% higher diameter than the control.

Strength of relationship between berry diameter and berry weight

Figure 3 shows the significant relationship between berry transversal and longitudinal diameter with berry weight in the average data of 2023 and 2024. Berry transversal diameter explained 55.22% variation in berry weight (Fig. 3A), while 55.12% variation in berry weight was explained by berry longitudinal diameter (Fig. 3B). Berries of cv. *Poloskei Muskotaly* is relatively round in shape, thus transversal and longitudinal diameter had similar role in berry weight. Abu-Zahra (2010) documented a significant positive correlation between berry diameter and berry weight, cluster weight, and cluster length in cv. *Thompson seedless*. Dahal *et*

Table 2. Interaction effect of GA_3 (stages and doses) application on berry attributes (Mean ± SE) of grapevine cv. *Poloskei Muskotaly* in mid-hill condition of Nepal in 2024.

Stages	Doses (ppm)	Berry longitudinal diameter (mm)	Berry number
S0 (No GA_3 application)	0	17.30^{b}	42.07^{c}
S1 (Post flowering)	5	17.71^{b}	41.97^{c}
S1 (Post flowering)	10	18.43^{ab}	58.60^{ab}
S1 (Post flowering)	20	17.87^{ab}	41.87^{c}
S2 (4–5 mm berry)	5	18.01^{ab}	43.17^{c}
S2 (4–5 mm berry)	10	17.67^{b}	45.50^{bc}
S2 (4–5 mm berry)	20	19.19^{a}	67.47^{a}
S3 (both S1 and S2)	5	17.30^{b}	47.56^{bc}
S3 (both S1 and S2)	10	19.07^{a}	60.43^{ab}
S3 (both S1 and S2)	20	18.45^{ab}	56.98^{abc}
F-test		*	**

Symbol '*' indicates significant ($P < 0.05$) and symbol '**' indicates significant ($P < 0.01$). S1 = post-flowering, S2 = 4–5 mm berry size and S3 = both post-flowering and 4–5 mm berry size stage.

Table 3. Effect of GA_3 (stages and doses) application on cluster attributes (Mean ± SE) of grapevine cv. *Poloskei Muskotaly* in mid-hill condition of Nepal (average of 2023 & 2024).

Factors	Treatments	Cluster width (mm)	Cluster length (mm)	10-Cluster weight (g)
Combine control	S0: No GA_3 application	56.08±0.37	112.60±3.65	1080.00±70.68
Factor A: Stages (S)	S1: Post flowering	60.06±1.84	119.10±4.52	1253.00±105.67
	S2: 4–5 mm berry	60.36±1.91	127.20±7.04	1449.00±126.86
	S3: both S1 and S2	61.01±2.00	128.00±7.37	1408.00±102.52
Factor B: Doses (D)	D0: 0 ppm	56.08^{c}±0.37	112.60±3.65	1080.00±70.68
	D1: 5 ppm	56.12^{c}±1.41	112.40±5.66	1208.00±78.56
	D2: 10 ppm	60.95^{b}±1.55	130.60±5.01	1376.00±124.32
	D3: 20 ppm	64.36^{a}±1.63	131.20±6.79	1525.00±112.90
F-test	S	ns	ns	*
	D	**	**	**
	D × S	ns	**	**

Symbol 'ns' indicates non-significant ($P > 0.05$), symbol '*' indicates significant ($P < 0.05$), and symbol '**' indicates significant ($P < 0.01$).

Table 4. Interaction effect of GA_3 (stages and doses) application on cluster length (Mean ± SE) of grapevine cv. *Poloskei Muskotaly* in mid-hill condition of Nepal.

Stages	Doses (ppm)	2023	2024	Average (2023 & 2024)
S0 (No GA_3 application)	0	105.90^{cde}	119.40^{bcd}	112.64^{cd}
S1 (Post flowering)	5	121.60^{bcd}	121.50^{bcd}	121.54^{bcd}
S1 (Post flowering)	10	112.80^{cd}	135.70^{abcd}	124.23^{bc}
S1 (Post flowering)	20	113.30^{cd}	109.70^{d}	111.47^{cd}
S2 (4–5 mm berry)	5	101.40^{de}	118.10^{cd}	109.74^{cd}
S2 (4–5 mm berry)	10	120.50^{bcd}	126.90^{bcd}	123.72^{bc}
S2 (4–5 mm berry)	20	137.90^{ab}	158.60^{a}	148.27^{a}
S3 (both S1 and S2)	5	90.70^{e}	121.40^{bcd}	106.05^{d}
S3 (both S1 and S2)	10	142.5^{a}	145.4^{ab}	143.96^{a}
S3 (both S1 and S2)	20	126.6^{abc}	141.4^{abc}	134.00^{ab}
F-test		**	*	**

symbol'*' indicates significant ($P < 0.05$) between doses and stages and symbol '**' indicates significant ($P < 0.01$) between doses and stages

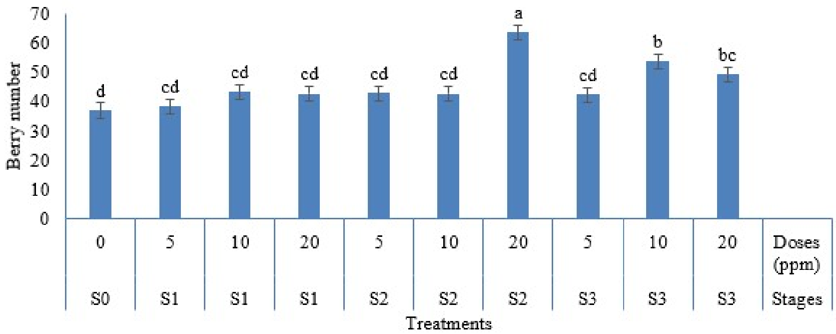

Figure 2. Effect of GA_3 spray on berry number per cluster of grapevine cv. *Poloskei Muskotaly* (average of 2023 and 2024). Mean ± SE; S1=post-flowering, S2=4-5 mm berry size and S3=both post-flowering and 4-5 mm berry size stage.

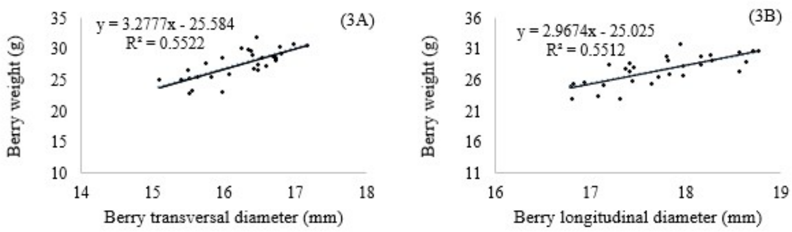

Figure 3. Linear regression showing the berry weight relation with berry transversal diameter (3A) and berry longitudinal diameter (3B) of cv. *Poloskei Muskotaly* (average of 2023 & 2024).

Table 5. Interaction effect of GA_3 (stages and doses) application on 10-cluster weight (Mean ± SE) of grapevine cv. *Poloskei Muskotaly* in mid-hill condition of Nepal.

Stages	Doses (ppm)	2024	Average (2023 & 2024)
S0 (No GA_3 application)	0	1220.00^{d}	1080.10^{c}
S1 (Post flowering)	5	1237.00^{d}	1132.86^{c}
S1 (Post flowering)	10	1695.00^{abc}	1261.78^{c}
S1 (Post flowering)	20	1446.00^{bcd}	1363.19^{bc}
S2 (4–5 mm berry)	5	1228.00^{d}	1240.76^{c}
S2 (4–5 mm berry)	10	1379.00^{cd}	1274.52^{c}
S2 (4–5 mm berry)	20	1902.00^{a}	1830.72^{a}
S3 (both S1 and S2)	5	1401.00^{cd}	1249.93^{c}
S3 (both S1 and S2)	10	1799.00^{ab}	1592.69^{ab}
S3 (both S1 and S2)	20	1542.00^{abcd}	1380.36^{bc}
F-test		**	**

Symbol '**' indicates significant ($P < 0.01$) between doses and stages.

al. (2018) reported that berry weight was positively correlated with berry transversal diameter (R^2=0.99). Likewise, in cv. *Cabernet Sauvignon* under similar management system, the transversal diameter accounted for 30.56% of the variation, while the longitudinal diameter explained 24.33% (Acharya *et al.* 2025).

Doses and stages of GA_3 application on cluster attributes

The highest cluster width was found with the application of 20 ppm GA_3 (64.36 mm), followed by 10 ppm (60.95 mm) and 5 ppm (56.12 mm) GA_3 application (Table 3.). There was no effect of stage of GA_3 application in the cluster width and cluster length. However, both the doses and stages of GA_3 application were found significant ($P < 0.05$) as in case of 10-cluster weight. GA_3 applied at the 4–5 mm berry size stage had the highest 10-cluster weight (1449.00 g) and the highest 10-cluster weight (1525.00 g) was found with the application of 20 ppm GA_3. As cluster weight is directly responsible to grapevine yield, on an average of respective years 2023 and 2024, 20 ppm GA_3 application at 4–5 mm berry size stage increased cluster weight by 41.17% over control (no GA application), followed by 27.42% and 11.83% with the application of 10 and 5 ppm GA_3 application, respectively.

Anjum *et al.* (2020) found the same in which the gibberellic acid treatments influenced the average cluster weight. Dimovska *et al.* (2011) on the *Belgrade* cultivar demonstrated that the highest concentration applied (20 ppm) in three spray treatments caused cluster weight to increase by 31%, and by 19% in the case of *Thompson Seedless*, while Dimovska *et al.* (2014) reported a 66% increase in cluster weight in *Flame Seedless* after three times 20 ppm GA_3 applications.

Increased yield with the application of GA_3 is due to enhanced fruit growth and improved cluster architecture. Kaplan *et al.* (2019) and Mekawy & Ahmed (2019) reported that GA_3 might be associated with optimal nutrient delivery to the developing cluster, linked to improved photosynthetic potential. According to Elgendy *et al.* (2012), the rise in cluster (bunch) weight was driven by the GA_3 treatment increase in berry weight and size. Treatment accelerated the synthesis of proteins and carbohydrates and increased the availability and mobilization of organic nutrients towards the clusters.

Table 6. Effect of GA_3 application (stages and doses) in 2024 on the vine fruitfulness (number of inflorescence) in 2025 (Mean ± SE) of grapevine cv. *Poloskei Muskotaly*.

Treatments (2024)	No. of inflorescence (fruitfulness) (2025)
Factor A: Stages (S)	
S0: Control	20.00±2.52
S1: Post-flowering	18.00±1.56
S2: 4–5 mm berry	21.78±1.77
S3: both S1 and S2	20.00±3.57
LSD (0.05)	7.32^{ns}
F probability	0.566
Factor B: GA_3 Doses (D)	
D0: 0 ppm	20.00±2.52
D1: 5 ppm	19.56±3.39
D2: 10 ppm	21.89±2.21
D3: 20 ppm	18.33±1.41
LSD (0.05)	7.32^{ns}
F probability	0.593
Stages × Doses	ns
CV (%)	37.1
Grand mean	19.90

Means followed by common letter(s) within a column do not differ significantly at ≤ 5% level of significance by DMRT; LSD = Least significant difference; ns = non-significant; SEM = Standard error of mean; CV = Coefficient of variation.

The interaction effect of GA_3 doses and stages of application was found significant ($P < 0.05$) for cluster length in 2023, in 2024 and in pooled data (average) of two years 2023 and 2024 (Table 4), whereas the significant effect of doses and stages was of 10-cluster weight in 2024 and in average data of two years 2023 and 2024 (Table 5). The highest cluster length was with the application of 10 ppm GA_3 applied at both post-flowering and 4–5 mm berry size in 2023 (142.50 mm), 20 ppm GA_3 applied at 4–5 mm berry size in 2024 (158.60 mm), and 20 ppm GA_3 applied at 4–5 mm berry size (148.27 mm) at par with the 10 ppm GA_3 applied at both post-flowering and 4–5 mm berry size (143.96 mm) in average data of two years 2023 and 2024 (Table 4). Likewise, 20 ppm GA_3 applied at 4–5 mm berry size had the highest 10-cluster weight in 2024 (1902.00 g) and in average data of two years 2023 and 2024 (1830.72 g) (Table 5).

Regarding cluster length and width, Dimovska *et al.* (2014) reported that the length and width of clusters treated with GA_3 were greater than the control ones with the exception of the clusters sprayed once with 200 ppm whose length did not differ from the control. Da Silva *et al.* (2018) evaluated the impact of various dose of GA_3 on *Pinor Noir* grapevine and confirmed higher cluster length. Shah *et al.* (2015) also found similar results in grape cv. *Perlett* in which maximum cluster length recorded at 25 ppm. Expansion of the cell wall most likely caused the cluster length to increase, encourage the breakage of hydrogen bonds between polysaccharides and increase the flexibility of the cell wall, which permits water to enter and encourages cell stretching (Da Silva *et al.* 2018).

Effect of GA_3 application on return fruitfulness

The number of effective shoots is an important factor in determining a grapevine's yield performance (Archer 2011). Clusters are initiated during the previous year's growing season bloom, and the final number of clusters is determined by approximately a month after bloom. In California's Central Valley, bud fruitfulness (clusters per shoot) can vary by about 25% from year to year, and growers can get a first estimate of yield potential by dissecting buds and counting cluster primordia during the dormant season (Martinson *et al.* 2012).

Chadha & Cheema (1971) also reported that fruit bud formation in grape takes place for the next year on current season's growth, concurrent with fruit set under temperate conditions. Fruitfulness of a bud is a product of complex interaction of various factors leading to the formation of fruit bud (Palanichamy *et al.* 2011). Williams (2000) also stated that the maximum number of clusters per vine (and thus the potential yield) is determined during the previous year and the formation of clusters for next year's crop begins concurrently with the formation of leaf primordia within the compound bud. Dahal *et al.* (2019) revealed that GA_3 had an inconsistent influence on return fruitfulness when applied at mid or late flowering stages in cv. *Menindee Seedless* grapevine.

This study revealed that GA_3 doses (0, 5, 10 and 20 ppm) and stages of application (post-flowering, 4–5 mm size berry and both at post-flowering and 4–5 mm berry size) in 2024 had non-significant ($P > 0.05$) effect on return fruitfulness in the following year in grapevine cv. *Poloskei Muskotaly* (Table 6.).

CONCLUSIONS

GA_3 applied 0, 5, 10 and 20 ppm at post-flowering, 4–5 mm berry size and both at post-flowering and 4–5 mm berry size stages of table grape cv. *Poloskei Muskotaly* had pronounced effect on berry and cluster yield. Application of 20 ppm GA_3 at the 4–5 mm berry size stage increased berry weight by 26.91% and cluster weight by 41.17%. The relationship between berry diameter and berry weight found that about 55.22% variation in berry weight was explained by berry transversal diameter, while 55.12% variation in berry weight was explained by berry longitudinal diameter. GA_3 doses and stages of application in previous season did not show any effect on return fruitfulness in the following season.

Acknowledgements

The authors gratefully acknowledge to the Tribhuvan University (TU), Collaborative Research Grant-Research Coordination and Development Council (RCDC) for funding this research. The *Kewalpur* Agro Farm is thanked for providing the necessary arrangements of this research.

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