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Influence of Different Application Methods of Gibberellic acid (GA_3) on Quality and Yield of Grapes (*Vitisvinifera*L.)

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ABSTRACT

Israel blue is the seeded grape variety commonly cultivated by Jaffna farmers. Farmers face problems in marketing of grapes and obtaining lower prices due its poor quality. Gibberellic acid (GA_3) is commonly used to improve quality of grape berries globally. A proper method of application has to be recommended for maximum efficiency of GA_3 application. Therefore a study was carried out in farmer fields to study the effect of different methods of applications such as spraying, plunging and combination of spraying and plungingon improvement of berries' quality without changing the concentration of gibberellic acid package. The experiment design was carried out in randomized complete block design with six replicates at three AI divisions Thellipalai, Sandilipay and Urumpirai in Jaffna district. The grape bunches were collected when all the berries in the bunch were fully ripen and physical, chemical and sensory parameters were recorded. The data were subjected to analysis of variance and means of the different treatments were compared using least significant difference test. The analyses were performed using SAS statistical packages at $\alpha = 0.05$. Berries received GA_3 by spraying with plunging method recorded the highest berry weight, berry diameter, heaviest bunches and highest yield per vine compare to other treatments and control. Gibberellic acid treated berries recorded high total soluble solids, pH and lower titrable acidity compare to control. Based on sensory characters, gibberellic acid treated by spraying or by spraying with plunging scored high for taste, aroma, flavour and berry color. Both spraying and spraying along with plunging in different growing stage improved quality of Israel blue berry significantly compare to other treatments. Based on the economic analysis and feasibility of adaptation by farmers, spraying method is recommended as suitable method for the application of GA_3 to improve the berry quality and yield of Israel blue cultivar grapes in Jaffna district.

Keywords: Grapes, Berries quality, Berries yield, Gibberallic acid

INTRODUCTION

Grape (*Vitisvinifera*L.) is one of the important sub-tropical, earliest fruits known to mankind and is grown for its juicy and tasty berries. It is one of the commercially important fruit crops grown in Jaffna and is cultivated in 178 ha with a total production of 2498 metric tons with productivity of 17 tons/ha in Jaffna district (Agriculture extension service, 2012/2013). Israel blue is the cultivar, mainly cultivated by Jaffna farmers.

Though Jaffna farmers face many constraints in marketing of grapes because of poor quality berries this is mainly due to excessive fruit set. It may cause the growing berries to become tightly packed into compact clusters which are highly susceptible to rot disease. Berry quality and size are affected by many factors like hormones, nutrients and environmental factors (Ollat *et al*. 2002). To overcome this problem, severa1 cultural practices adopted in grape production include the use of plant growth regulators. Among the compounds used as plant regulators, gibberellc acid (GA_3) has been extensively used and was proven to have effect on reducing cluster compactness of grapes by reducing fruit set and allowing for the development of large, un crowded berries (Korkutal *et al*., 2007; Dimovska *et al*., 2011).

The application of gibberellc acid (GA_3) is made either by spraying or bunch plunging in different concentrations at different stages of berry development, depends on cultivar and the climatic condition (Abu-Zahra, 2013).

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Considering the positive effect of GA_3 on berry quality a study was carried out in Jaffna district with the objectives of improve the quality of grape berry to meet market standard and to study the effect of different GA_3 application methods on berry quality of grapes and physical, chemical and organoleptic properties of grapes with the application of GA_3.

METHODOLOGY

The trial was conducted at three AI divisions of Sandilipay, Thellipalai and Urumpirai in Jaffna district. Two to three years old healthy and vigorous vines of Israel blue seeded variety was selected. The experiment design was randomized complete block design (RCBD) with a single grape vine as an experimental unit with four treatments and six replicates. The plants were grown in Pandhal trellis system in the experimental vineyard. GA_3 was applied extensively to vine clusters of Israel blue. The experiment had four treatments.

In treatments 1and 2, Plunging and Spraying was done as 5 ppm of GA_3 at pre-bloom stage, 10 ppm, 15 ppm, 40 ppm and 30 ppm of GA_3 solution at 2^{nd}, 4^{th}, 6^{th} and 8^{th}weeks after blooming respectively.

In treatment 3, first two application was done by spraying of 5ppm of GA_3 at 2^{nd} week after blooming and 10ppm of GA_3 at 3^{rd} week after blooming and last three applications were done by plunging the berries at 15ppm, 40ppm and 30ppm GA_3 concentrations at 4^{th}, 6^{th} and 8^{th} week respectively after blooming.

Table1. *Different Methods of GA_3Applications as Treatments*

Treatments	Methods of GA_3 applications
Treatment 1	Plunging
Treatment 2	Spraying
Treatment 3	Combination of plunging and spraying
Treatment 4	Control (no gibberalic acid application)

Treatment 4, the berries were untreated with GA_3 (control).

The treated grape bunches were harvested separately when all berries in the bunch were fully ripen and randomly selected three berries per bunch for sensory evaluation and six cluster per vine for physical and chemical analysis.

Physical Parameters

Number of bunches per vine and number of berries per cluster were counted at harvesting time. Cluster length was measured from the point of attachment of stalk to the last berry end as linear distance. Berry diameter was determined by using Vernier calipers. Weight of harvested cluster and individual berry were measured**.**

Chemical Parameters

Percentage of total soluble solids (TSS %) was determined by using Refractometer (0-30^o Brix range). The values were corrected at 20^{o}C and expressed as Brix (Anonymous, 2007). The titrable acidity was determined by acid-base titration method. The titrable acidity percentage was expressed as grams of tartaric acid per 100ml of juice (Weaver and Winker, 1952). pH value was measured by using pH meter (Hach 5010T).

Organoleptic Parameters

Sensory panel had forty members. Evaluation cards were given to members in sensory panel for assessing the berries color, taste, flavor and aroma. Taste, flavor, skin color and aroma were evaluated and each was scored using hedonic scale (IPGRI) and analyzed in SAS package using Friedman's two way non-parametric ANOVA. The differences between means of different treatments were compared by Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Organoleptic Properties

The application of gibberellic acid (GA_3) is generally effective on increasing the anthocyanin content of grape (Peppi *et al*., 2006).The content of anthocyanin in the skin influences on the organoleptic characteristics of table grape varieties and the time of harvesting.

The grapes which are used either as fresh or for decorative purpose are designated as table grapes and they must be attractive in color, good taste, flavor and aroma. These can be analyzed by sensory evaluation.

Based on the sensory panel evaluation (table2) for taste, the plunging treatment was scored the highest mean (3.20) and differed from control and spraying treatment and there are no significant differences with the combination of plunging and spraying treatment.

Table2. *Effect of Different Methods of GA_3Treatments on Sensory Characters of Grape Berries*

Treatments	Taste	Aroma	Flavor	Berry color
Control	1.07^{c}	3.14^{a}	1.07^{c}	1.32^{c}
Plunging	2.70^{b}	2.46^{b}	2.67^{b}	$2,62^{b}$
Spraying	3.20^{a}	2.81^{ab}	3.18^{a}	2.98^{ab}
Spraying with Plunging	3.01^{ab}	3.14^{a}	3.06^{a}	3.06^{a}

Means with same letter are not significantly different at 5%

Aroma scored high average rating (3.14) in the combination of plunging and spraying treatment and it significantly differed with plunging and untreated (control)and non- significantly differed with spraying treatments. Non- significant differences were obtained between plunging and spraying.

Flavor score was higher in all treatments in comparison to untreated (control) grape vines. Highest flavor score (3.18) was obtained in spraying treatment and the significant differences were observed in plunging and spraying treatments and non-significant difference were obtained in the combination of plunging and spraying treatment.

Berry color scored high average rating (3.06) in combination of plunging and spraying treatment and significant difference was obtained in plunging and control treatments and non-significantly differs with spraying treatment. Non-significant difference was obtained between plunging and spraying treatments.

Physical Properties of Grapes

Berry Diameter and Individual Berry Weight

Table3. *Effect of Different Application Methods on Weight and Diameter of Grape Berries*

Treatments	Berry weight (g)	Berry diameter (cm)
Control	3.72^{c}	15.95^{c}
Plunging	4.68^{a}	19.41^{a}
Spraying	4.24^{b}	18.57^{b}
Spraying with Plunging	4.85^{a}	19.66^{a}

Means with same letter are not significantly different at 5%

The increased berry mass is a result of the enhanced cell division and cell expansion. Berry diameter was increased with the application of GA_3in all treatments irrespective of application method compare to control. As the results given in the table 3, combination of plunging and spraying treatment resulted larger berries size and higher individual berry weight which was significantly differed with other treatments except spraying treatment. A similar result of gibberellic acid on cluster and berry weight was shown by Hyunggook *et al*. (2008).

Number of Berries per Cluster

As results show in table 4, berries numbers were low in all treatments in comparison to the control grape vine. The highest berries number (62.55) was obtained in control treatment and significant difference was observed among the all treatments. This might be due the effect of GA_3 on reducing cluster compactness (Korkutal *et al*., 2007; Dimovska *et al*., 2011).

Weight of Cluster

Statistical analysis showed that significant differences were observed between all treatments. Even though, the highest cluster weight (297.67g) was obtained in combination of plunging and spraying treatment and the lowest weight (210.35 g) was obtained in control bunches. This coincides with earlier observations of Abu-Zahra (2013)who showed plunged in 80 mgl^{-1} GA_3, showed significantly larger clusters than the control treated ones.

Length of Cluster

The longest bunch (22.9cm) was obtained in the combination of plunging and spraying treatment, but non-significant difference was observed ins praying treatment. It differed significantly with control and plunging treatment. The shortest bunch (16.13cm) was obtained in control.

Total Yield per Vine

Vine per yield was increased in all treatment in comparison to the control. Non-significant difference was observed between the treatments of spraying and plunging but significantly differed with combination of plunging and spraying treatment (Table 4). The highest yield (13.29 kg) was obtained in the combination of plunging and spraying treatment. (Dimovska *et al*., 2011) got the same results in his study as GA_3 increase the weight of the cluster and the number of fertilized berries, thus increasing the yield of berries.

Table4. *Effect of Different Methods of GA_3 Application on Physical Properties of Grapes*

Treatments	Number of berries/cluster	Cluster weight (g)	Cluster length (cm)	Yield (kg)
Control	62.55^{a}	210.35^{d}	16.13^{c}	8.05^{c}
Plunging	51.99^{c}	249.02^{c}	18.25^{b}	10.86^{b}
Spraying	57.63^{b}	268.25^{b}	22.83^{a}	11.38^{b}
Spraying with Plunging	55.11^{d}	297.67^{a}	22.90^{a}	13.29^{a}

Means with same letter are not significantly different at 5%

Analysis of Chemical Properties of Grapes

Table5. *Effect of Different GA_3Application Methods on pH, Titrable acidity and Total Soluble Solids*

Treatments	pH	Titrable acidity %	Total Soluble Solids ^{o} Brix
Control	3.31^{b}	0.61^{a}	15.56^{c}
Plunging	3.61^{a}	0.43^{b}	16.63^{b}
Spraying	3.68^{a}	0.35^{c}	17.28^{a}
Spraying with Plunging	3.62^{a}	0.41^{bc}	16.80^{ab}

Means with same letter are not significantly different at 5%

Total Soluble Solid (TSS) content is an important tool used to indicate the ripeness and the quality of fruits besides the total sugars. Increase in sugars and TSS increases the quality of the produce. Total soluble solids were increased in all treatments compared to the control treatment. Highest Brix value (17.28) was obtained in spraying treatment without significant difference in combination of plunging and spraying treatment. Significant difference was obtained in control and plunging treatment. The plunging treatment was showed significant difference with control and spraying treatment and no any significant difference with combination of plunging and spraying treatment (Table 5).Application of GA_3 increased the TSS by increasing the capacity of grape berries to draw more carbohydrates through increased endogenous auxin content directly or indirectly due to the quick metabolic transformation in soluble compounds (Singh, 1993).

The highest titrable acidity percentage (0.61%) was obtained in control and it significantly differed with all other treatments.

The average pH among the all treatments except control was not significantly differed. Spraying treatment had the highest (3.68) pH value. The control treatment was significantly differed from all other treatment and showed lowest pH (3.31) value. Similar results were obtained by Morris (1987).

CONCLUSION

The quality of berries could be improved by the application of plant growth regulator GA_3 in grapes. Results obtained in chemical and sensory analysis showed that's praying and plunging treatments were better than the combination of plunging and spraying treatment and control. Based on the physical parameter, best performance was recorded in the combination of plunging and spraying treatment. Based on the chemical parameters spraying treatment was superior to the combination of plunging and spraying treatment. Sensory evaluation scores were more or less equal for these two treatments (spraying and combination of plunging and spraying treatment).Based on the economic analysis and feasibility of adaptation by Jaffna farmers, spraying method is recommended as the

suitable method for the application of GA_3 to improve the berry quality and yield of Israel blue cultivar grapes in Jaffna district.

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