*J. Plant Production, Mansoura Univ., Vol. 10 (2): 101 - 105, 2019*

# Effect of Exogenous Abscisic Acid (ABA), Gibberellic Acid ($GA_3$) and Cluster Thinning on Yield of some Grape Cultivars

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## ABSTRACT

Experiment was carried out throughout two successive seasons of 2016 and 2017 on Flame Seedless, Ruby Seedless and Thompson Seedless grapevines grown at the Experimental Orchard of Assiut University, Faculty of Agriculture. The aim of this study was to assess the impacts of abscisic acid (ABA), cluster thinning and their combinations with $GA_3$ on yield weight of three important grape cultivars grown under hot region. Data revealed that, the application of abscisic acid (ABA) increased yield weight (kg/vine), while cluster thinning decreased it. During the 1st season of study (2016), all individual ABA treatments and ABA at 400 ppm combined with $GA_3$ at 10 ppm significantly increased yield weight (kg/vine) comparing with the control treatment. As a result of ABA treatments at 200, 400 and 600 ppm and ABA at 400 ppm plus $GA_3$ at 10 ppm, the yield was increased by 15.5%, 10.5%, 9.8% and 9.2%, respectively. During the 2nd season of study (2017), only ABA at 600 ppm treatment significantly surpassed the control treatment with an increment percentage of 20.5%. The rest of treatments either had no effect or reduced the yield weight comparing with the control. On the other side, cluster thinning by removing 30% of the total clusters that the vine bearing significantly reduced the yield weight (kg/vine) during the two studied seasons. As a result of such treatment, the yield was reduced by 37.2% and 39.2% in 2016 and 2017 seasons, respectively.

**Keywords:** Grape, *Vitis vinifera*, ABA, Cluster thinning, Yield.

## INTRODUCTION

Grape is the most important fruit crop in the world either for fresh consumption or for processing. World cultivated area devoted for grapes reached about 7.5 million hectares produced about 67 million tons (FAO, 2015). According to the FAO, 75.866 square kilometers of the world land are consecrated to grapes. Almost 71% of world grape production is used for wine making, 27% as table grapes and 2% raisin. In Egypt, grape occupies the second position after citrus, production and exportation. The total area devoted for grape was 199212 feddans, while the fruiting area of it was 184254, which produced about 1691194 tons (Yearly Book of Statistic and Agricultural Economic Department, 2016).

Abscisic acid is a plant growth regulator discovered about 70 years ago. It plays an essential role in many physiological processes in plants including the adaptation of trees to many harsh environmental stresses, seed and bud dormancy and fruit growth and development (Setha, 2012). ABA controls stomatal closure, which is an essential process that limits gas exchange and thereby affects indirectly the photosynthesis (Berli and Bottini, 2013). Reduce of water lose, inhibit growth, and induce adaptive responses are functions related to stomatal closure of plant leaves.

Cluster thinning has been used for increasing berry and cluster weight and improving the quality of various grape cultivars especially the seedless ones. It applied alone or in combination with $GA_3$ treatments (Zhao *et al.*, 2006; Mohamed and Shaaban, 2008; Damota *et al.*, 2010; El-salhy *et al.*, 2010; Mohsen, 2015 and Bogicevic *et al.*, 2015).

Gibberellins (GAs) are plant growth regulators widely used on many table grape cultivars for improving the eating quality as well as yield of the grapevine. Gibberellin action mostly works on stimulation of cell elongation and division, especially for seedless cultivars. The compound generally used is the gibberellic acid ($GA_3$). The effectiveness of $GA_3$ depends on the cultivar, concentration used and time of application. Gibberellic acid mostly applied several weeks before full bloom of seedless grapes to elongate the main cluster stem. This practice is mostly used on Thompson seedless grapes (Jawandg *et al.*, 1974; Hassan, 2002; Gowda *et al.*, 2006; El-salhy *et al.*, 2009; Dimovska *et al.*, 2011 and Kanthi-kumar and Sharma, 2016).

The aim of this study was to assess the impacts of abscisic acid (ABA), cluster thinning and their combinations with $GA_3$ on yield weight of three important grape cultivars grown under hot region.

## MATERIALS AND METHODS

Experiment was carried out throughout two successive seasons of 2016 and 2017 on Flame seedless, Ruby seedless and Thompson seedless grapevines grown at the Experimental Orchard of Assiut University, Faculty of Agriculture. The grapevines age were 17 years old at the beginning of the experiment and they were planted at 1.6 X 1.3 m apart trained according to the bilateral double cordon system. Sixty-five uniform grapevines (13 treatments x 5 replications) of each cultivar were chosen .All grapevines were planted in clay soil, and received the same horticultural managements.

Abscisic acid (ABA) treatments were applied to the surface of grape cluster at the beginning véraison. As well as, cluster thinning was applied individually or in combination with either ABA and/or $GA_3$.

The plant growth regulators (PGRs) were applied directly to the clusters with a handheld sprayer until runoff. The cluster thinning was executed by removing 10, 20 and 30 % from all clusters on the vines. Grapevines were sprayed with $GA_3$ at 10 ppm when the cluster length reached about 8-10 cm. The treatment categories were:

1. Spraying with abscisic acid (ABA) at 200 ppm.
2. Spraying with abscisic acid (ABA) at 400 ppm.
3. Spraying with abscisic acid (ABA) at 600 ppm.
4. Spraying with gibberellic acid ($GA_3$) at 10 ppm + cluster thinning at 10%.
5. Spraying with gibberellic acid ($GA_3$) at 10 ppm + cluster thinning at 20%.
6. Spraying with gibberellic acid ($GA_3$) at 10 ppm + cluster thinning at 30%.

7. Cluster thinning at 10 %.
8. Cluster thinning at 20 %.
9. Cluster thinning at 30 %.
10. Spraying with Abscisic acid (ABA) at 400 ppm + spraying with Gibberellic acid ($GA_3$) at 10 ppm.
11. Spraying with Abscisic acid (ABA) at 400 ppm + cluster thinning at 20%.
12. Spraying with Abscisic acid (ABA) at 400 ppm + spraying with Gibberellic acid ($GA_3$) at 10 ppm + cluster thinning at 20%.
13. Control – spraying with water.

At harvest date in both seasons, clusters per each vine were collected and weighed to determine the yield components weight (kg/vine).

**Statistical analysis:**

Data were analyzed as a split plot design where the treatments in the sup plot and the cultivars in the whole plots. The analysis of variance (ANOVA) was conducted according to the method described by Snedecor and Cochran (1989). Means were compared using the least significant differences (LSD) values at 5% level of the probability.

## RESULTS AND DISCUSSION

**Results**

Application of Abscisic acid (ABA) increased yield weight (kg/vine), while cluster thinning decreased it (Table 1 and Fig.1).

**Table 1. Effect of Abscisic acid, cluster thinning and Gibberellic acid applications on yield weight (Kg/Vine) of Flame Seedless, Ruby Seedless and Thompson Seedless grape cultivars during 2016 and 2017 seasons.**

| Cultivars / Treatment | Yield weight (Kg/Vine) | | | | | | Mean (T) | |
|---|---|---|---|---|---|---|---|---|
| | Flame Seedless | | Ruby Seedless | | Thompson Seedless | | | |
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| ABA 200 p.p.m | 11.28 | 15.75 | 12.49 | 13.73 | 5.51 | 7.66 | 9.76 | 12.38 |
| ABA 400 p.p.m | 11.29 | 16.47 | 10.91 | 14.94 | 5.81 | 6.41 | 9.34 | 12.61 |
| ABA 600 p.p.m | 10.25 | 16.14 | 11.84 | 17.55 | 5.73 | 9.50 | 9.27 | 14.40 |
| $GA_3$ 10 p.p.m + 10% Cluster Thinning | 8.02 | 13.39 | 8.95 | 11.94 | 5.93 | 7.57 | 7.63 | 10.97 |
| $GA_3$ 10 p.p.m + 20% Cluster Thinning | 7.07 | 14.30 | 8.34 | 13.16 | 5.25 | 8.03 | 6.89 | 11.83 |
| $GA_3$ 10 p.p.m + 30% Cluster Thinning | 7.56 | 10.85 | 8.86 | 14.98 | 3.69 | 5.08 | 6.70 | 10.30 |
| 10% Cluster Thinning | 9.71 | 14.20 | 8.17 | 11.44 | 6.82 | 4.28 | 8.23 | 9.97 |
| 20% Cluster Thinning | 8.63 | 12.04 | 8.22 | 10.86 | 5.86 | 5.24 | 7.57 | 9.38 |
| 30% Cluster Thinning | 7.17 | 10.42 | 6.08 | 10.55 | 5.23 | 4.78 | 6.16 | 8.58 |
| ABA 400 p.p.m + $GA_3$ 10 p.p.m | 9.25 | 15.21 | 12.51 | 14.44 | 5.93 | 4.97 | 9.23 | 11.54 |
| ABA 400 p.p.m + 20% Cluster Thinning | 8.11 | 15.42 | 10.89 | 12.47 | 4.88 | 8.33 | 7.96 | 12.07 |
| ABA 400 p.p.m + $GA_3$ 10 p.p.m + 20% Cluster Thinning | 7.55 | 12.45 | 8.13 | 14.13 | 5.13 | 8.00 | 6.94 | 11.53 |
| Control | 9.26 | 15.49 | 10.19 | 13.33 | 5.91 | 7.00 | 8.45 | 11.94 |
| Mean (C) | 8.86 | 14.01 | 9.66 | 13.35 | 5.51 | 6.68 | 8.01 | 11.35 |

| LSD 0.05 (2016) | LSD 0.05 (2017) |
|---|---|
| (T) = 0.51 | (T) = 0.84 |
| (C)= 0.29 | (C)= 0.52 |
| (TxC)= 0.99 | (TxC)= 1.74 |

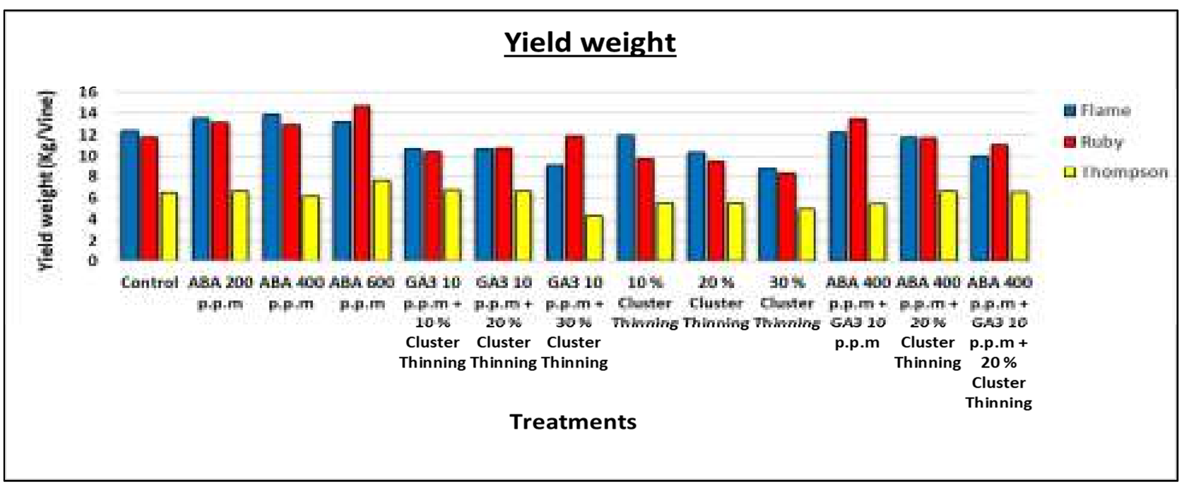


**Fig. 1. Effect of Abscisic acid, cluster thinning and Gibberellic acid applications on yield weight (Kg/Vine) of Flame Seedless, Ruby Seedless and Thompson Seedless grape cultivars (two seasons average data).**

During the 1st season of study (2016), all individual ABA treatments and ABA at 400 ppm combined with $GA_3$ at 10 ppm significantly increased yield weight (kg/vine) comparing with the control treatment. As a result of ABA treatments at 200, 400 and 600 ppm and ABA at 400 ppm plus $GA_3$ at 10 ppm, the yield was increased by 15.5%, 10.5%, 9.8% and 9.2%, respectively. During the 2nd season of study (2017), only ABA at 600 ppm treatment significantly surpassed the control treatment with an increment percentage of 20.5%. The rest of treatments either had no effect or reduced the yield weight comparing with the control. On the other side, cluster thinning by removing 30% of the total clusters that the vine bearing significantly reduced the yield weight (kg/vine) during the two studied seasons. As a result of such treatment, the yield was reduced by 37.2% and 39.2% in 2016 and 2017 seasons, respectively.

Data presented in Table 1 and Fig. 1 revealed that Ruby seedless grape cultivar significantly surpassed the other two cultivars in 2016 season, while in 2017 season Flame seedless significantly impacted yield comparing with the other two cultivars. However, Thompson seedless produced the lowest yield (kg/vine) in both seasons of study.

The interaction effect of 2016 season showed that the application of ABA at 400 ppm combined with $GA_3$ at 10 ppm followed by ABA at 200 ppm and then ABA at 600 ppm of Ruby seedless cultivar gave the highest yield weight (kg/vine). In 2017 season, application of ABA at 600 ppm on Ruby seedless and ABA at 400 ppm and 600 ppm on Flame Seedless produced the highest yield weight (kg/vine).

Two seasons average data (Fig. 1) revealed that, ABA treatments increased yield weight (kg/vine) comparing with the control while cluster thinning decreased it in the three grape cultivars.

**Discussion**

The application of ABA individually or combined with $GA_3$ led to a significant increase in yield weight during the $1^{st}$ season while ABA at 600 ppm was the only impacted treatment in 2017. The increase of yield weight in this study was closely correlated with water accumulation in the berries due to ABA application. Nakagawa *et al.* (1980) found that the number of stomata on the berry surface was different among grape cultivars but the average was found to be 16 stomata. Application of ABA rapidly reduced the rate of apparent photosynthesis by regulating stomatal opening (Pharis and Reid, 1985). Stomata developed in grapes two weeks after anthesis and consisted of small and compacted cells (Blanke *et al.*, 1999). The increase yield weight found in the present study primarily was due to the ability of ABA to close the stomata, subsequently decrease the transpiration rate and reflected on the increase, of water accumulation in berries. Transpiration of the grape berry was happened from anthesis until the fruit maturation (Blanke and Leyhe, 1987). The current study was executed at a very hot region, so, it is expected that a higher transpiration rate from the vines comparing with such vines if planted in cold or moderate weather regions.

Accordingly, the application of ABA on vines planted in hot regions has more impact than its impact on cold regions. These results were accordant with that reported by Quiroga *et al.* (2009). They found that ABA increased both yield and cluster weight and concluded that ABA promoted allocation of photo assimilates to the berries. Our results also came on line with that reported by Peppi and Fidelibus (2008) on Flame seedless grape cultivar and Lurie *et al.* (2009) on Crimson Seedless grapes. They demonstrated that ABA significantly increased berry weight. On the other side, González *et al.*, 2012; Ferrara *et al.*, 2015 and Reynolds *et al.*, 2016 and other investigators found that ABA had not a significant effect on yield components or berry weight.

Cluster thinning alone or combined with $GA_3$ or ABA either decreased the yield weight or had no effect. However, it had a remarkable effect on the cluster weight, but such increase did not completely compensate the decrement in the yield weight. Our results concerning the effect of cluster thinning on yield weight and cluster weight have been confirmed by many workers (Looney and Wood, 1977; Looney, 1981; Kaps and Cahoon, 1989; Ferree *et al.*, 2003; Dami, 2005; Reynolds *et al.*, 2007; Gil-Muñoz *et al.*, 2009; El-salhy *et al.*, 2009; Kamiloglu, 2011; Zhuang *et al.*, 2014 and Bogicevic *et al.*, 2015), they found that cluster thinning of grape cultivars reduced yield. Naor *et al.*, 2002; Sun *et al.*, 2012 and Rescic *et al.*, 2015 noted that the reduction of yield weight resulted from cluster thinning led to a significant increase of cluster weight. Cluster thinning reduced yield weight by about 20-40% depending on thinning severity and/or the cultivar, (Palliotti and Cartechini, 1998; Guidoni *et al.*, 2002; El-salhy *et al.*, 2010; Kok, 2011; Gil *et al.*, 2013 and Vicente and Yuste, 2015). The later accordant with the findings of current study which found that the severe cluster thinning by removing 30% of the clusters reduced yield by 37.2 and 39.2% in the two season of study. On the other side, $GA_3$ combined with cluster thinning had not a significant effect on yield weight.

Our results also showed that the total harvested yield was greater in the second season of study comparing with the first one and that Thompson seedless produced lesser yield comparing with Ruby or Flame seedless cultivars. The later may be due to that Thompson seedless characterized by a lower fertility than that of the other two cultivars.

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## تأثير اضافة حامضى الابسيسيك والجبريليك وخف العناقيد على المحصول فى بعض أصناف العنب

**أيمن كمال أحمد محمد ، عبد الفتاح مصطفى الصالحى ، رأفت أحمد على مصطفى ، مروه طلعت المهدى و عزه سامى حسين**
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أجريت هذه التجربة خلال موسمين متتالين 2016-2017 على أصناف العنب الفليم سيدلس والروبى سيدلس والطومسون سيدلس المزروعة بمزرعة أبحاث كلية الزراعة جامعة اسيوط. وكان الهدف من الدراسة هو تقييم تأثيرات حامض الابسيسيك وخف العناقيد وتراكيب منهما مع حامض الجبريليك على وزن المحصول لثلاثة أصناف من الاعناب الهامه التى تنمو فى المناطق الحاره. وقد أظهرت البيانات أن المعاملة بحامض الابسيسيك (ABA) أدت الى زيادة فى وزن المحصول (كجم/ كرمه) بينما قلل خف العناقيد من ذلك. ففى خلال الموسم الاول من الدراسة (2016) أدت كل معاملات حامض الابسيسيك المنفرده وكذلك حامض الابسيسيك عند 400 جزء فى المليون + حامض الجبريليك عند 10 جزء فى المليون الى زيادة معنوية فى وزن المحصول (كجم/ كرمه) مقارنة بمعاملة الكنترول. وكنتيجة لمعاملات ABA عند 200 و 400 و 600 جزء في المليون و ABA عند 400 جزء في المليون + حامض الجبريليك ($GA_3$) عند 10 جزء في المليون زاد وزن المحصول بنسبة 15.5 ٪ , 10.5 ٪ , 9.8 ٪ و 9.2 ٪ على التوالي. وخلال الموسم الثاني من الدراسة (2017) تفوقت معاملة حامض الابسيسيك عند 600 جزء في المليون معنويا على معاملة الكنترول بنسبة زيادة 20.5 ٪. فى حين بقية المعاملات لم يكن لها أي تأثير أو قللت من وزن المحصول مقارنة مع معاملة الكنترول. من ناحية اخرى سبب خف العناقيد بازالة 30 % من مجموع العناقيد المحمولة على الكرمة نقص معنوى فى وزن المحصول (كجم/ كرمه) خلال موسمى الدراسة.وكنتيجة لهذه المعاملة قل وزن المحصول بنسبة 37.2 ٪ و 39.2 ٪ في موسمى 2016 -2017 على التوالى.