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# EFFECT OF GIBBERELLIC ACID AND SUCCINIC ACID ON RUBY SEEDLESS GRAPEVINES: 1- VEGETATIVE GROWTH AND PRUNING WOOD WEIGHT OF VINES

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## ABSTRACT

**This study was carried out during the three successive seasons of, 2004, 2005 and 2006 to assess the relative benefits of spraying $GA_3$ and succinic acid on vegetative growth of Ruby Seedless grapevines, grown in a vineyard at Faculty of Agriculture, Assiut University, Egypt. Different concentrations of $GA_3$ (5, 10, 15 and 20 ppm) and succinic acid (50, 100, 150 and 200 ppm) were sprayed when cluster length reached about 10-12 cm. Selected vines were pruned leaving 48 buds/vine (16 fruiting spurs, 3 buds each).**

**Results showed that all $GA_3$ treatments increased significantly the shoot length and thickness, internode length and pruning wood weight /vine as well as leaf area and its contents of chlorophyll A and B compared to untreated ones. Also, all succinic acid concentrations significantly improved such traits. The maximum values on such traits were detected on vines, sprayed with either $GA_3$ at 10 ppm or succinic acid at 100 ppm compared to other treatments.**

**In conclusion, it can be recommended to spraying 10 ppm of $GA_3$ or 100 ppm of succinic acid when the cluster length reached 10-12 cm to increase leaf surface expansion ,hence, improve the vine vegetative growth and vigor as well as pruning wood weight/vine, therefore, it can be easy date (mined the favorable bud load/vine).**

## INTRODUCTION

Grapes are the most widely produced fruit in the world. In Egypt, grape is one of the most important fruit crops after citrus. It is mainly consumed as fresh grape.

Gibberellic acid seemed to be very effective in enhancing growth and fruit development especially in seedless grapevine cultivars through its important role in enhancing cell division, cell elongation and regulating the availability of water and nutrients (Moore, 1979). $GA_3$ applications at 10, 20 and 50 ppm pre bloom to some grape cvs increased shoot length, thickness and pruning wood weight. The chlorophyll content decreased temporarily following treatment with the higher concentrations, but, the leaf area increased (Hagiwara *et al.*, 1980; Dzagnidze *et al.*, 1986 and Mahmoud, 1989). $GA_3$ at 25, 40 or 50 ppm applied either at pre bloom or after flowers initiation resulted in a significant increase in shoot length, thickness and pruning wood weight of Thompson Seedless grapevines, also, $GA_3$ increased significantly the leaf growth parameters (Abdel-Kawi *et al.*, 1992, Marzouk *et al.*, 1998, Nomier, Safaa, 2000 and Hassan, 2002).

Succinic acid plays a significant role in intermediary metabolism (Krebs cycle) in plants. Kreb's cycle is a sequence process of enzymatic reaction in which two carbon acetyl unit is oxidized to carbon dioxide and water to provide energy in the form of high-energy phosphate bonds (ATP). There is no available literature concerning succinic acid effects on vegetative growth of fruit trees, but on some plants i.e. cauliflower and safflower. Succinic acid significantly increased the vegetative growth of cauliflowers, and maximum growth was obtained by applications of 500 ppm (Bijarnia and Dixit, 1996). $GA_3$ at 50 ppm and succinic acid at 1% showed an increase in the branches and capitula number per plant, and harvest index of safflowers (Dholekar *et al.*, 2001).

The present investigation aimed mainly to assess the relative benefits of $GA_3$ and succinic acid foliar spray on vegetative growth of Ruby Seedless grapevines to solve some problems which face the growers of this cultivar.

## MATERIALD AND METHODS

This investigation was carried out during the three successive seasons of 2004 to 2006 on Ruby Seedless grapevines, grown in a vineyard at Faculty of Agriculture, Assiut University, Egypt.

Thirty-six vines, 14 years old, were chosen according to their similarity in growth and vigor. The vines were trained as the double bilateral cordon system with a total buds load of 48 buds/vine (16 fruiting spurs, 3 buds each) and the trellis system was traditional three wires. The chosen grapevines were subjected to normal horticulture practices, except the testing of different treatments.

The experiment design was a randomized complete block with four replicates, one vine each. $GA_3$ was sprayed at 5, 10, 15 and 20 ppm, and succinic acid was sprayed at 50, 100, 150 and 200 ppm and untreated vines were sprayed with water as control. All vines were spayed when cluster reached about 10-12 cm (pre-bloom). $GA_3$ and succinic acid solutions were prepared by dissolving the assigned amount in the required water. The vines received both $GA_3$ and succinic acid solutions ran off using trition B as a wetting agent at a concentration of 0.1%.

Five main shoots per vine during each growth season were labeled, for growth measurements at growth cessation of each studied seasons. Vegetative growth parameters were assessed as follows:

- Lengths of main shoots (cm) were recorded by measuring the length of labeled shoots per vine and then the average shoot length was calculated.
- Main shoots diameter (mm) was measured by recording the average of the diameter of shoot between the third and fourth basal nods by using vernier caliper.
- Average internodes length were estimated by dividing the ultimate shoot length by number of the internodes per shoot.
- Number of leaves/shoot.
- Average leaf area (cm) was estimated by weighting ten mature leaves at the opposite site of the first cluster on the labeled shoots from each vine. Weighting 40 sections of 0.7 $cm^2$ and then the average leaf area was calculated according to the following equation:

$$Average\ leaf\ area\ (cm^2) = \frac{Leaves\ weight\ (g)\ x\ 2.8}{Section\ weight\ (g)}$$

- Chlorophyll A & B was determined by cutting mature leaf samples (the 4th and 5th leaves) into small pieces. Grinding samples of 0.2 g in a mortar with 85% aqueous acetone in the presence of little amount of $Na_2Co_3$ and silica quartz, then filtered through central glass funnel $G_4$. The optical density of the filtrate was determined using Carl-Zeis spectrophotometer at wave length of 662 and 644 nm according to Metzner *et al.* (1965).
- Pruning wood weight (kg) vine was estimated by weighting the removal one year old wood, after winter pruning, as an indicator for vine vegetative growth vigor in the previous seasons.

All obtained data were tabulated and subjected to the proper statistical analysis according to Gomez and Gomez (1984) and Snedecor and Cochran (1990) using the L.S.D. test at 0.05 level for distinguishing the significance differences between treatment means.

## RESULTS AND DISCUSSION

**Effect on main shoot growth:**

It is evident from the data in Tables 1 and 2 that all $GA_3$ treatments significantly increased the shoot length, thickness and internodes length. The maximum values of such traits were detected on vines, which sprayed with 10 ppm of $GA_3$ compared to other $GA_3$ treatments. The increment percentage of shoot length attained were 17.62, 32.98, 22.59 and 18.98% as an average of the three studied seasons due to $GA_3$ sprayed at 5, 10, 15 and 20 ppm, respectively. The corresponding increments of shoot thickness were 23.28, 32.88, 19.18 and 8.22%, and the values for internodes were 6.0, 10.33, 4.00 and 5.00% ,with $GA_3$ concentrations respectively. These findings emphasized that $GA_3$ seemed to be very effective in enhancing growth of seedless grapevine cultivars through their important role in enhancing cell division, cell elongation and regulating the availability of water and nutrients (Moore, 1979).

Spraying succinic acid at 50 or 100 ppm significantly improved shoot length, thickness and internodes length than the unsprayed ones. However, both 150 or 200 ppm concentrations failed to show any significant effect on such traits. The improvement of shoot growth may be due to the significant role of succinic acid in intermediary metabolism and consequently acceleration the formation of both proteins and carbohydrates.

It is also clear that $GA_3$ was more effective on such traits compared to succinic acid. Generally, all treatments increased the shoot growth parameters, which resulted in pronounced increase in vegetative growth.

**Effect on pruning wood weight/vine:**

Pruning wood is the end results of the vine growth through the previous season, which indicated to a great extent the activity of the vine in building up storage material through the previous season. Therefore, pruning wood is taken as a parameter to indicate the degree of vine response to the different $GA_3$ and succinic acid. It is clear from Table 2, that pruning wood weight took similar trend in respond to all treatments during the three experimental seasons. All $GA_3$ treatments significantly increased pruning wood weight/vine. Spraying $GA_3$ at 10 ppm gave the heaviest weight of pruning wood than other $GA_3$ concentrations.

All tested concentrations of succinic acid significantly increased the weight of pruning wood/vine. The highest values were recorded on vine sprayed with 100 ppm of succinic acid. The increment percentages of pruning wood over the untreated vine were 35.47, 70.54, 59.07, 57.51 , 12.43, 20.20, 8.48 and 7.95% as average of the three studied seasons due treatment with $GA_3$ at 5, 10, 15 & 20 ppm and succinic acid at 50, 100, 150 and 200 ppm concentrations, respectively.

These could be attributed to plant growth regulators role in producing new cell and tissues, as well as, the positive role of succinic acid in increasing the vegetative growth. Since the increase in weight of pruning wood could be used as an indicator to the vine vigor during the previous seasons. It might refer also to the possibility of high

productive ability of the vine during the following season.

It could be concluded that all $GA_3$ treatments and succinic acid at 100 ppm were effective in improving vine vigour, expressed as an increase in the weight of one-year-old wood pruning.

The results were confirmed earlier by Dzagnidze *et al.* (1986), Mahmoud (1989), Abdel-Kawi *et al.* (1992), Marzouk *et al.* (1998).

**Effect on grape leaf characters:**

Data concerning leaf number/shoot, leaf-area ($cm^2$) and chlorophyll A & B in leaves as affected by $GA_3$ or succinic acid are presented in Tables 3 and 4. The results indicate that all $GA_3$ treatments caused a significant increase in leaves number per shoot. Maximum number of leaves per shoot was detected in vines sprayed with $GA_3$ 10 ppm. The increment percentages of leaves number due to $GA_3$ spraying were 8.31, 15.01; 11.28 and 3.19% as an average of the three seasons, as compared to unsprayed ones, respectively. Succinic acid at 100 ppm improved leaves number, whereas, succinic acid at 150 and 200 ppm (unsignificnatly) decreased it.

**Table 1: Effect of spraying $GA_3$ and succinic acid on shoot length and shoot diameter of Ruby Seedless grapevines during 2004, 2005 and 2006 seasons.**

| Treatment | Shoot length (cm) | | | | Shoot diameter (mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | Average | 2004 | 2005 | 2006 | Average |
| $GA_3$ (5 ppm) | 79.9 | 79.7 | 74.7 | 78.1 | 8.5 | 9.3 | 9.2 | 9.0 |
| $GA_3$ (10 ppm) | 91.3 | 97.0 | 76.7 | 88.3 | 9.5 | 10.7 | 9.0 | 9.7 |
| $GA_3$ (15 ppm) | 89.6 | 81.0 | 73.7 | 81.4 | 8.3 | 9.0 | 8.9 | 8.7 |
| $GA_3$ (20 ppm) | 86.7 | 80.4 | 70.0 | 79.0 | 7.4 | 8.2 | 8.3 | 7.9 |
| Succinic acid (50 ppm) | 77.3 | 70.1 | 68.3 | 71.9 | 7.8 | 8.3 | 8.5 | 8.2 |
| Succinic acid (100 ppm) | 86.2 | 80.3 | 70.7 | 79.1 | 8.2 | 9.8 | 9.3 | 9.1 |
| Succinic acid (150 ppm) | 72.7 | 66.3 | 63.3 | 67.4 | 7.2 | 7.2 | 7.3 | 7.2 |
| Succinic acid (200 ppm) | 67.7 | 64.8 | 61.2 | 64.6 | 7.0 | 6.9 | 7.2 | 7.0 |
| Control (untreated vines) | 68.5 | 67.0 | 63.7 | 66.4 | 7.2 | 7.4 | 7.4 | 7.3 |
| Mean | 80.0 | 76.3 | 69.1 | 75.1 | 7.9 | 8.5 | 8.3 | 8.2 |
| $LSD_{0.05}$ | 2.38 | 1.90 | 2.40 | 2.47 | 0.55 | 0.84 | 0.75 | 0.87 |

**Table 2: Effect of spraying $GA_3$ and succinic acid on internode length and pruning wood weight of Ruby Seedless grapevines during 2004, 2005 and 2006 seasons.**

| Treatment | Internode length (cm) | | | | Pruning wood weight (g) | | | |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | Average | 2004 | 2005 | 2006 | Average |
| $GA_3$ (5 ppm) | 3.47 | 2.95 | 3.07 | 3.16 | 982.0 | 750.0 | 1162.0 | 964.7 |
| $GA_3$ (10 ppm) | 3.85 | 3.59 | 3.14 | 3.53 | 1030.0 | 960.0 | 1640.0 | 1210.0 |
| $GA_3$ (15 ppm) | 3.83 | 3.08 | 3.03 | 3.31 | 992.5 | 813.3 | 1580.0 | 1128.6 |
| $GA_3$ (20 ppm) | 3.69 | 3.34 | 3.02 | 3.35 | 966.0 | 761.5 | 1625.0 | 1117.5 |
| Succinic acid (50 ppm) | 3.63 | 3.07 | 2.85 | 3.18 | 850.0 | 718.0 | 825.0 | 797.7 |
| Succinic acid (100 ppm) | 3.83 | 3.24 | 2.85 | 3.31 | 952.0 | 806.5 | 800.0 | 852.8 |
| Succinic acid (150 ppm) | 3.58 | 2.97 | 2.81 | 3.12 | 787.0 | 710.0 | 812.0 | 769.7 |
| Succinic acid (200 ppm) | 3.33 | 3.24 | 2.89 | 3.15 | 788.0 | 709.8 | 800.0 | 765.9 |
| Control (untreated vines) | 3.26 | 2.93 | 2.81 | 3.00 | 725.0 | 666.5 | 737.0 | 709.9 |
| Mean | 3.61 | 3.16 | 2.94 | 3.23 | 896.9 | 766.2 | 1108.7 | 923.3 |
| $LSD_{0.05}$ | 0.12 | 0.12 | 0.09 | 0.15 | 55.8 | 40.9 | 46.11 | 50.61 |

**Table 3: Effect of spraying $GA_3$ and succinic acid on No. leaves/shoot and leaf area of Ruby Seedless grapevines during 2004, 2005 and 2006 seasons.**

| Treatment | No. leaves/shoot | | | | Leaf area ($cm^2$) | | | |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | Average | 2004 | 2005 | 2006 | Average |
| $GA_3$ (5 ppm) | 23.0 | 27.0 | 24.3 | 24.77 | 189.3 | 180.4 | 213.7 | 194.5 |
| $GA_3$ (10 ppm) | 23.7 | 27.8 | 24.4 | 25.30 | 210.0 | 180.4 | 213.7 | 201.4 |
| $GA_3$ (15 ppm) | 23.4 | 26.3 | 24.3 | 24.67 | 167.6 | 170.8 | 200.3 | 179.6 |
| $GA_3$ (20 ppm) | 23.5 | 24.1 | 23.2 | 23.60 | 160.0 | 165.8 | 179.2 | 168.3 |
| Succinic acid (50 ppm) | 21.3 | 22.8 | 24.0 | 22.70 | 187.4 | 193.8 | 196.1 | 192.4 |
| Succinic acid (100 ppm) | 22.5 | 24.8 | 24.8 | 24.03 | 211.9 | 229.2 | 209.6 | 216.9 |
| Succinic acid (150 ppm) | 20.3 | 22.3 | 22.5 | 21.70 | 183.7 | 184.9 | 194.2 | 187.6 |
| Succinic acid (200 ppm) | 20.3 | 20.0 | 21.2 | 20.50 | 166.0 | 176.8 | 169.9 | 170.9 |
| Control (untreated vines) | 21.0 | 22.8 | 22.7 | 22.17 | 153.8 | 162.2 | 160.5 | 158.8 |
| Mean | 22.11 | 24.21 | 23.49 | 23.27 | 181.1 | 182.7 | 193.0 | 185.6 |
| $LSD_{0.05}$ | 1.60 | 1.72 | 0.81 | 1.54 | 6.33 | 10.6 | 7.37 | 9.45 |

**Table 4: Effect of spraying $GA_3$ and succinic acid on chlorophyll A and chlorophyll B in leaves of Ruby Seedless grapevines during 2004, 2005 and 2006 seasons.**

| Treatment | Chlorophyll a (mg/g f.wt*) | | | | Chlorophyll b (mg/g f.wt*) | | | |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | Average | 2004 | 2005 | 2006 | Average |
| $GA_3$ (5 ppm) | 0.480 | 0.507 | 0.412 | 0.466 | 0.413 | 0.405 | 0.350 | 0.389 |
| $GA_3$ (10 ppm) | 0.537 | 0.503 | 0.490 | 0.510 | 0.465 | 0.427 | 0.400 | 0.431 |
| $GA_3$ (15 ppm) | 0.557 | 0.520 | 0.507 | 0.528 | 0.475 | 0.428 | 0.407 | 0.437 |
| $GA_3$ (20 ppm) | 0.690 | 0.578 | 0.660 | 0.643 | 0.483 | 0.462 | 0.502 | 0.482 |
| Succinic acid (50 ppm) | 0.500 | 0.537 | 0.440 | 0.492 | 0.430 | 0.430 | 0.340 | 0.400 |
| Succinic acid (100 ppm) | 0.695 | 0.680 | 0.685 | 0.687 | 0.485 | 0.507 | 0.430 | 0.474 |
| Succinic acid (150 ppm) | 0.620 | 0.630 | 0.595 | 0.615 | 0.435 | 0.467 | 0.415 | 0.439 |
| Succinic acid (200 ppm) | 0.543 | 0.507 | 0.443 | 0.498 | 0.420 | 0.400 | 0.377 | 0.399 |
| Control (untreated vines) | 0.405 | 0.438 | 0.380 | 0.407 | 0.360 | 0.375 | 0.323 | 0.353 |
| Mean | 0.559 | 0.544 | 0.512 | 0.538 | 0.441 | 0.433 | 0.394 | 0.423 |
| $LSD_{0.05}$ | 0.031 | 0.018 | 0.021 | 0.028 | 0.022 | 0.015 | 0.018 | 0.019 |

* g.f.wt = Gram of fresh weight of leaves.

All $GA_3$ treatments except $GA_3$ at 20 ppm as well as all succinic acid spraying significantly increased the leaf area compared with unsprayed ones. Spraying $GA_3$ at 10 ppm or succinic acid at 100 ppm was the most effective concentration in increasing leaf area. The increment percentage of leaf area were 22.48, 26.83, 13.06 & 5.98 and 21.16, 36.58, 18.14 & 7.62% as an average of the three studied seasons due $GA_3$ 5, 10, 15 & 20 ppm and succinic acid 50, 100, 150 and 200 ppm, respectively. So, it can be deduced that spraying $GA_3$ at 10 ppm or succinic acid at 100 ppm induced an increase on both number of leaves and leaf area, such effect gave a pronounced increase in leaf surface expansion and improved the general vegetative growth of vines.

All $GA_3$ and succinic acid treatments significantly increased leaf contents of chlorophyll A and B. There was a gradual promotion on this traits with increasing $GA_3$ concentration, whereas, the maximum values of leaf contents of chlorophyll A and B were detected on vine leaves sprayed with succinic acid at 100 ppm compared with $GA_3$ and the other succinic acid concentrations.

These finding could be attributed to the positive effect of $GA_3$ or succinic acid on regulating the availability of water and nutrients, i.e. nitrogen which is a constituent of chlorophyll molecule. Also, succinic acid stimulates the photosynthesis and production of more carbohydrates, therefore, the vegetative growth improves as well as leaf chlorophyll A & B contents.

The present results are in agreement with those reported by Hagiwara *et al.* (1980), Mahmoud (1989), Marzouk *et al.* (1998), Nomier, Safaa (2000) and Hassan (2002). On the light of the present results, it can be concluded that spraying $GA_3$ at 10 ppm or succinic acid at 100 ppm when the cluster length reached 10-12 cm is suggested to improve the vegetative growth as well as increase leaf surface expansion. Also, spraying $GA_3$ or succinic is the best and easy way to determine favourable bud load/vine during winter pruning of grapevines.

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# تأثير حمض الجبريليك وحمض السكسنيك على العنب صنف روبى سيدلس ١- النمو الخضرى ووزن خشب التقليم للشجيرات

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أجريت هذه الدراسة على شجيرات العنب صنف " روبى سيدلس " بمزرعة كلية الزراعة – جامعة أسيوط – مصر خلال مواسم ٢٠٠٤ ، ٢٠٠٥ ، ٢٠٠٦ م– وذلك بهدف معرفة تأثير رش كل من حمض الجبريليك والسكسنيك على النمو الخضرى ووزن خشب التقليم الشتوى للشجيرات حيث تم رش حمض الجبريليك بتركيزات ٥ ، ١٠ ، ١٥ ، ٢٠ جزء فى المليون بينما تم رش حمض السكسنيك بتركيزات ٥٠، ١٠٠، ١٥٠ ، ٢٠٠ جزء بالمليون وذلك قبل التزهير وعندما وصل طول النورة الى حوالى ١٠-١٢ سم .

وقد أوضحت النتائج المتحصل عليها ما يلى :

- أن الرش بحمض الجبريليك أدى إلى حدوث زيادة مؤكدة احصائياً فى كل من طول وسمك الأفرع والسلاميات ومساحة الأوراق ومحتواها من الكلوروفيل وبالتالى زيادة وزن خشب التقليم الشتوى للشجيرات وذلك بالمقارنة بالشجيرات الغير معاملة (الكونترول).
- بالمثل حدثت زيادة مؤكدة إحصائياً فى القياسات الخضرية السابقة نتيجة رش حمض السكسنيك مقارنة بالشجيرات الغير معاملة (الكنترول) .
- سجلت أعلى القيم لهذه القياسات بالشجيرات المعاملة بكل من حمض الجبريليك عند رش ١٠ جزء بالمليون أو حمض السكسنيك عند تركيز ١٠٠ جزء بالمليون .

وبناءاً على نتائج هذه الدراسة ينصح برش حمض الجبريليك بتركيز ١٠ جزء بالمليون أو حمض السكسنيك بتركيز ١٠٠ جزء بالمليون قبل التزهير وعندما يصل طول النورة حوالى ١٠-١٢ سم حيث يؤدى ذلك إلى زيادة المسطح الورقى للشجيرات وبالتالى تحسين قوة نموها الخضرى وسهولة إجراء التقليم وتحديد حمولة البراعم المناسبة لهذا الصنف .