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# The Influence of Paclobutrazol on The Yield and Fruit Quality of Superior Seedless Grapevines

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## ABSTRACT

Paclobutrazol is classified chemically in the family of triazoles (Diterpenoid carboxylic acids) and is considered one of the growth regulators and plant hormones such as gibberellin and abscisic acid, that are used as sprays on grapevines to improve vegetative characteristics and yield quality.

This study was carried out during the 2018/2019, 2019/2020, and 2020/2021 seasons to examine the effect of spraying Paclobutrazol on the superior grapevine. Application of Paclobutrazol at three levels (0, 500, and 1000 ppm) at the time of bud burst. Results showed a reduction in total shoot and bud numbers, increased fruit set, and increased berry weight, fruit yield, and fruit quality for all PBZ treatments compared to the control. The yield was harvested on the third week of June. The main objectives of this work are to study the impacts of Paclobutrazol on earlier, improved berry quality, and increased yield of superior seedless grapes for exportation.

**KEYWORDS:** vegetative growth, superior seedless, and paclobutrazol

## 1. INTRODUCTION

Grapevine (*Vitis vinifera* L.) is the second largest fruits after citrus in Egypt. The fruiting area is estimated by 157380 feddan produced 1472418 tonnes according to the Ministry of Agriculture's annual statistics, 2021. Soumya *et al.*, (2017) found that two consecutive years of paclobutrazol (PBZ) treatment increased the number of grape bunches because vines were only sprayed at bud break and before flowering. The sugar and acid levels of grapes from different treatments did not differ significantly. Negative effects on yield were observed if the treatments were applied at flowering. PBZ

increases berry size (Christov *et al.,* 1996). The use of this product also reduced shoot length and the number of grapes per stalk in a year increased with the use of paclobutrazol. The greatest effect was seen when high doses were used Carreno *et al.,* (2007).

A powerful and targeted inhibitor of GA3 production is paclobutrazol. Paclobutrazol was reported to reduce leaf area, somewhat shorten shoot length, and enhance the chlorophyll content of all leaves. According to reports, paclobutrazol increases fruit tree output (Lolaei *et al.,* 2013).

Desta and Amare (2021) discovered that the use of PBZ improved fruit quality by increasing the quantity and weight of fruits produced per tree, as well as by increasing the number of carbs, TSS, TSS/TA, and decreasing acidity. The entire tomato production cycle was affected by the growth inhibitor Paclobutrazol (PBZ), according to Fernández *et al.,* (2021).

According to Sha *et al.,* (2021), one significant technique to enhance the quality of apple fruits is to prevent the proliferation of autumn branches during the fruit enlargement period. Four levels of paclobutrazol (PBZ) are shown here (0, 500, 1000, 1500, and 2000 mg/L). In autumn branches, it had no appreciable impact on chlorophyll or net photosynthetic rate. In the early spring, PBZ enhanced the quantity of free amino acids, soluble sugar, starch, soluble protein, and soluble sugar in the roots to varied degrees.

The main objectives of this work are to study the impacts of Paclobutrazol on earlier, improve berry quality and increase the yield of superior Seedless grapes for exportation.

## 2. MATERIALS AND METHODS

The present study was carried out during three seasons of 2018/2019 2019/2020 and 2020/2021 an exceptional seven-year-old vines. The experimental vines were chosen because they were strong and had approximately identical growth rates. The chosen vines were planted at a distance of 2.0 x 3.0 m. Vine growing in clay soil with flood irrigation and supported by gabble trellis. All vines received the following spraying treatments: Paclobutrazol (PBZ) (0,500, 1000 ppm) and the crop was harvested on the 3rd (week) of June.

The present work included the following three treatments:

1. Control (untreated vines).
2. Spraying Paclobutrazol at 500 ppm.
3. Spraying paclobutrazol at 1000 ppm.

Add paclobutrazol when the bud breaks. Follow the recommended concentrations reported by Christov (1996) and Carreno (2007).

Harvesting occurred when TSS/acid in control treatment berries reached 25/1 in three seasons. Yield per bunch was reported as weight (kg) and number of bunches per vine and average weight of bunches (g). In addition, the weight and dimensions of the berries (equatorial and longitudinal in centimeters) were recorded. The chemical properties of the berries, ie % total soluble solids, % total sugars and total acidity (expressed in g tartaric acid/100 ml juice) were determined according to the method described in AOAC, (2000). According to (Von-Wettstein, 1957), the plant pigments chlorophyll a and b and total carotenoids (mg/1.0 g fresh weight) were determined in the berries. The total chlorophyll is then calculated.

### 2.1. Statistical Analysis:

Data were analyzed according to the standard methods of Mead *et al.,* (1993) performed statistical analyzes and performed all comparisons of different treatments using the new LSD 5% test.

## 3. RESULTS AND DISCUSSION

### 3.1. Effect of Paclobutrazol (PBZ) on some vegetative growth aspects of Superior grapevines during 2018/2019, 2019/2020 and 2020/2021

According to the findings, Paclobutrazol (PBZ) considerably increased four growth features when compared to the control treatment, including main branch length, leaf area, wood maturity index, and wood weight. When paclobutrazol (PBZ) was sprayed at 0, 500, and 1000 ppm, significant changes in these growth characteristics were seen between the main stem

length and leaf area. The highest values were obtained using Paclobutrazol (PBZ) at 1000 ppm. The highest values were obtained by increasing the weight of the wood being pruned and spraying Paclobutrazol (PBZ) (0, 500, and 1000 ppm) using Paclobutrazol (PBZ) Impact of Paclobutrazol (PBZ) on Superior grapevines during 2018–2019/ 2019–2020/ 2020 - 2021 seasons in terms of TSS %, acidity, reducing sugars, and ratio.

Table (1) makes it evident that Paclobutrazol (PBZ), a superior grapevine spraying agent, had a substantial favorable impact on raising the total soluble solids when compared to the control. Findings in the same Table (1) demonstrated that as total soluble solids rose, the juice's overall acidity decreased. In the three trial seasons, this was declared. According to Basiouny, (1994), and Soumya, *et al.*, (2017) the vines were sprayed with Paclobutrazol (PBZ) at 1000 ppm over the three experimental seasons, which had the highest effect in this regard.

**Table 1. Effect of three concentrations of Paclobutrazol on some vegetative growth aspects of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.**

| Characters / Treatments | Main shoot length (cm.) | | | Leaf area $(cm)^2$ | | |
|---|---|---|---|---|---|---|
| | 2018/2019 | 2019/2020 | 2020/2021 | 2018/2019 | 2019/2020 | 2020/2021 |
| **Control** | 111.0 | 111.5 | 112.0 | 107.0 | 108.0 | 108.5 |
| **Spraying Paclobutrazol at 500 ppm** | 111.0 | 110.5 | 110.0 | 105.0 | 105.5 | 106.0 |
| **Spraying Paclobutrazol at 1000 ppm** | 107.0 | 107.0 | 106.5 | 103.5 | 103.0 | 104.0 |
| **New L.S.D. at 5%** | 1.7 | 1.9 | 2.0 | 1.2 | 1.3 | 1.4 |
| | **Wood ripening coefficient** | | | **Pruning wood weight /vine (kg.)** | | |
| | **2018/2019** | **2019/2020** | **2020/2021** | **2018/2019** | **2019/2020** | **2020/2021** |
| **Control** | 0.76 | 0.75 | 0.76 | 1.88 | 1.85 | 1.88 |
| **Spraying Paclobutrazol at 500 ppm** | 0.81 | 0.83 | 0.85 | 1.92 | 1.93 | 1.95 |
| **Spraying Paclobutrazol at 1000 ppm** | 0.87 | 0.88 | 0.91 | 1.98 | 2.00 | 2.10 |
| **New L.S.D. at 5%** | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 | 0.04 |

### 3.2.Effect of Paclobutrazol on the yield and cluster aspects of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.

The information gained is shown in Table (2), which demonstrates the impact of paclobutrazol spraying on the yield composition and bunch size and weight of premium grapes throughout the season. According to Table (2) findings, no treatment significantly changed the number of grapes produced per vine during the first experimental season when compared to the control. Both the second and third tryout seasons saw comparable early tendencies. According to the current findings, paclobutrazol application at 1000 ppm considerably enhanced yield as measured by weight (kg), number of grapes produced per vine, weight, and size of grapes. Spray paclobutrazol was significantly higher than control. During the 2018/2019, 2019/2020 and 2020/2021 seasons, vines received 1000 ppm paclobutrazol and recorded the highest number of grapes per vine (22.0-29.0-30.0), grape weight (420.0 - 425.0 - 430.0 g) and yield (12.9 - 12.3 - 12.9 kg). The untreated vines recorded the least values of the number of clusters/vines, cluster weight, and yield. The yield of the untreated vines reached (8.2 - 8.3 - 8.4 kg) during the 2018/ 2019, 2019/ 2020, and 2020/2021 seasons, respectively. Our results are in agreement with those obtained by Fei et al., (2022) and Shaltout et al., (1988).

**Table 2. Effect of three concentrations of Paclobutrazol on the yield and cluster aspects of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.**

| Characters / Treatments | No. of clusters per vine | | | Av. Cluster weight | | | Yield/ vine (kg.) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 |
| **Control** | 21.0 | 21.0 | 21.0 | 390.0 | 395.0 | 400.0 | 8.2 | 8.3 | 8.4 |
| **Spraying Paclobutrazol at 500 ppm** | 22.0 | 26.0 | 27.0 | 410.0 | 415.0 | 420.0 | 9.0 | 10.7 | 11.3 |
| **Spraying Paclobutrazol at 1000 ppm** | 22.0 | 29.0 | 30.0 | 420.0 | 425.0 | 430.0 | 9.2 | 12.3 | 12.9 |
| **New L.S.D. at 5%** | NS | 1.2 | 1.4 | 0.9 | 1.1 | 1.2 | 0.9 | 1.00 | 1.05 |

### 3.3. Effect of Paclobutrazol (PBZ) on the berry weight (g.), height and diameter of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.

Table (3) showed the berry weight (g.), height and diameter of Superior grapevines. was positively affected only by the treatment including Paclobutrazol (PBZ) at (0, 500, and 1000) ppm sprayed at the beginning of growth (first week in March. These above results are true and existed in the three experimental seasons. Concerning the effect of different treatments on the Berry weight (g,) and Berry longitudinal (cm) and Berry equatorial (cm) of superior grape cv. during the three experimental seasons results showed that the highest positive effect of treatments on Berry weight (g) and Berry longitudinal (cm) and Berry equatorial (cm) were obtained from spraying superior vines with the maximum value Paclobutrazol (PBZ) at (1000) ppm. The effect of this treatment was positively higher than any other treatment including the control. One can be stated that most of the treatments used were not differ statistically from the control. As well (Hunter and Proctor 1994).

**Table 3. Effect of three concentrations of Paclobutrazol on the berry weight (g), height and diameter of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.**

| Characters / Treatments | Berry weight (g,) | | | Berry longitudinal (cm) | | | Berry equatorial (cm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 |
| **Control** | 3.30 | 3.30 | 3.35 | 2.15 | 2.15 | 2.18 | 2.03 | 2.05 | 2.05 |
| **Spraying Paclobutrazol at 500 ppm** | 3.40 | 3.42 | 3.45 | 2.30 | 2.40 | 2.50 | 2.15 | 2.20 | 2.25 |
| **Spraying Paclobutrazol at 1000 ppm** | 3.44 | 3.48 | 3.50 | 2.50 | 2.60 | 2.65 | 2.30 | 2.40 | 2.50 |
| **New L.S.D. at 5%** | 0.07 | 0.08 | 0.09 | 0.03 | 0.04 | 0.04 | 0.02 | 0.02 | 0.02 |

### 3.4. Effect of Paclobutrazol on leaf photosynthetic pigments (mg/ g F.W.) of Superior grapevines during 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.

Table (4) shows that paclobutrazol (0, 500, and 1000 ppm) was significantly accompanied by an increase in leaf chlorophyll a, b and total chlorophyll and carotenoids compared to the control. Chlorophyll A (5.8 - 5.9 - 6 mg/g FW), Chlorophyll B (2.2 - 2.3 - 2.5 mg/g FW), total chlorophyll in leaf grapevines (8.0 - 8.2 - 8.5 mg/g FW) and in 2018/2019 Carotenoids (2.3 - 2.4 - 2.6 mg/g FW) were detected in grape leaves grown in 2018/2019, 2019/2020 and 2020/2021 seasons, sprayed with 1000 ppm paclobutrazol. Minimum levels of chlorophyll A (4.9 - 5.0 - 5.1 mg/g FW), chlorophyll B (1.4 - 1.3 - 1.4 mg/g FW), total chlorophyll in vines (6.3 - 6.3 - 6.5 mg/g FW) and carotenoids (1.5 - 1.5 - 1.6 mg/g FW) were detected on untreated vines. It is obvious from the data that the results took similar tend during the three studied seasons .as well (Desta and Amare 2021).

**Table 4. Effect of three concentrations of Paclobutrazol on photosynthetic pigments (mg/ g F.W.) of Superior grapevines during 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.**

| Characters / Treatments | Chlorophyll a (mg/ g F.W.) | | | Chlorophyll b (mg/ g F.W.) | | |
|---|---|---|---|---|---|---|
| | 2018/2019 | 2019/2020 | 2020/2021 | 2018/2019 | 2019/2020 | 2020/2021 |
| Control | 4.9 | 5.0 | 5.1 | 1.4 | 1.3 | 1.4 |
| Spraying Paclobutrazol at 500 ppm | 5.3 | 5.4 | 5.6 | 1.8 | 1.9 | 1.9 |
| Spraying Paclobutrazol at 1000 ppm | 5.8 | 5.9 | 6.0 | 2.2 | 2.3 | 2.5 |
| New L.S.D. at 5% | 0.2 | 0.3 | 0.4 | 0.1 | 0.2 | 0.2 |
| | Total chlorophylls (mg/ g F.W.) | | | Total carotenoids (mg/ g F.W.) | | |
| | 2018/2019 | 2019/2020 | 2020/2021 | 2018/2019 | 2019/2020 | 2020/2021 |
| Control | 6.3 | 6.3 | 6.5 | 1.5 | 1.5 | 1.6 |
| Spraying Paclobutrazol at 500 ppm | 7.1 | 7.3 | 7.5 | 1.9 | 2.0 | 2.1 |
| Spraying Paclobutrazol at 1000 ppm | 8.0 | 8.2 | 8.5 | 2.3 | 2.4 | 2.6 |
| New L.S.D. at 5% | 0.3 | 0.4 | 0.5 | 0.2 | 0.2 | 0.3 |

### 3.5. Effect Paclobutrazol on the percentages of N, P, K and Mg in the leaves of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.

Tables (5) it is evident from the available data that Paclobutrazol considerably improved N, P, K, and Mg leaf nutrition when compared to the control treatment. When Paclobutrazol was used, a significant increase in these nutrients was seen (0, 500, and 1000 ppm). The leaves of the vines that had Paclobutrazol sprayed at 1000 ppm during the 2018/ 2019, 2019/ 2020, and 2020/2021 seasons, respectively, showed the highest levels of N (1.82 - 1.84 - 1.86 %), P (0.20 - 0.21 - 0.21 %), K (1.19 - 1.21 - 1.22 %), and Mg (0.83 - 0.85 - 0.86 %). For untreated vines, minimal values were discovered. The data clearly show that the outcomes followed a similar trend throughout the three research seasons. Our results are in agreement with those obtained by Alabadí et al., (2009) and Steffens et al., (1985).

**Table 5. Effect of three concentrations of Paclobutrazol on the percentages of N, P, K and Mg in the leaves of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.**

| Characters / Treatments | Leaf N % | | | Leaf P % | | |
|---|---|---|---|---|---|---|
| | 2018/2019 | 2019/2020 | 2020/2021 | 2018/2019 | 2019/2020 | 2020/2021 |
| Control | 1.70 | 1.72 | 1.72 | 0.14 | 0.14 | 0.15 |
| Spraying Paclobutrazol at 500 ppm | 1.77 | 1.79 | 1.81 | 0.18 | 0.18 | 0.19 |
| Spraying Paclobutrazol at 1000 ppm | 1.82 | 1.84 | 1.86 | 0.20 | 0.21 | 0.21 |
| New L.S.D. at 5% | 0.03 | 0.04 | 0.05 | 0.01 | 0.01 | 0.01 |
| | Leaf K % | | | Leaf Mg % | | |
| | 2018/2019 | 2019/2020 | 2020/2021 | 2018/2019 | 2019/2020 | 2020/2021 |
| Control | 1.13 | 1.13 | 1.14 | 0.67 | 0.7 | 0.67 |
| Spraying Paclobutrazol at 500 ppm | 1.16 | 1.17 | 1.18 | 0.78 | 0.80 | 0.81 |
| Spraying Paclobutrazol at 1000 ppm | 1.19 | 1.21 | 1.22 | 0.83 | 0.85 | 0.86 |
| New L.S.D. at 5% | 0.02 | 0.02 | 0.03 | 0.01 | 0.02 | 0.03 |

### 3.6. Effect of Paclobutrazol on the percentage of TSS, acidity, reducing sugars and ratio of Superior grapevines during 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.

Results in Table 6 showed the effect of spraying superior grapevine with Paclobutrazol on fruit chemical characteristics which included TSS%, total acidity%, and TSS / acid% reducing sugars during the three experimental seasons 2018/ 2019, 2019/ 2020 and 2020/2021.

It is clear from Table (6) that superior grapevine spraying (Paclobutrazol) showed that all treatments were of positive effect in increasing the total soluble solids, significantly as compared with the control. Results in the same Table (6) showed that total soluble solids increased by decreasing the total acidity in the juice. This was declared in the three experimental seasons.

Data in the same table also declared that the TSS of the juice was also increased due to spraying paclobutrazol at (0, 500, and 1000 ppm) presenting the same previous trend in the three experimental seasons. The highest total soluble solids were presented by spraying the vines with Paclobutrazol at 1000 ppm. Concerning the effect of (Paclobutrazol) on the acidity of the juice of superior grapevine results indicated that all treatments reduced the acidity of the juice compared with the control. Regarding the effect of (Paclobutrazol) on the TSS /acid ratio results in Table (6) showed in the first experimental season, all treatments were of higher TSS/acid ratio compared with the control. Results also showed that paclobutrazol at (0, 500, and 1000 ppm), indicated Asın et al., (2007). the same trend in increasing the TSS/acid ratio. Results in the second season and third seasons took a similar trend to that of the first one only three exceptions. The highest effect in this concern was due to spraying the vines with paclobutrazol at 1000 ppm in the three experimental seasons. The present results are confirmed by those of Desta and Amare, (2021) and Hunter and Proctor (1994).

**Table 6. Effect of three concentrations of Paclobutrazol on the percentage of TSS, acidity, reducing sugars and ratio of Superior grapevines during the 2018/ 2019, 2019/ 2020 and 2020/2021 seasons.**

| Characters / Treatments | TSS% | | | Acidity % | | |
|---|---|---|---|---|---|---|
| | 2018/2019 | 2019/2020 | 2020/2021 | 2018/2019 | 2019/2020 | 2020/2021 |
| **Control** | 17.5 | 17.8 | 18.0 | 0.630 | 0.620 | 0.610 |
| **Spraying Paclobutrazol at 500 ppm** | 18.2 | 18.5 | 18.6 | 0.620 | 0.615 | 0.610 |
| **Spraying Paclobutrazol at 1000 ppm** | 18.6 | 18.8 | 19.0 | 0.600 | 0.595 | 0.590 |
| **New L.S.D. at 5%** | 0.3 | 0.4 | 0.4 | 0.019 | 0.022 | 0.024 |
| | **TSS/ acid ratio** | | | **Reducing sugars %** | | |
| | **2018/2019** | **2019/2020** | **2020/2021** | **2018/2019** | **2019/2020** | **2020/2021** |
| **Control** | 27.8 | 28.7 | 29.6 | 15.5 | 15.8 | 15.9 |
| **Spraying Paclobutrazol at 500 ppm** | 29.4 | 30.1 | 30.5 | 16.1 | 16.4 | 16.5 |
| **Spraying Paclobutrazol at 1000 ppm** | 31.0 | 31.6 | 32.2 | 16.5 | 16.8 | 16.9 |
| **New L.S.D. at 5%** | 0.9 | 1.0 | 1.1 | 0.06 | 0.06 | 0.07 |

## 4. CONCLUSION

Early maturity and reducing the length of shoots and leaves and the overall number of leaves on plants and improving the quality of berry paclobutrazol application greatly slowed the pace of vegetative development. Paclobutrazol had an impact on the yield that was accompanied by an increase in the size, and quantity of fruit on the plant and improvement quality of superior grapevine when using Paclobutrazol in concentration (1000 ppm) (Hedden and Graebe, 1985; Reynolds and Wardle, 1990; Basiouny, 1994).

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## الملخص العربي

# تأثير الباكلوبيترازول على المحصول وجودة الثمار لصنف العنب السوبريور سيدليس

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[٢]قسم بحوث العنب – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة

يُصنف Paclobutrazol كيميائيًا من عائلة التريازول ويعتبر أحد منظمات النمو والهرمونات النباتية مثل gibberellin، abscisic acid، والتي تستخدم رشاً على أشجار العنب من أجل تحسين الخصائص الخضرية وجودة المحصول.

أجريت هذه الدراسة خلال مواسم ٢٠١٨–٢٠١٩ / ٢٠١٩–٢٠٢٠ و٢٠٢٠–٢٠٢١ لدراسة تأثير رش الباكلوبوترازول على العنب صنف السوبيريور. تم تطبيق الرش بالـ Paclobutrazol بثلاثة تركيزات (٠، ٥٠٠، ١٠٠٠ جزء في المليون) خلال مرحلة تفتح البراعم. أظهرت النتائج انخفاضًا في إجمالي عدد الفروع والبراعم، وتحسين جودة الثمار، وزيادة وزن الحبات، وزيادة محصول الثمار كماً ونوعاً لجميع معاملات PBZ مقارنةً بالكنترول. وتم جمع الثمار في الأسبوع الثالث من شهر يونيو. وكان الهدف من تلك الدراسة تبكير موعد نضج الحبات مع زيادة كمية المحصول كماً ونوعاً.