

BEHAVIOUR OF PRIME SEEDLESS GRAPEVINES GROWN UNDER SANDY SOIL CONDITIONS TO FOLIAR APPLICATION OF CHITOSAN

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ABSTRACT

This study was undertaken three times during 2015 and 2016 seasons to test the effect of spraying chitosan at 50 to 800 ppm three times on vegetative growth, vine nutritional status, berry setting %, yield, shot berries % and berries quality of prime seedless grapevines grown under sandy soil condition.

Carrying out three sprays of chitosan at 50 to 800 ppm had an obvious promotion on all vegetative growth aspects chlorophylls a & b, total carotenoids, N, P, K and Mg in the leaves, berry setting %, cluster weight, vine yield and berries quality relative to the control. A remarkable reduction on the percentage of shot berries was recorded with using chitosan treatments.

***Conclusively**, the best results with regard to yield and berries quality of Prime seedless grapevines grown under sandy soil condition were obtained due to treating the vines thrice with chitosan at 200 ppm.*

Keywords: Chitosan, Prime seedless grapevines, yield, berries quality

INTRODUCTION

Many attempts were accompanied for alleviating the adverse effect of soil and water salinity as well as drought on yield and berries quality of grapevine cvs grown under sandy saline soil. Therefore, the idea of using chitosan as a promising and new natural compound for overcoming of these problems was raised. Chitosan is considered a biopolymer produced from chitin and is very safe for human being. It has bioactivity and bio-compatibility (Dias *et al.*, 2013). Using it in plants resulted in improving the yield and reducing transpiration (Dzung *et al.*, 2011 and Mondal *et al.*, 2012). It is an important antioxidant and using it was accompanied with blocking relative oxygen species (ROS) and protecting the vines from their damages (Parl *et al.*, 2004). It is responsible for enhancing the tolerance of plants to bacterial, viral and fungal attack (Al-Hetar *et al.*, 2011). The plants subjected to chitosan are less prone to all biotic and abiotic stresses

(Lizarraga-Pauli *et al.*, 2011; Jabeen and Ahmad, 2013 and Pongprayoon *et al.*, 2013). It enhances vital processes and changing expression of genes (Limpanavech *et al.*, 2008; Hadwiger, 2013 and Nguyen-Van *et al.*, 2013). It stimulated plant reacting and the impact on microorganisms and the molecular weight seems to be one of the most essential factors affecting the biological activity of this material (Kulikov *et al.*, 2006; Aranaz *et al.*, 2009 and Li *et al.*, 2011).

Previous studies emphasized the essential role of chitosan on stimulating growth aspects, as well as, improving yield and quality parameters of fruits (Chibv and Shibayamia, 1999; Li and Yu, 2000; Bittelle *et al.*, 2001 and Devlieghere *et al.*, 2004). The results of experiments confirmed the beneficial effects of using chitosan on both physical and chemical characteristics of the fruits (Imeri and Knorr, 1988; Gasen-Metithanis, 1996; Siripatrawan and Harte, 2010; Corradinin *et al.*, 2010; Ghasemneznad *et al.*, 2010; Abdel-Mawgoud *et al.*, 2010; Abd Jabbar and Miamaj, 2012; Salachna and Zawadzinska, 2014; Plainsirichai *et al.*, 2015).

The merit of this study was throw some lights on the effects of chitosan on growth, vine nutritional status, yield as well as physical and chemical characteristics of the berries of Prime seedless grapes vines grown under Sandy soil condition.

MATERIALS AND METHODS

This study was conducted during 2015 and 2016 seasons on thirty-six uniform in vigour 5-years old Prime seedless grapevines. The chosen vines are grown in private vineyard located at West Souhag, Souhag district, Souhag Governorate when the texture of the soil is sandy (Table 1). Soil analysis was done according to the procedures that outlined by Cottenie *et al.*, (1982). The selected vines are planted at 2 X 3 meters a part. Spur pruning system using Gable supporting method was followed. At the first week of Jan. during both seasons, pruning was carried out leaving 72 eyes (on the basis of leaving 20 fruiting spurs each with three eyes plus six replacement spurs X two eyes). The vines were irrigated via deip irrigation system (EC = 1000 ppm).

The selected vines (36) received all the regular horticultural practices that are commonly applied in the vineyard.

This study contained the following six treatments from different concentrations of chitosan:

Table 1: Analysis of the vineyard soil.

Constitute	Values
Sand %	81.9
Silt %	8.1
Clay %	10.0
Texture	Sandy
pH (1:2.5 extract)	7.99
E.C (1:2.5 extract, ppm)	940
CaCO ₃ %	4.1
O.M %	0.15
Total N %	0.009
Available P (ppm)	1.92
Available K (ppm)	41.3

- 1- Control (water sprayed vines)
- 2- Spraying chitosan at 50 ppm.
- 3- Spraying chitosan at 100 ppm.
- 4- Spraying chitosan at 200 ppm.
- 5- Spraying chitosan at 400 ppm.
- 6- Spraying chitosan at 800 ppm.

Each treatment was replicated three times, two vines per each. Chitosan was sprayed three times on vine canopy at growth start (1st week of Mar.) and at three week intervals (1st week of Mar. and 3rd week of Apr.). Chitosan at the assigned amounts was dissolved in few drops of 0.1 N NaOH for facilitating the solubility. Triton is a wetting agent was added at 0.1% to all solution spraying of chitosan and spraying was done till runoff. Randomized complete block design (RCBD) was followed.

During both seasons, the following measurements were conducted:

- 1- Vegetative growth aspects namely; main shoot length (cm), number of leaves/shoot, leaf area (cm²) (Ahmed and Morsy, 1999); wood ripening coefficient (Bouard, 1966) were all determined in the middle of May. In addition, pruning wood weight (kg)/vine and cane thickness (mm) were determined in the middle of January.
- 2- Chlorophylls a and b, total carotenoids (as mg/100g F.W) after extraction by acetone(Hiscox and Isralstam, 1979).
- 3- Percentages of N, P, K and Mg in the petioles of leaves located opposite to the basal clusters, on dry weight basis (Cottenie *et al.*, 1982 and Balo *et al.*, 1988).

- 4- Berry setting%, yield expressed in weight (kg) and number of cluster/vine as well as cluster weight and percentage of shot berries (determined by dividing the number of small berries by the total number of berries per cluster and multiplying the product by 100).
- 5- Physical and chemical characteristics of the berries namely berry weight (g) and dimensions (longitudinal and equatorial in cm), TSS% (by a hand refractometer), total sugars and total acidity% (as g tartaric acid/100ml juice) (A.O.A.C., 2000).

Statistical analysis was manually done and the treatment means were compared using New L.S.D. at 5% according to method described by Mead *et al.* (1993).

RESULTS AND DISCUSSION

1. *Vegetative growth characteristics:*

Data in Table 2 clearly show that treating Prime seedless grapevines with chitosan at 50 to 800 ppm significantly stimulated the six growth aspects namely main shoot length, number of leaves/shoot, leaf area, wood ripening coefficient, cane thickness and pruning wood weight relative to the check treatment. The promotion was in proportional to the increase in chitosan concentrations. Using chitosan at concentrations above 200 ppm had no significant promotion on the six growth aspects when compared to 200 ppm. The maximum values were recorded on the vines that treated three times chitosan at 800 ppm. The lowest values were recorded on untreated vines. These results were true during both seasons.

2. *Leaf chemical composition:*

It is noticed from the data in Table 3 that chlorophylls a & b, total carotenoids, N, P, K and Mg in the leaves were significantly affected by foliar application of chitosan at 50 to 800 ppm compared to the control treatment. The promotion was correlated with increasing concentrations of chitosan at 50 to 200 ppm. However, using concentrations of chitosan above 200 ppm failed to show significant promotion on these chemical components in comparison to applying chitosan at 200 ppm. The maximum values were recorded on the vines that received three sprays of chitosan at 800 ppm. The untreated vines produced the minimum values. Similar results were announced during both seasons.

Table 2: Effect of chitosan on some growth aspects of Prime seedless grapevines during 2015 and 2016 seasons

Treatments	Mainshoot length (cm)		No. of leaves/shoot		Leaf area (cm ²)		Wood ripening coefficient		Cane thickness		Pruning wood weight (kg/vine)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	97.6	99.9	11.0	12.0	96.9	98.9	0.65	0.64	9.1	9.4	1.1	1.0
Chitosan at 50 ppm	101.3	104.6	13.0	15.0	99.8	101.9	0.71	0.71	9.8	10.5	1.6	1.5
Chitosan at 100 ppm	105.0	110.9	15.0	17.0	104.6	105.5	0.79	0.78	10.9	11.9	2.1	2.0
Chitosan at 200 ppm	111.6	115.0	18.0	20.0	110.0	111.6	0.89	0.88	11.9	12.8	2.6	2.4
Chitosan at 400 ppm	111.9	115.3	18.0	20.0	110.3	112.0	0.90	0.88	12.0	12.9	2.6	2.5
Chitosan at 800 ppm	112.0	115.6	18.0	20.0	110.6	112.3	0.91	0.89	12.1	12.9	2.6	2.6
New L.S.D at 5%	1.0	1.3	2.0	2.0	1.1	1.4	0.05	0.07	0.5	0.4	0.5	0.4

Table 3: Effect of chitosan on the leaf content of pigments and different nutrient elements of Prime seedless grapevines during 2015 and 2016 seasons

Treatments	Chlorophyll a (mg/100g F.W)		Chlorophyll b (mg/100g F.W)		Total carotenoids (mg/100g F.W)		Leaf N %		Leaf P %		Leaf K %		Leaf Mg %	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	3.0	2.9	1.0	0.9	1.1	1.1	1.59	1.64	0.14	0.15	1.09	1.11	0.55	0.57
Chitosan at 50 ppm	3.7	3.9	1.4	1.4	1.5	1.4	1.69	1.74	0.17	0.18	1.15	1.18	0.60	0.63
Chitosan at 100 ppm	4.8	5.0	1.9	2.0	1.9	1.8	1.79	1.79	0.21	0.22	1.21	1.25	0.64	0.69
Chitosan at 200 ppm	6.0	6.2	2.6	2.7	2.3	2.4	1.90	1.89	0.24	0.26	1.29	1.35	0.69	0.74
Chitosan at 400 ppm	6.1	6.3	2.7	2.7	2.4	2.5	1.91	1.90	0.24	0.26	1.30	1.36	0.69	0.75
Chitosan at 800 ppm	6.2	6.4	2.8	2.8	2.4	2.5	1.92	1.90	0.25	0.27	1.31	1.37	0.70	0.76
New L.S.D at 5%	0.6	0.7	0.4	0.5	0.4	0.3	0.06	0.04	0.02	0.03	0.04	0.03	0.03	0.03

3. Berry setting %, yield and cluster weight:

It is clear from the data in Table 4 that subjecting Prime seedless grapevines three times with chitosan at 50 to 800 ppm significantly berry setting%, improved yield expressed in weight and number of clusters/vine and cluster weight relative to the control treatment. The promotion was associated with increasing concentrations of chitosan. Using chitosan with concentrations above 200 ppm had negligible promotion. Number of clusters/vine was significantly unaffected with varying concentrations of chitosan in the first seasons of study. From economical point view, using chitosan at 200 ppm gave the best results with regard to yield. Under such promised treatment, yield per vine reached 11.7 and 14.9 kg while the yield of untreated vines reached 9.6 and 10.2 kg during both seasons, respectively. The percentage of increment on the yield due to using the previous promised treatment over the check treatment reached 21.9 and 46.1 during both seasons, respectively.

4. Percentage of shot berries:

As shown in Table 4, it was significantly reduced with using chitosan via leaves at 50 to 800 ppm relative to the control treatment. There was a gradual reduction on such undesirable phenomena with increasing concentrations of chitosan from 50 to 800 ppm no significant reduction on such parameter was observed when chitosan was applied at concentrations above 200 ppm compared to 200 ppm itself. The lowest value was recorded on the vines that treated with chitosan at 800 ppm. Treating the vines with chitosan at 0.0 ppm gave the highest values. Similar trend was noticed during both seasons.

5. Physical and chemical characteristics of the berries:

It is clear from the data in Table 5 that treating Prime seedless grapevines with chitosan at 50 to 800 ppm was significantly effective in improving berries quality in terms of increasing berry weight and dimensions (longitudinal and equatorial), TSS% and total sugars % and reducing titratable acidity% over the check treatment. There was a progressive promotion on berries quality with increasing concentrations of chitosan. Significant differences on quality of berries were detected with increasing concentrations from 0.0 to 200 ppm. Using chitosan at concentrations above 200 ppm had no significant promotion on quality parameters compared to applying chitosan at 200 ppm. The maximum berry weight and dimensions, TSS% and total sugars% and the minimum titratable acidity% were recorded on the vines that treating with chitosan at

Table 4: Effect of chitosan on the percentage of berry setting, yield, cluster weight and percentage of shot berries of Prime seedless grapevines during 2015 and 2016 seasons

Treatments	Berry setting (%)		No. of cluster/vine		Yield/vine (kg)		Cluster weight (g)		Shot berries (%)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	17.1	16.9	29.0	30.0	9.6	10.2	330.0	341.0	10.0	10.9
Chitosan at 50 ppm	19.2	20.0	30.0	33.0	10.3	11.7	341.9	355.0	8.1	9.0
Chitosan at 100 ppm	21.4	22.9	30.0	36.0	10.7	13.2	355.9	366.9	6.9	7.9
Chitosan at 200 ppm	24.1	25.3	30.0	38.0	11.7	14.9	391.0	393.0	4.4	4.1
Chitosan at 400 ppm	24.2	25.4	30.0	38.0	11.8	15.0	392.0	394.0	4.3	4.0
Chitosan at 800 ppm	24.3	25.6	30.0	39.0	11.8	15.4	393.0	395.0	4.2	4.0
New L.S.D at 5%	1.9	2.2	NS	2.6	0.8	0.9	10.1	10.0	1.0	0.9

Table 5: Effect of chitosan on some physical and chemical characteristics of the berries of Prime seedless grapevines during 2015 and 2016 seasons

Treatments	Berry weight (g)		Berry longitudinal (cm)		Berry equatorial (cm)		TSS (%)		Total sugars %		Total acidity %	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	3.41	3.50	2.11	2.20	1.49	1.60	17.0	16.9	14.9	15.0	0.679	0.675
Chitosan at 50 ppm	3.70	3.80	2.20	2.29	1.60	1.71	17.4	17.3	15.3	15.5	0.645	0.640
Chitosan at 100 ppm	4.00	4.09	2.39	2.50	1.70	1.84	18.0	17.9	15.6	16.0	0.615	0.609
Chitosan at 200 ppm	4.40	4.42	2.50	2.59	1.84	1.92	18.4	18.3	16.0	16.6	0.591	0.588
Chitosan at 400 ppm	4.41	4.43	2.51	2.60	1.85	1.93	18.5	18.4	16.1	16.7	0.588	0.587
Chitosan at 800 ppm	4.44	4.44	2.53	2.61	1.87	1.94	18.6	18.5	16.2	16.7	0.587	0.586
New L.S.D at 5%	0.20	0.23	0.08	0.06	0.07	0.06	0.2	0.2	0.2	0.2	0.016	0.014

800 ppm. Treating the vines with vehicle (water only) gave unfavorable effects on quality of the berries. These results were true during both seasons.

DISCUSSION

The previous positive action of chitosan on growth and fruiting of Prime seedless grapevines might be attributed to its essential effect on enhancing the tolerance of plants to biotic and abiotic stresses and plant metabolism as well as reducing transpiration and the formation of reactive oxygen species (ROS) and protecting the plants from aging (Park *et al.*, 2004; Limpanuvech *et al.*, 2008; Dzung *et al.*, 2011; Mondal *et al.*, 2012; Jabeen and Ahmad, 2013 and Pongprayaan *et al.*, 2013).

The results are in harmony with those obtained by Imeri and Knoor, (1988); Gasen-Metithanis, (1996); Siripatrawan and Harte, (2010); Corradinin *et al.*, (2010); Ghasemneznad *et al.*, (2010); Abdel-Mawgoud *et al.*, (2010); Abd Jabbar and Miamaj, (2012); Salachna and Zawadzinska, (2014) and Plainsirichai *et al.*, (2015).

Conclusively, treating Prime Seedless grapevines grown under sandy soil condition three times with chitosan at 200 ppm gave the best results with regard to yield and berries quality.

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سلوك كرمات العنب البرايم سيدلس النامية فى التربة الرملية لرش الشتوسان

إسراء محمود السيد حسين

قسم البساتين- كلية الزراعة- جامعة أسوان- مصر

أجريت هذه الدراسة خلال موسمى 2015، 2016 لاختبار تأثير رش
الشتوسان ثلاث مرات بتركيز 50 إلى 80 جزء فى المليون على صفات النمو
الخضرى، الحالة الغذائية للكرمة والنسبة المئوية لعقد الحبات وكمية المحصول
للكرمة والنسبة المئوية للحبات الصغيرة وخصائص الجودة للحبات فى كرمات العنب
البرايم سيدلس النامى فى التربة الرملية.
إن رش الشتوسان ثلاث مرات بتركيز ما بين 50 إلى 80 جزء فى المليون
يؤدى إلى حدوث تحسن واضح فى جميع صفات النمو الخضرى ومحتوى الكلوروفيل
أ، ب والكاروتينات الكلية والنيتروجين والفوسفور والبوتاسيوم والماغنسيوم فى
الورقة والنسبة المئوية لعقد الحبات، وزن العنقود وكمية المحصول وخصائص الجودة
للحبات وذلك بالمقارنة بمعاملة الكونترول وكان هناك نقص ملحوظ فى النسبة المئوية
للحبات الصغيرة فى معاملات الشتوسان.
التوصية: أمكن الحصول على أفضل النتائج بخصوص كمية المحصول وخصائص
الجودة لكرمات العنب البرايم سيدلس النامى فى التربة الرملية عند رش الكرمات
ثلاث مرات بالشتوسان بتركيز 200 جزء فى المليون.
الكلمات الدالة : الشتوسان-العنب البرايم سيدلس- كمية المحصول – خصائص
الجودة للحبات.

