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# ENHANCING IRRIGATION WATER USE EFFICIENCY IN RED ROOMY VINEYARDS BY USING SOME ANTITRANSPIRANTS

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**ABSTRACT :** *During 2012 and 2013 seasons, Red Roomy grapevines subjected to irrigation with water at 3300 ( without holding any irrigation), 3000(with holding one irrigation) and 2700 $m^3$ / fed / year (with holding two irrigations) with or without the application of three antitranspirants namely salicylic acid at 50 ppm; Vapor guard at 2% and kaolin at 3%. The target was enhancing irrigation water use efficiency. Growth as well as , physiological parameters, yield and fruit quality in response to the present treatments were investigated.*
*Reducing irrigation water regimes from 3300 to 2700 $m^3$/ year caused a gradual reduction on all growth characters, leaf relative turgidity % ,total indoles, wood total carbohydrates%, N, P, K, berry setting%, yield, and quality parameters and was responsible for increasing hard leaf character, leaf succulence grade, osmotic pressure, proline, total phenols and shot berries%. Using any one of the three antitranspirants succeeded in counteracting the adverse effects of drought conditions or water stress on growth and fruiting of the vines. The best antitranspirant in this respect was kaolin, vapor guard and salicylic acid, in descending order*
*The best results with regard to enhancing irrigation water efficiency as well as improving yield and fruit quality of Red Roomy grapevines were obtained due to irrigating the vines with 3000 $m^3$ water/ year at ten times besides spraying kaolin at 3% four times.*

***Key words***: *Water deficit, antitranspirants, fruiting, Red Roomy grapevines.*

## INTRODUCTION

The lack of water is the major restricting factor to cultivation in arid and semi arid regions. Water deficit occurs whenever the loss of water in transpiration exceeds the rate of absorption. It is characterized by the reduction in water content accompanied with the loss of turgor, closure of stomata and inhibit growth and photosynthesis process. (Boyer, 1995 and Hassan, 1998).

There is a critical need to balance water availability, water requirements and water consumption thus water conserving is becoming a decisive consideration for agriculture, particularly in arid and semi-arid regions where water is the main limiting factor for plant growth. Moreover, plants are prodigal in the water use because only roughly 5% of water uptake is used for its growth and development while the remaining 95% is lost for transpiration (Prakash and Ramachandran, 2000). Actively growing plants would transpire a weight of water equal to their leaf fresh weight each hour under conditions of arid and semi-arid regions if water is supplied adequately.

Certain chemicals with some biological activities could be used to reduce the transpiration rate and mitigate plant water stress by increasing the leaf resistance to the diffusion of water vapor. Based on their mechanism of action, such antitranspirants were grouped into three categories namely film-forming types (which coat leaf surface with films that are impervious to water vapor), reflecting materials (which reflect back a portion of the incident radiation falling on the upper surface of the leaves) and stomata closing types (which affect the metabolic processes in leaf tissues). Film forming and reflecting antitranspirants were found to be non- toxic and have longer period of effectiveness than metabolic types. Moreover, in contrast to most film-forming antitranspirants which are impermeable to $CO_2$ exchange and thus may reduce the rate of photosynthesis, the pinolene-base Vapor gard has not been reported to reduce the photosynthetic rate. It dries on plants to form a clear, glossy film which retards normal moisture loss without interfering with plant growth or normal respiration. It is also

safe for human use as well as it has been used on various fruit crops. In addition, a reflective Kaolin spray was found to decrease leaf temperature by increasing leaf reflectance and to reduce transpiration rate more than photosynthesis in many plant species grown at high solar radiation levels. (Bergovis *et al.,* 2001; Cheng *et al.,* 2008 and Peter, 2008)

Using antitranspirants will lower the surface tension of water, which increases the efficiency of water penetration but reduces the build-up of water droplets on the plant. This can lead to a reduction in the incidence of scorch during bright weather conditions and the time available for any fungal spores to try and germinate on the leaf surface. Some products coat the leaf surface with a thin plastic film which prevents water loss. When it is applied to plant tissue it forms a very thin, transparent layer over the leaves and stems. Application is recommended early in the morning or late afternoon. Once dry, the coating allows gases to permeate but not liquids, which allows normal plant respiration but reduces transpiration by up to 80%. They have also been used effectively at reducing foliage damage to roadside trees during periods of salt applications. (Bose *et al.,* 2001; Gindaba and Wand, 2005 and Lolicato, 2011).

Recently, salicylic acid has been proposed to be a new kind of antitranspirants, since when it apply to plant tissues it forms a very thin transparent layer over the leaves, consequently reduces leaf temperature and increases leaf reflectance (Gumes *et al.,* 2007 and Joseph *et al.,* 2010).

Previous studies showed that water stress has negative action on growth and fruiting of fruit crops (Abd El- Moteleb, 1991; Hassan, 1998; Gupta *et al.,* 1999 and Gowda , 2002).

Application of antitranspirants namely vapor gard, kaolin and calcium carbonate has beneficial effects on growth and fruiting of fruit crops (Yazici *et al.,* 2005 ; Morsy *et al.,* 2008 ; Glenn, 2009; Ahmed *et al.,* 2011; Ahmed *et al.*, 2012 and Ebrahiem- Asmaa, 2012).

Using salicylic acid was found by many authors to improve growth and fruiting in different grapevine cvs (Abdelaal, 2012; Mohamed, 2014 a and 2014b).

The target of this study was enhancing water use efficiency and reducing the adverse effects of water stress on growth and fruiting of Red Roomy grapevines by using some antitranspirants.

## MATERIALS AND METHODS

This investigation was carried out during 2012 & 2013 seasons on 900 uniform in vigor 18- years old Red Roomy grapevines. The selected vines are grown in a private vineyard located at Mohamed Sultan village, Minia district, Minia Governorate, where the soil texture is clay (Table 1). Soil analysis was done according to the procedures that outlined by Chapman and Pratt (1975). The selected vines are planted at 2x2 meters apart. The chosen vines are trained according to head pruning system leaving 72 eyes/ vine (20 fruiting spurs x three eyes plus six replacement spurs x two eyes). Winter pruning was conducted at the middle of Jan. during both seasons. Surface irrigation system was followed using Nile water.

The selected vines (900 vines) received the same horticultural practices that already applied in the vineyard except those dealing with irrigation as well as the application of antitranspirants.

This experiment included twelve treatments from two factors (A & B) . The first factor (A) consisted form three levels of irrigation water regimes namely 3300 & 3000 and 2700 $m^3$/ fed/ year (i.e. 82.5 & 75 & 67.5 $m^3$ water per each plot containing 25 vines, while the second factor (B) comprised from four antitranspirant treatments namely untreated vines, using kaolin at 3%, using vapor guard at 2% and salicylic acid at 50 ppm. Each treatment was replicated three times, one plot per each. The area of each plot was 10 x 10 $m^2$. Each plot contained 25 vines. The selected vines were irrigated eleven times during each season at the 1$^{st}$

week of Mar. Apr. and May, mid May, 1st week of June, mid June, 1st week of July , mid of July, 1st week of August and September and mid September. The irrigation water regime namely 3300 $m^3$ (the recommended rate) was added at the previous eleven dates of irrigation. Irrigation with 3000 and 2700 $m^3$ water / fed. / year were carried out by with holding the irrigation that carried out on the first week of May as well as with holding the two irrigations that carried out in the middle of June and July, respectively. Each irrigation was applied at fixed rate namely 300 $m^3$ / fed/ year. The amount of water was adjusted by using tensiometer apparatus. The three antitranspirants namely salicylic acid, Vapor guard and kaolin were sprayed at four times namely mid of April (growth start stage) , first week of June (just after berry setting) and at one month intervals ( first week of July and August) Triton B as a wetting agent was added to all antitranspirant solutions at 0.5% . All antitranspirant spray applications must be applied for full coverage. Randomized complete block design (RCBD) in split plot arrangement was adopted. The three irrigation water regimes and the four antitranspirant treatments occupied the main and subplots , respectively.

At the end of each season, the following growth, and physiological parameters, yield as well as physical and chemical characters of the fruits were measured:

1- Vegetative growth characters namely main shoot length (cm) , leaf area ($cm^2$) (Ahmed and Morsy, 1999), pruning weight (kg.), cane thickness (mm), and wood ripening coefficient .
2- Physiological aspects of leaves such as leaf relative turgidity % of leaves (Ahmed – Safaa, 1994); leaf succulence grade (g $H_2O$/ $dec^2$ of leaf) according to Hassan, (1998), hard leaf character (g dry matter / $dec^2$ of leaf) according to Hassan, (1998) and leaf osmotic pressure (bar) according to Gusov, (1960).
3- Chemical characters namely total chlorophylls (as mg/ 1.0 g F.W.) according to Von- Westtstein, (1987), proline content (mg/ g. F.W.) according to Draz, (1986), total phenols ( as mg/ 1.0 g F.W.) according to A.O.A.C, (2000), total indoles ( mg / g F.W.) according to Larson *et al.,* (1962) wood total carbohydrates % (Smith *et al.,* 1956) and N, P and K (as percentages) according to Chapman and Pratt (1975).
4- Percentage of beery setting as well as yield expressed in weight (kg.) and number of clusters per vine and cluster weight (g.) and shot berries %
5- Fruit quality parameters namely berry weight (g.), T.S.S. %, total acidity % (as g tartaric acid/ 100 ml juice according to A.O.A.C., 2000) and total anthocyanin's (mg / 1.0 g F.W.) in the whole berries ( A.O.A.C., 2000).

Statistical analysis was done using new L.S.D. at 5% according to Mead *et al.,* (1993)

**Table (1) : Analysis of the tested soil**

| Constituents | Values |
|---|---|
| Sand % | 6.1 |
| Silt % | 13.9 |
| Clay % | 80.0 |
| Texture | Clay |
| O.M. % | 2.79 |
| pH ( 1 : 2.5 extract) | 7.49 |
| EC ( 1 : 2.5 extract ) mmhos / cm/ 25°C) | 0.91 |
| $CaCO_3$ % | 1.09 |
| Total N % | 0.11 |
| Available P ( ppm) | 4.2 |
| Available K ( ppm) | 447 |

## RESULTS AND DISCUSSION

## a) Results

### 1- Effect of various water irrigation regimes and antitranspirants on vegetative growth characters.

Data in Tables (2 & 3) clearly show that varying water irrigation regimes in Red Roomy orchards from 2700 to 3300 $m^3$/ year significantly varied all growth characters namely main shoot length, leaf area, pruning weight, cane thickness and wood ripening coefficient. All growth characters significantly inhibited due to irrigation with water at 2700 to 3000 $m^3$/ fed/ year rather than irrigation with water at 3300 $m^3$ (normal irrigation). There was a gradual reduction on such growth aspects with increasing water stress conditions. The maximum values were recorded on the vines under normal irrigation system (3300 $m^3$ / fed / year).

Carrying out four sprays of any antitranspirants namely vapor guard, kaolin and salicylic acid was significantly followed by stimulating the previous five growth characters comparing with the control. Using Kaolin at 5% , vapor gard at 2% and salicylic acid at 50 ppm, in descending was significantly very effective in enhancing these growth traits. Application of kaolin at 3% was significantly superior than using vapor guard at 2% in this respect. Using salicylic occupied the last position in this connection. The maximum values were recorded on the vines that received fours sprays of kaolin at 3%. The lowest values were presented in untreated vines.

Using anyone of the four antitranspirants under water stress conditions significantly was associated with reducing the adverse effects of water stress on growth characters. The maximum values of growth characters were observed on the vines that irrigated with 3300 $m^3$ water / fed./ year besides the use of kaolin at 3%. The second best treatment was the application of water at 3000 $m^3$/ fed./ year plus using kaolin at 3%. Untreated vines produced the minimum values. These results were true during both seasons.

### 2- Effect of various water irrigation regimes and antitranspirants on some physiological characters:

It is evident from the obtained data in Tables ( 3 & 4) that reducing levels of water irrigation from 3300 to 2700 $m^2$/ fed/ year was significantly followed by a progressive reduction on leaf relative turgidity and promotion on hard leaf character , leaf succulence and leaf osmotic pressure. Using irrigation water at 3300 $m^3$ gave the minimum values of leaf relative turgidity and the maximum values of hard leaf character, leaf succulence and osmotic leaf pressure. Similar results were announced during 2012 and 2013 seasons.

Treating Red Roomy grapevines four times with any one of the four antitranspirants ( kaolin at 3% , vapor guard at 2% and salicylic acid at 50 ppm) had significant promotion on leaf relative turgidity and reduction on hard leaf character , leaf succulence and osmotic pressure leaf over the check treatment . The effect either in increase or decrease was significantly associated with using kaolin at 3% , vapor guard at 2% and salicylic acid at 50 ppm, in descending order. The maximum values of leaf relative turgidity and the minimum values of hard leaf character, leaf succulence and osmotic pressure was presented in the vines that received four sprays of kaolin at 3%. The untreated vines produced the minimum values of leaf relative turgidity and the maximum values of hard leaf, leaf succulence and leaf succulence. Similar results were observed during both seasons.

The interaction among water stress and antitranspirants had significant effect on the previous four physiological aspects. Using kaolin at 3% under water stress conditions (using irrigation water at 2700 to 3000 $m^3$/ fed/ year effectively reduced leaf osmotic pressure comparing with subjecting the vines with the same amount of water alone. These results were nearly the same during both seasons.

**Table 2**

**Table 3**

**Table 4**

## 3- Effect of various water irrigation regimes and antitranspirants on the leaf chemical compositions.

It is obvious from the data in Tables (4 to 6) that total chlorophylls, N, P and K in the leaves as well as wood total carbohydrates % significantly declined with reducing water regimes from 3300 to 2700 $m^3$/ fed/ year. However, both total phenols and proline in the leaves were significantly enhanced with increasing water stress conditions. The maximum values of total chlorophylls, N, P, K and wood total carbohydrates were observed on the vines that irrigated with water at 3300 $m^3$/ fed/ year. In the same previous treatment both total phenols and proline content were maximized. The vice versa was obtained on the vines under stress conditions (2700 $m^3$ water / fed./ year) These results were true during both seasons.

Subjecting Red Roomy grapevine four times with any one of the three antitranspirants namely kaolin at 3% , vapor guard at 2% and salicylic acid at 50 ppm significantly was accompanied with enhancing total chlorophylls, N, P, K and wood total carbohydrates and reducing both total phenols and proline content relatively to the control treatment . The effects either in increase or decrease was significantly related to using kaolin, vapor guard and salicylic acid in descending order. These results were true during both seasons.

Different nutrients ( N, P and K) total chlorophylls in the leaves as well as wood total carbohydrates were significantly maximized, however both total phenols and proline in the leaves were minimized with application of water regime at 3300 $m^3$/ fed/ year plus kaolin at 3% . The opposite trend was attributed to using water regime at 2700 $m^3$/ fed. / year plus salicylic acid at 50 ppm. Generally speaking using antitranspirants had a definite role in counteracting the adverse effects of water stress on total chlorophylls, total carbohydrates, N, P and K in the leaves. Similar results were announced during 2012 and 2013 seasons.

## 4- Effect of various water irrigation regimes and antitranspirants on berry setting %, yield and cluster weight

Data illustrated in Tables (6 & 7) clearly show that berry setting %, yield expressed in weight (kg.) and number of clusters per vine as well as cluster weight reduced gradually due to reducing water regimes from 3300 to 2700 $m^3$/ fed./ year. Significant differences were observed among all levels of water regimes. Number of clusters / vine in the first season of this study did not alter significantly with the three water stress treatments. Normal irrigation water regime ( 3300 $m^3$/ fed/ year) gave the maximum values. Under higher water stress conditions (2700 $m^3$/ fed/ year) these parameters tended significantly to minimize. Similar results were obtained during both seasons.

Spraying kaolin at 3 %, vapor guard at 2% or salicylic acid at 50 ppm significantly improved berry setting %, yield, number of clusters ( in the second season) and cluster weight over the control treatment. The promotion was significantly associated with using salicylic acid at 50 ppm, vapor gard at 2% and kaolin at 3% , in ascending order. Similar results were observed during both seasons.

Combined application of water at various regimes plus anyone of the three antitranspirants had an announced and significant influence on the studied parameters. Under water stress conditions (using water regimes at 3000 or 2700 $m^3$/ fed./ year). Using antitranspirants especially kaolin at 3% significantly succeeded in alleviating the adverse effects of water stress on berry setting %, yield and cluster weight. Yield per vine reached 7.5 and 10.1 kg. during both seasons, respectively in the vine that irrigated with water regime at 3000 $m^3$/ fed/ year besides foliar application of kaolin at 3% . This means that using kaolin at 3% saved water amount by 300 $m^3$/ fed. Vines irrigated with water at 3300 $m^3$ water / fed/ year plus spraying kaolin at 3% produced yield per vine reached 7.6 and 10.7 kg. during 2012 and 2013 seasons, respectively. The reduction on the yield in the former treatment (2700 $m^3$/ fed/ year + kaolin at 3%) reached 1.33 and 5.94 % over the treatment included the application of 3300 $m^3$/ fed/ year + kaolin at 3% . These results were true during both seasons.

**Table 5**

**Table 6**

**Table 7**

## 5- Effect of various water irrigation regimes and antitranspirants on quality of the berries

One can state from the data in Tables (7&8) that reducing water irrigation regimes from 3300 to 2700 $m^3$/ fed/ year significantly was followed by a gradual inferior effects on quality of the berries in terms of reducing berry weight , T.S.S., and reducing sugars % and increasing total acidity %. The adverse effects on quality of the berries were significantly correlated with increasing water stress conditions. The best fruit quality was presented in the vines that received water regime at 3300 $m^3$/ fed/ year. The vice versa was obtained with using water at lower levels namely 2700 $m^3$/ fed/ year. These results were true during both seasons.

A significant promotion on quality of the berries was observed due to using any one of the three antitranspirants (kaolin , vapor guard or salicylic acid) over the control treatment. This promotion was significantly appeared in terms of increasing berry weight, T.S.S. %, reducing sugars % and total anthocyanin's and reducing total acidity %. The best antitranspirant in this connection was kaolin at 3% followed by vapor guard at 2% . Salicylic acid ranked the last position in this respect.

Under water stress conditions (i.e. using 2700 to 3000 $m^3$/ fed/ year) application of the antitranspirant kaolin at 3% or vapor guard at 2% four times significantly reduced the adverse effects of water stress on quality of the berries. The same trend was noticed during 2012 and 2013 seasons.

## b) Discussion

The previous adverse and inferior effects of water stress on growth, leaf chemical composition, yield and quality of the berries might be attributed to the negative impact of water deficit on cell division and elongation, plastid's, IAA biosynthesis, building of organic foods, plant pigments, photosynthesis, nutrient uptake , root development as well as collapsing all plant metabolism and enzymes( Boyer, 1995 and Hassan, 1998).

However, the beneficial effects of antitranspirants on counteracting the adverse effects of water deficient on growth and fruiting are mainly ascribed to the important role of these materials on blocking stomata without causing any inferiors effects on photosynthesis. Antitranspirants coat leaf surface with films that are impervious to water vapor, reflect back a portion of the incident radiation falling on the upper surface of the leaves. Some antitranspirants dried on plants to form a clear glossy film which retards normal moisture loss without interfering with plant growth or normal respiration (Cheng *et al.*, 2008 and Peter, 2008).

Previous studies showed that using salicylic acid forms a very thin transparent layers over the leaves consequently reduced leaf temperature and increases leaf reflectance (Joseph *et al.,* 2010).

These results regarding the adverse effects of water stress on growth and fruiting of grapevines are in agreement with those obtained by Abd El- Moteleb (1991); Hassan (1998); Gupta *et al.,* (1999) and Gowda (2002).

The beneficial effects effect of antitranspirants on growth and fruiting of Red Roomy grapevines are in harmony with those obtained by Morsy *et al.,* (2008); Glenn (2009); Ahmed *et al.,* (2011) and Ebrahiem – Asmaa (2012).

The results of Abdelaal (2012); Mohamed (2014a) and (2014b) emphasized the present results regarding the effect of salicylic acid .

## Conclusion:

For alleviating the adverse effects of water stress and at the same time saving irrigation water, it is advised to use any antitranspirant under the conditions of this study. Irrigating Red Roomy grapevines with water at 3000 $m^3$/ fed/ year certainly required four sprays of kaolin at 3%. This means that using water at 3000 instead of using 3300$m^3$/ fed/ year surely required four sprays of kaolin at 3% for saving 300 $m^3$ water per feddan. This means that it is possible for saving 5400000 $m^3$ i.e. 5.4 million $m^3$ water / year (18000 feddans planted with Red Roomy vines x 300 $m^3$ = 5400000 $m^3$ ).

Table 8

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# تحسين كفاءة استخدام مياه الرى فى كروم العنب الرومى الاحمر باستخدام بعض مضادات النتح

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## الملخص العربى

خلال موسمى ٢٠١٢ ، ٢٠١٣ تم رى كرمات العنب الرومى الأحمر بمعدلات ٣٣٠٠ متر مكعب مياه فى الفدان فى العام ( بدون اسقاط أية رية) ، ٣٠٠٠ متر مكعب (مع اسقاط رية واحدة) ، ٢٧٠٠ متر مكعب / للفدان / العام ( مع اسقاط ريتين) مع او بدون استخدام ثلاثة مضادات للنتح هى حامض السلسليك بتركيز ٥٠ جزء فى المليون، الفابورجارد بتركيز ٢% والكاولين بتركيز ٣% وكان الهدف هو تحسين كفاءة استخدام مياه الرى. وتم دراسة تأثر بعض الصفات الخضرية والفسيولوجية والمحصول وخصائص الجودة بهذه المعاملات.

أدى نقص كمية المياه المستخدمة من ٣٣٠٠ الى٢٧٠٠ متر مكعب للفدان / السنة الى حدوث نقص تدريجى فى جميع صفات النمو الخضرى وصفة ضغط الامتلاء للاوراق والاندولات الكلية، ومحتوى الخشب من المواد الكربوهيدراتية، النيتروجين، الفوسفور، البوتاسيوم، النسبة المئوية لعقد الحبات وكمية المحصول وخصائص الجودة للحبات بينما أدى الى زيادة وزن الورقة الجاف وصفة غضاضة الاوراق وزيادة قيم الضغط الاسموزى للورقة والفينولات الكلية والنسبة المئوية للعقد. أن استخدام أى مادة مضادة للنتح من المواد المستخدمة الثلاثة قد نجح فى تقليل الاثار الضارة لنقص الماء او الجفاف على النمو والاثمار فى هذه الكرمات وكانت أفضل مادة مضادة للنتح هى الكاولين بتركيز ٣% ثم الفابورجارد بتركيز ٢% ثم حامض السلسليك بتركيز ٥٠ جزء فى المليون مرتبا ترتيبا تنازليا.

أمكن الحصول على أفضل النتائج بخصوص تحسين كفاءة استخدام مياه الرى وكذلك تحسين كمية المحصول وجودة الحبات فى كرمات العنب الرومى الاحمر عند رى الكرمات عشر ريات بمعدل ٣٠٠٠ متر مكعب للفدان/ العام جنبا الى جنب مع رش الكاولين بتركيز ٣% أربع مرات، فى مرحلة بداية النمو وبعد عقد الحبات مباشرة ثم بفاصل شهر بعد ذلك.

**Table (2): Effect of antitranspirants under various irrigation water regimes on the main shoot length, leaf area, pruning weight and cane thickness of Red Roomy grapevines during 2012 & 2013 seasons.**

| Water regimes (A) / Antitranspirant treatments(B) | Mean shoot length (cm) | | | | | | | | Leaf area ($cm^2$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | | 2012 | | | | 2013 | | | |
| | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) |
| $b_1$ Untreated | 91.0 | 81.3 | 76.6 | 83.0 | 94.1 | 86.1 | 80.0 | 86.7 | 141.3 | 138.1 | 135.2 | 138.2 | 141.9 | 137.0 | 133.0 | 137.3 |
| $b_2$ Kaolin at 3% | 100.0 | 90.0 | 88.0 | 92.7 | 106.0 | 100.0 | 104.5 | 103.5 | 151.3 | 148.0 | 146.0 | 148.6 | 155.9 | 150.0 | 145.0 | 150.3 |
| $b_3$ Vapor gard at 2% | 96.0 | 84.3 | 82.0 | 87.4 | 100.0 | 95.0 | 97.0 | 97.3 | 147.0 | 144.0 | 141.0 | 144.0 | 149.9 | 145.0 | 140.6 | 145.2 |
| $b_4$ Salicylic acid at 50 ppm | 93.3 | 82.0 | 80.3 | 85.2 | 96.6 | 90.0 | 84.0 | 90.2 | 144.0 | 141.0 | 137.5 | 140.8 | 145.0 | 141.5 | 137.0 | 141.2 |
| Mean (A) | 95.1 | 84.4 | 81.7 | | 99.2 | 92.8 | 91.3 | | 145.9 | 142.8 | 139.9 | | 148.2 | 143.4 | 138.9 | |
| New L.S.D. at 5% | A 1.8 | B 1.7 | AB 2.9 | | A 2.0 | B 1.9 | AB 3.3 | | A 1.9 | B 2.0 | AB 3.5 | | A 1.8 | B 1.9 | AB 3.3 | |
| Characters | Pruning weight (kg.) | | | | | | | | Cane thickness (cm.) | | | | | | | |
| $b_1$ Untreated | 2.11 | 1.90 | 1.71 | 1.91 | 2.31 | 2.18 | 2.05 | 2.18 | 1.19 | 1.09 | 1.03 | 1.10 | 1.11 | 1.04 | 1.00 | 1.05 |
| $b_2$ Kaolin at 3% | 2.69 | 2.49 | 2.30 | 2.49 | 2.79 | 2.60 | 2.41 | 2.60 | 1.43 | 1.35 | 1.28 | 1.39 | 1.44 | 1.37 | 1.30 | 1.37 |
| $b_3$ Vapor gard at 2% | 2.45 | 2.30 | 2.17 | 2.31 | 2.52 | 2.40 | 2.29 | 2.40 | 1.36 | 1.28 | 1.19 | 1.28 | 1.37 | 1.31 | 1.25 | 1.31 |
| $b_4$ Salicylic acid at 50 ppm | 2.29 | 2.19 | 2.08 | 2.19 | 2.41 | 2.29 | 2.18 | 2.29 | 1.29 | 1.21 | 1.14 | 1.21 | 1.24 | 1.17 | 1.10 | 1.17 |
| Mean (A) | 2.39 | 2.22 | 2.22 | | 2.51 | 2.37 | 2.23 | | 1.32 | 1.23 | 1.16 | | 1..29 | 1.22 | 1.16 | |
| New L.S.D. at 5% | A 0.10 | B 0.11 | AB 0.19 | | A 0.10 | B 0.12 | AB 0.21 | | A 0.05 | B 0.06 | AB 0.10 | | A 0.05 | B 0.05 | AB 0.09 | |

**Table (3): Effect of antitranspirants under various irrigation water regimes on wood ripening coefficient, hard leaf character, leaf succulence and leaf relative turgidity % of Red Roomy grapevines during 2012 & 2013 seasons.**

| Water regimes (A) / Antitranspirant treatments(B) | Wood ripening coefficient | | | | | | | | Hard leaf character ( g / dec$^2$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | | 2012 | | | | 2013 | | | |
| | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) |
| $b_1$ Untreated | 0.71 | 0.67 | 0.62 | 0.67 | 0.74 | 0.69 | 0.64 | 0.69 | 0.06 | 0.09 | 0.11 | 0.09 | 0.08 | 0.11 | 0.14 | 0.11 |
| $b_2$ Kaolin at 3% | 0.88 | 0.81 | 0.76 | 0.82 | 0.89 | 0.84 | 0.79 | 0.84 | 0.01 | 0.03 | 0.05 | 0.03 | 0.01 | 0.04 | 0.06 | 0.04 |
| $b_3$ Vapor gard at 2% | 0.84 | 0.72 | 0.67 | 0.74 | 0.85 | 0.79 | 0.73 | 0.79 | 0.02 | 0.04 | 0.06 | 0.04 | 0.03 | 0.06 | 0.09 | 0.06 |
| $b_4$ Salicylic acid at 50 ppm | 0.75 | 0.70 | 0.64 | 0.70 | 0.80 | 0.74 | 0.69 | 0.74 | 0.04 | 0.06 | 0.08 | 0.06 | 0.06 | 0.08 | 0.11 | 0.08 |
| Mean (A) | 0.80 | 0.73 | 0.67 | | 0.82 | 0.77 | 0.71 | | 0.03 | 0.06 | 0.08 | | 0.05 | 0.07 | 0.10 | |
| New L.S.D. at 5% | A | B | AB | | A | B | AB | | A | B | AB | | A | B | AB | |
| | 0.03 | 0.03 | 0.05 | | 0.03 | 0.04 | 0.07 | | 0.02 | 0.02 | 0.03 | | 0.02 | 0.02 | 0.03 | |
| Characters | Leaf succulence ( g $H_2O$/ Dec$^2$) | | | | | | | | Leaf relative turgidity % | | | | | | | |
| $b_1$ Untreated | 0.09 | 0.20 | 0.27 | 0.19 | 0.13 | 0.28 | 0.33 | 0.25 | 55.0 | 40.0 | 30.0 | 41.7 | 50.0 | 31.0 | 27.0 | 36.0 |
| $b_2$ Kaolin at 3% | 0.02 | 0.10 | 0.14 | 0.09 | 0.03 | 0.11 | 0.17 | 0.10 | 20.0 | 16.0 | 13.0 | 16.3 | 19.0 | 15.0 | 9.0 | 14.3 |
| $b_3$ Vapor gard at 2% | 0.04 | 0.15 | 0.18 | 0.12 | 0.05 | 0.16 | 0.23 | 0.15 | 30.0 | 20.0 | 17.0 | 22.5 | 30.0 | 19.0 | 13.0 | 20.7 |
| $b_4$ Salicylic acid at 50 ppm | 0.07 | 0.17 | 0.23 | 0.16 | 0.09 | 0.20 | 0.30 | 0.20 | 40.0 | 30.0 | 22.0 | 30.7 | 41.0 | 24.0 | 17.0 | 27.3 |
| Mean (A) | 0.06 | 0.16 | 0.21 | | 0.09 | 0.19 | 0.26 | | 36.3 | 26.5 | 20.5 | | 35.0 | 22.3 | 16.5 | |
| New L.S.D. at 5% | A | B | AB | | A | B | AB | | A | B | AB | | A | B | AB | |
| | 0.04 | 0.05 | 0.09 | | 0.04 | 0.05 | 0.09 | | 1.8 | 2.0 | 3.5 | | 2.0 | 2.0 | 3.5 | |

**Table (4): Effect of antitranspirants under various irrigation water regimes on the leaf osmotic pressure , total chlorophylls , total indoles and total phenols in the leaves of Red Roomy grapevines during 2012 & 2013 seasons.**

| Water regimes (A) / Antitranspirant treatments(B) | Leaf osmotic pressure ( bars) | | | | | | | | Total chlorophylls (mg/ g F.W.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | | 2012 | | | | 2013 | | | |
| | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) |
| $b_1$ Untreated | 11.0 | 16.0 | 20.0 | 15.7 | 11.9 | 17.0 | 20.9 | 16.6 | 1.23 | 1.13 | 1.01 | 1.12 | 1.40 | 1.30 | 1.18 | 1.29 |
| $b_2$ Kaolin at 3% | 5.0 | 8.3 | 11.0 | 8.1 | 6.0 | 9.5 | 12.3 | 9.3 | 1.71 | 1.50 | 1.40 | 1.54 | 1.89 | 1.67 | 1.57 | 1.71 |
| $b_3$ Vapor gard at 2% | 7.0 | 12.0 | 15.0 | 11.3 | 8.0 | 12.9 | 16.0 | 12.3 | 1.55 | 1.41 | 1.30 | 1.42 | 1.72 | 1.58 | 1.47 | 1.59 |
| $b_4$ Salicylic acid at 50 ppm | 9.1 | 14.0 | 17.1 | 13.4 | 10.2 | 15.0 | 18.2 | 14.5 | 1.33 | 1.24 | 1.10 | 1.22 | 1.50 | 1.41 | 1.37 | 1.43 |
| Mean (A) | 8.0 | 12.6 | 15.8 | | 9.0 | 13.6 | 16.9 | | 1.46 | 1.32 | 1.20 | | 1.63 | 1.49 | 1.40 | |
| New L.S.D. at 5% | A 0.8 | B 0.9 | AB 1.6 | | A 0.9 | B 0.8 | AB 1.4 | | A 0.06 | B 0.07 | AB 0.12 | | A 0.05 | B 0.06 | AB 0.10 | |
| Characters | Total indoles ( mg /g F.W.) | | | | | | | | Total phenols ( mg/ g F.W.) | | | | | | | |
| $b_1$ Untreated | 13.1 | 9.1 | 6.3 | 9.5 | 14.0 | 10.0 | 7.2 | 10.4 | 3.1 | 4.7 | 8.9 | 5.6 | 3.9 | 5.5 | 9.7 | 6.4 |
| $b_2$ Kaolin at 3% | 18.3 | 14.1 | 11.3 | 14.6 | 19.2 | 15.0 | 11.9 | 15.4 | 1.2 | 1.8 | 4.0 | 2.3 | 2.0 | 2.6 | 4.7 | 3.1 |
| $b_3$ Vapor gard at 2% | 15.9 | 12.0 | 9.0 | 12.3 | 16.9 | 13.0 | 10.0 | 13.3 | 1.8 | 2.4 | 5.1 | 3.1 | 2.5 | 3.1 | 5.8 | 3.8 |
| $b_4$ Salicylic acid at 50 ppm | 14.2 | 10.0 | 7.0 | 10.4 | 15.3 | 11.0 | 8.0 | 11.4 | 2.5 | 3.6 | 7.2 | 4.4 | 3.2 | 4.3 | 8.0 | 5.2 |
| Mean (A) | 15.4 | 11.3 | 8.4 | | 16.4 | 12.3 | 9.3 | | 2.2 | 3.1 | 6.3 | | 2.9 | 3.9 | 7.1 | |
| New L.S.D. at 5% | A 0.5 | B 0.6 | AB 1.0 | | A 0.5 | B 0.5 | AB 0.9 | | A 0.5 | B 0.6 | AB 1.0 | | A 0.4 | B 0.6 | AB 1.0 | |

**Table (5): Effect of antitranspirants under various irrigation water regimes on the wood total carbohydrates percentage, proline content as well as percentages of N and P in the leaves of Red Roomy grapevines during 2012 & 2013 seasons.**

| Water regimes (A) / Antitranspirant treatments(B) | Wood total carbohydrates % | | | | | | | | Proline ( mg / g F.W.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | | 2012 | | | | 2013 | | | |
| | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) |
| $b_1$ Untreated | 12.1 | 11.0 | 9.4 | 10.8 | 13.0 | 11.8 | 10.3 | 11.7 | 0.66 | 0.81 | 0.92 | 0.73 | 0.73 | 0.88 | 0.99 | 0.87 |
| $b_2$ Kaolin at 3% | 15.9 | 14.1 | 11.8 | 13.9 | 16.8 | 15.0 | 12.7 | 14.8 | 0.31 | 0.42 | 0.53 | 0.42 | 0.38 | 0.50 | 0.60 | 0.49 |
| $b_3$ Vapor gard at 2% | 14.5 | 13.0 | 10.7 | 12.7 | 15.5 | 13.8 | 11.6 | 13.6 | 0.41 | 0.51 | 0.61 | 0.51 | 0.48 | 0.58 | 0.79 | 0.62 |
| $b_4$ Salicylic acid at 50 ppm | 13.1 | 12.1 | 9.9 | 11.7 | 14.0 | 13.0 | 10.8 | 12.6 | 0.56 | 0.71 | 0.81 | 0.69 | 0.63 | 0.77 | 0.88 | 0.76 |
| Mean (A) | 13.9 | 12.6 | 10.5 | | 14.8 | 13.4 | 11.4 | | 0.49 | 0.61 | 0.72 | | 0.56 | 0.68 | 0.82 | |
| New L.S.D. at 5% | A 0.5 | B 0.5 | AB 0.9 | | A 0.4 | B 0.5 | AB 0.9 | | A 0.05 | B 0.06 | AB 0.10 | | A 0.05 | B 0.05 | AB 0.9 | |
| Characters | Leaf N % | | | | | | | | Leaf P % | | | | | | | |
| $b_1$ Untreated | 1.56 | 1.41 | 1.31 | 1.43 | 1.61 | 1.46 | 1.37 | 1.48 | 0.22 | 0.18 | 0.13 | 0.18 | 0.21 | 0.18 | 0.12 | 0.17 |
| $b_2$ Kaolin at 3% | 1.88 | 1.70 | 1.60 | 1.73 | 1.94 | 1.73 | 1.64 | 1.77 | 0.36 | 0.29 | 0.25 | 0.30 | 0.37 | 0.30 | 0.24 | 0.30 |
| $b_3$ Vapor gard at 2% | 1.80 | 1.61 | 1.51 | 1.64 | 1.85 | 1.66 | 1.55 | 1.69 | 0.31 | 0.25 | 0.21 | 0.26 | 0.31 | 0.25 | 0.20 | 0.25 |
| $b_4$ Salicylic acid at 50 ppm | 1.66 | 1.51 | 1.40 | 1.52 | 1.71 | 1.56 | 1.45 | 1.57 | 0.26 | 0.22 | 0.17 | 0.22 | 0.24 | 0.19 | 0.15 | 0.19 |
| Mean (A) | 1.73 | 1.56 | 1.46 | | 1.78 | 1.60 | 1.50 | | 0.29 | 0.24 | 0.19 | | 0.18 | 0.23 | 0.18 | |
| New L.S.D. at 5% | A 0.06 | B 0.07 | AB 0.12 | | A 0.06 | B 0.06 | AB 0.10 | | A 0.03 | B 0.04 | AB 0.07 | | A 0.03 | B 0.03 | AB 0.05 | |

**Table (6): Effect of antitranspirants under various irrigation water regimes on the percentage of potassium in the leaves, berry setting %, number of clusters and yield per vine of Red Roomy grapevines during 2012 & 2013 seasons.**

| Water regimes (A) / Antitranspirant treatments(B) | Leaf K % | | | | | | | | Berry setting % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | | 2012 | | | | 2013 | | | |
| | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) |
| $b_1$ Untreated | 1.31 | 1.24 | 1.18 | 1.24 | 1.40 | 1.33 | 1.26 | 1.33 | 5.9 | 5.2 | 4.3 | 5.5 | 7.2 | 5.5 | 4.6 | 5.8 |
| $b_2$ Kaolin at 3% | 1.56 | 1.47 | 1.40 | 1.48 | 1.65 | 1.55 | 1.47 | 1.56 | 8.3 | 7.4 | 6.6 | 7.4 | 8.6 | 7.7 | 7.0 | 7.8 |
| $b_3$ Vapor gard at 2% | 1.46 | 1.38 | 1.33 | 1.39 | 1.54 | 1.46 | 1.41 | 1.47 | 7.3 | 6.5 | 5.6 | 6.5 | 7.6 | 6.8 | 6.0 | 6.8 |
| $b_4$ Salicylic acid at 50 ppm | 1.39 | 1.32 | 1.25 | 1.32 | 1.47 | 1.40 | 1.33 | 1.40 | 6.6 | 5.8 | 5.0 | 5.8 | 7.0 | 6.1 | 5.2 | 6.1 |
| Mean (A) | 1.43 | 1.35 | 1.29 | | 1.52 | 1.44 | 1.37 | | 7.3 | 6.2 | 5.4 | | 7.6 | 6.5 | 5.7 | |
| New L.S.D. at 5% | A | B | AB | | A | B | AB | | A | B | AB | | A | B | AB | |
| | 0.05 | 0.05 | 0.09 | | 0.04 | 0.05 | 0.09 | | 0.6 | 0.5 | 0.9 | | 0.6 | 0.5 | 0.9 | |
| Characters | No. of clusters / vine | | | | | | | | Yield / vine (kg.) | | | | | | | |
| $b_1$ Untreated | 18.0 | 18.0 | 17.0 | 17.7 | 19.0 | 17.0 | 14.8 | 16.9 | 6.1 | 5.5 | 4.8 | 5.5 | 6.5 | 5.2 | 4.2 | 5.3 |
| $b_2$ Kaolin at 3% | 19.0 | 19.0 | 19.0 | 19.0 | 26.3 | 25.3 | 22.0 | 24.5 | 7.6 | 7.5 | 6.5 | 7.2 | 10.7 | 10.1 | 7.7 | 9.5 |
| $b_3$ Vapor gard at 2% | 18.0 | 18.0 | 18.0 | 18.0 | 24.6 | 22.0 | 20.0 | 22.2 | 6.9 | 6.2 | 5.8 | 6.3 | 9.6 | 7.2 | 6.5 | 7.8 |
| $b_4$ Salicylic acid at 50 ppm | 18.0 | 18.0 | 18.0 | 18.0 | 22.0 | 20.0 | 18.0 | 20.0 | 6.5 | 5.8 | 5.4 | 5.9 | 8.1 | 6.6 | 5.5 | 6.7 |
| Mean (A) | 17.8 | 18.3 | 18.0 | | 23.0 | 21.1 | 18.7 | | 6.8 | 6.3 | 5.6 | | 8.7 | 7.3 | 6.0 | |
| New L.S.D. at 5% | A | B | AB | | A | B | AB | | A | B | AB | | A | B | AB | |
| | NS | NS | NS | | 1.9 | 2.2 | 3.8 | | 0.5 | 0.4 | 0.7 | | 0.6 | 0.5 | 0.9 | |

**Table (7): Effect of antitranspirants under various irrigation water regimes on the weights of cluster and berry, percentages of shot berries and total soluble solids in the berries of Red Roomy grapevines during 2012 & 2013 seasons.**

| Water regimes (A) / Antitranspirant treatments(B) | Cluster weight (g.) | | | | | | | | Berry weight (g.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | | 2012 | | | | 2013 | | | |
| | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) |
| $b_1$ Untreated | 339.0 | 305.0 | 281.0 | 308.3 | 341.0 | 306.0 | 283.0 | 310.0 | 4.60 | 4.40 | 4.20 | 4.40 | 4.66 | 4.45 | 4.25 | 4.45 |
| $b_2$ Kaolin at 3% | 400.0 | 395.0 | 341.0 | 378.7 | 406.0 | 400.0 | 350.0 | 385.3 | 5.25 | 5.00 | 4.80 | 5.02 | 5.30 | 5.05 | 4.85 | 5.07 |
| $b_3$ Vapor gard at 2% | 383.0 | 344.0 | 320.0 | 349.0 | 390.0 | 351.0 | 325.0 | 355.3 | 5.00 | 4.80 | 4.60 | 4.80 | 5.06 | 4.85 | 4.66 | 4.86 |
| $b_4$ Salicylic acid at 50 ppm | 361.0 | 324.0 | 300.0 | 328.3 | 366.0 | 330.0 | 305.0 | 333.7 | 4.81 | 4.60 | 4.41 | 4.61 | 4.86 | 4.65 | 4.46 | 4.66 |
| Mean (A) | 370.8 | 342.0 | 310.5 | | 375.8 | 256.8 | 315.8 | | 4.92 | 4.70 | 4.050 | | 4.97 | 4.75 | 4.56 | |
| New L.S.D. at 5% | A 18.0 | B 19.0 | AB 32.9 | | A 17.2 | B 18.0 | AB 31.1 | | A 0.13 | B 0.14 | AB 0.24 | | A 0.13 | B 0.14 | AB 0.24 | |
| Characters | Shot berries % | | | | | | | | T.S.S. % | | | | | | | |
| $b_1$ Untreated | 9.1 | 10.1 | 11.0 | 10.1 | 10.0 | 11.0 | 11.8 | 10.9 | 17.7 | 17.1 | 16.8 | 17.2 | 18.0 | 17.4 | 17.0 | 17.5 |
| $b_2$ Kaolin at 3% | 4.1 | 5.1 | 6.4 | 5.2 | 5.0 | 6.0 | 7.3 | 6.1 | 20.3 | 19.4 | 18.8 | 19.5 | 20.5 | 19.6 | 19.0 | 19.7 |
| $b_3$ Vapor gard at 2% | 6.0 | 7.0 | 8.3 | 7.1 | 6.8 | 7.7 | 9.0 | 7.8 | 19.0 | 18.4 | 18.0 | 18.5 | 19.3 | 18.6 | 18.3 | 18.7 |
| $b_4$ Salicylic acid at 50 ppm | 7.3 | 8.3 | 9.5 | 8.4 | 8.1 | 9.2 | 10.3 | 9.2 | 18.2 | 17.5 | 17.2 | 17.6 | 18.5 | 17.8 | 17.5 | 17.9 |
| Mean (A) | 6.6 | 7.6 | 8.8 | | 7.5 | 8.5 | 9.6 | | 18.8 | 18.1 | 17.7 | | 19.1 | 18.4 | 18.0 | |
| New L.S.D. at 5% | A 0.5 | B 0.5 | AB 0.9 | | A 0.5 | B 0.5 | AB 0.9 | | A 0.2 | B 0.3 | AB 0.5 | | A 0.3 | B 0.3 | AB 0.5 | |

**Table (8): Effect of antitranspirants under various irrigation water regions on the percentage of total acidity and total anthocyanin's in the berries of Red Roomy grapevines during 2012 & 2013 seasons.**

| Water regimes (A) / Antitranspirant treatments(B) | Total acidity % | | | | | | | | Total anthocyanins | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | | 2012 | | | | 2013 | | | |
| | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) | $a_1$ 3300 | $a_2$ 3000 | $a_3$ 2700 | Mean (B) |
| $b_1$ Untreated | 0.660 | 0.683 | 0.705 | 0.683 | 0.671 | 0.695 | 0.719 | 0.695 | 31.0 | 27.1 | 24.0 | 27.4 | 31.9 | 27.9 | 25.0 | 28.3 |
| $b_2$ Kaolin at 3% | 0.510 | 0.581 | 0.605 | 0.565 | 0.505 | 0.531 | 0.550 | 0.529 | 46.3 | 40.0 | 32.9 | 39.7 | 47.9 | 41.3 | 33.0 | 40.7 |
| $b_3$ Vapor gard at 2% | 0.580 | 0.599 | 0.699 | 0.626 | 0.589 | 0.611 | 0.644 | 0.615 | 41.5 | 34.3 | 29.5 | 35.1 | 42.3 | 35.3 | 30.0 | 35.9 |
| $b_4$ Salicylic acid at 50 ppm | 0.610 | 0.631 | 0.655 | 0.632 | 0.611 | 0.650 | 0.680 | 0.647 | 35.3 | 30.0 | 26.5 | 30.6 | 36.0 | 31.0 | 27.5 | 31.5 |
| Mean (A) | 0.590 | 0.624 | 0.666 | | 0.594 | 0.622 | 0.648 | | 38.5 | 32.9 | 28.2 | | 39.5 | 33.9 | 28.9 | |
| New L.S.D. at 5% | A | B | AB | | A | B | AB | | A | B | AB | | A | B | AB | |
| | 0.08 | 0.019 | 0.033 | | 0.019 | 0.019 | 0.033 | | 1.9 | 2.0 | 3.5 | | 1.8 | 2.0 | 3.5 | |