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EFFECT OF LIME AND CALCIUM ON GROWTH AND FRUIT QUALITY OF RUBY SEEDLESS GRAPEVINES

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ABSTRACT

The experiment was conducted at Khatatba, Monofia Governorate during 2003 to 2005 seasons, to study the effect of spraying Ruby Seedless grapevines by lime alone at 3 g/liter after two weeks of berry set, $CaCl_2$ at 3 g/liter after three weeks of berry set or lime followed by calcium one week later. Cluster weight, berry weight and size were significant increased with lime and $CaCl_2$ treated one week later, but with lime alone or $CaCl_2$ alone, the increment was not significantly at all seasons. However number of berries per cluster did not differ while in the second season was a significant reduction compared to control. Total soluble solids and berry firmness were significant increased compared to control in all seasons of the study, but TSS was insignificant with the lime alone in the third season. Acidity was significant lower with the lime followed by $CaCl_2$. However, with lime alone or $CaCl_2$ alone in the first and third seasons, but did not in the second season. The effect on leaf area and leaf chlorophyll a, b contents were insignificant. Lime followed by $CaCl_2$ significantly increased the specific leaf weight, pruning weight, carbohydrate content of basal cane (3 nods), although the increment was insignificant with lime alone or $CaCl_2$ alone. The highest berries quality and wood maturity were occurred with spraying Ruby Seedless grapevines with lime 3 g/liter after two weeks of berry set followed by $CaCl_2$ 3 g/Liter three weeks after berry set.

INTRODUCTION

Calcium is an essential macro element and it is a constituent of the middle lamella of cell walls. It affects cell membrane permeability and colloid hydration. Calcium combines with some toxic organic acids and renders them harmless by making them insoluble, favors translocation of amino acids and carbohydrates and stimulates root development (Weaver, 1976).

The relative importance of xylem and phloem systems in transporting Ca to fruit is not fully understood. Wiersum (1966) suggested that the xylem is the primary route of Ca supply early in the season, whereas the phloem predominates later. The net rate of Ca uptake decreases through the season, while the supply of phloem-mobile nutrients (K, Mg, P, and N) and photosynthesis increase or remain the same (Tromp, 1975). However, Spiers & Braswell (1994) detected that, increasing N supply reduced leaf K, Ca and Mn and increased leaf N and P concentrations of Sterling muscadine grape.

Lime is considered a source of Ca and there is two liming material varied in reactivity and incorporation rate. A microfine dolomatic hydrated lime (97 % $Ca(OH)_2$ MgO. A superfine dolomatic carbonate lime 99.5% $CaCO_3$. $MgCO_3$ (William and John, 1996).

The effect of water solution alkalinity in conjunction with lime. The water soluble Ca^{+2} and Mg^{+2} concentration that can be expected from the incorporation of dolomatic lime (Argo and Biernbaum, 1996). However, it has been suggested that not all incorporated liming material may have reacted upon reach-equilibrium. Lime is added to media to neutralize acidity and

increase the pH to an acceptable level for plant growth (William and John, 1996).

In the hole fruit of four cultivar of grapes (Sauvignon Blanc, Semillon, Merlot and Cabernet Sauvignon) the calcium content increased from anthesis to ripeness. In the pericarp, it decreased at the onset of ripening, while it increased in seeds. During ripening calcium was transported from the flesh to the skin (Cabanne & Doneche, 2003).

The objective of this study was to determine the importance of lime and Ca foliar spraying on growth and quality of Ruby Seedless grapes during early berries development.

MATERIALS AND METHODS

Eleven-year-old vines of Ruby Seedless grapevines growing at Khatatba district, Monofia governorate were used for this study. Vines were quadrilateral cordon trained and spur pruning as standard pruning, 2 buds per spur and two spurs on bearing unit (20 bearing unit gave 80 buds per vine), eighty four vines were chosen, seven vines per replicate. Vines were similar in size and was spaced at 2x3 meters apart. Winter pruning was performed in the first week of January of 2003 season and December of 2003 and 2004 seasons for weighting pruning weight, fertilization, herbicides and pest control practices and irrigation without Ca sprays.

The treatments were as follows:

1-Spraying the vines and clusters with 3 g./liter lime at the second week after berry set.

2-Spraying the vine and the clusters with 3 g./liter $CaCl_2$ at the third week after berry set.

3-Spraying the vines and the clusters with 3g./liter lime at the second week after berry set, followed by 3g./liter $CaCl_2$ one week later.

4-Untreated vines (control).

Cluster characteristics were determined as cluster weight (g), number of berries per clusters, berry weight (g), berry size (ml), juice total soluble solids percentage by using refractometer, titratable acidity percentage and berry firmness (g) per 0.018 cm^2.

Vine growth measurements, at the end of July. The average of leaves area of the mature 4^{th} and 5^{th} leaf was measured by weighting 10 leaves and 10 sections from these leaves of $4cm^2$ (section was 2x2 cm from each leaf according to the following equation :

$$\text{Average leaf area } (cm^2) = \frac{\text{Leaves weight (g)} \times 4}{\text{Sections weight (g)}}$$

The average weight of 100cm2 of leaf blade was recorded to determine the leaf specific weight. At the end of December, pruning weight per vine was recorded by weighting shoots of current season per vine.

Chlorophyll a & b, in the leaves were determined by grinding 0.5 (g) with acetone. The optical density of the filtrate was determined using Carl-

Zeis spectrophotometer at wavelength of 662 and 664 and calculated by means of Wettstein (1957) equations:

Chl. A= 9.784x 0.D.662-0.99x0.D644=mg/L.

Chl. B= 21.42x 0.D.644-4.65x0.D662=mg/L.

Chlorophyll A&B were calculated as mg/g. fresh weight.

Cane carbohydrate content, samples of canes were collected in December, samples of basal part of canes (1-3 nodes) was determined colorimetrically at 490 Mu wavelengths, using the phenol sulphoric acid method described by Smith et al. (1956).

The experiment was randomized complete block design with three replicate, data were tabulated and statistically analyzed according to Gomez and Gomez (1984).

REULTS AND DISCUSSION

Foliar spraying of Ruby Seedless grapevines with lime at 3 g/liter, two weeks after berry set or/and $CaCl_2$ at 3g/liter, three weeks after berry set improved clusters characteristics. Data presented in Table (1) cleared that, treatment of Ruby Seedless grapevines with lime alone or/and $CaCl_2$ increased cluster weight compared to untreated control. The increment was significant in the first season and third season with lime alone or $CaCl_2$ alone but in the second season was insignificant. These results are in accordance with Moon et al. (2003) who noted that, the cluster weight of Kyoho grapevines was increased by liquid calcium fertilizer treatment.

Number of berries per cluster were slightly increased with application of lime alone or $CaCl_2$ alone in the first season of the study, but it was slightly decreased with lime spraying after two weeks of berry set followed by $CaCl_2$ spraying one week later compared to untreated control. However, there was no significant differences in the third season. In this respect, Moon et al. (2003) reported that calcium vine-spray and cluster dipping treatments decreased berry shattering of Kyoho and Compbell Early grapes. However, fruit cracking and decay were not observed.

Table (1): Effect of spraying lime and calcium chloride on cluster characteristics of Ruby Seedless grapevines, Seasons 2003,2004&2005

Character	Cluster weight (g)			Berries/Cluster (No)			Berry weight (g)			Berry size (cm^3)		
Season Treat.	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
Lime	925	980	838	268	262	232	3.6	3.9	3.7	3.5	3.7	3.5
$CaCl_2$	945	1010	853	267	241	233	3.7	4.3	3.8	3.5	4.1	3.6
Lime+$CaCl_2$	1015	1119	945	246	258	222	4.3	4.5	4.4	4.2	4.4	4.3
Control	810	948	665	252	296	224	3.4	3.2	3.1	3.3	3.0	2.9
L.S.D at 5%	32.2	108	57.66	19.6	17.5	NS	0.36	0.19	0.034	0.33	0.15	0.42

Berry weight and size were significantly increased with applications of lime alone, $CaCl_2$ alone or lime (3g/L) after two weeks of berry set followed by $CaCl_2$ (3g/L) one week later, compared to the untreated control. Only in the first season, the increment was insignificant with lime alone or $CaCl_2$

alone. These results are in accordance with Chen et al. (1998) on Blueberry, when Ca was applied alone increased berry size.

Data presented in Table (2) showed that TSS percentage was significantly increased with lime alone (3g/L) at two weeks after berry set in the first and the second seasons, but insignificant in the third one compared to the untreated control. Moreover, $CaCl_2$ alone after three weeks of berry set or lime followed by $CaCl_2$ one week later significantly increased berry juice TSS in all seasons of study. The best increment was occurred with the application of lime at two weeks after berry set followed by $CaCl_2$ one week later. In this respect Moon et al. (2003) reported that in Kyoho and Compbell Early grapevines the soluble solids content of the fruit after 15 days of storage increased by fruit dipping and vine spraying of calcium, but after 90 days TSS and acidity did not differ.

Titratable acidity was significantly lowered with the application of lime alone (3g/L) at two weeks after berry set or/and $CaCl_2$ (3g/L) at three weeks after berry set in all seasons of the study compared to the control. Marawad *et al.* (2001) recorded that, Ca foliar spray at 750 ppm on Thompson Seedless grapevines did not affect berry acidity in the first season, but the acidity was significantly lower in the second season compared to control.

Regarding berry firmness, data presented in Table (2) indicated that, spraying Ruby Seedless grapevines with lime alone (3g/L) after two weeks of berry set or/and $CaCl_2$ (3g/L) after three weeks of berry set significantly increased berry firmness in the seasons of the study compared to untreated control. While the increment was insignificant in the second season with lime alone compared to the untreated vines. These results may be due to the effect of Ca on complexes in the middle lamella. In addition, foliar application of B and Ca could reduce the incidence of the defect and enhance fruit quality (Jin and Snapp, 2004). However, Song et al. (2003) recorded that Kyoho grape bunches dipped in N and K showed water berry, but ones dipped in Ca and Mg had low water berry symptoms.

Table (2): Effect of spraying lime and calcium chloride on TSS, acidity and berry firmness of Ruby Seedless grapevines, seasons 2003,2004 and 2005.

Character	TSS %			Acidity %			Firmness (g/0.018/cm^2)		
Season\ treat	2003	2004	2005	2003	2004	2005	2003	2004	2005
Lime	18.4	16.2	17.5	0.33	0.34	0.30	345	308	314
$CaCl_2$	18.9	16.5	19.0	0.32	0.34	0.30	397	375	373
Lime+$CaCl_2$	19.9	18.1	18.5	0.31	0.30	0.30	477	405	448
Control	17.4	15.9	16.8	0.36	0.35	0.33	280	267	275
L.S.D at 5%	0.42	0.19	1.34	0.021	0.015	0.02	48.02	44.9	37.8

Regarding leaf area of Ruby Seedless grapevines, data in Table (3) cleared that, there was no differences in leaf area as affected by lime or/and $CaCl_2$ applications. In contrary Moon et al (2003) noted that vine-spray of liquid Ca of grape cultivars Compbell Early and Kyoho at harvest, leaf blade and leaf stalk were increased in the second cultivar.

Concerning leaf specific weight, data presented in Table (3) cleared that, spraying Ruby Seedless vines with lime alone (3g/L) at two weeks after berry set slightly increased specific weight of leaves, while application of $CaCl_2$ alone (3g/L) at three weeks after berry set or lime followed by $CaCl_2$ one week later was significantly increased leaf specific weight of Ruby Seedless grapevines.

Pruning weight, expressed as weight of current seasons shoots at dormant season as indicator to vine growth as affected by lime or/and $CaCl_2$ applications. Data in Table (3) show that, there was insignificant increase of pruning weight of Ruby Seedless vines as affected by spraying vines with lime (3g/L) at two weeks after berry set or 3g/L $CaCl_2$ after three weeks of berry set in the three seasons of study. On the other hand, treatment of lime followed by $CaCl_2$ one week later significantly increased pruning weight per vine compared to untreated control. These results are in harmony with Silva et al. (2004) who studied the effect of various osmotic potential and Ca^{+2} contents of culture medium salts on dry biomass of explant of grapevine "R110". The smaller percentage of explant with Ca^{+2} deficiency symptoms were obtained of the lower osmotic potential and Ca^{+2} in culture medium. However, Marawad *et al.* (2001) noted that, foliar spraying of Ca at 750 ppm at full bloom and three weeks later increased pruning weight of Thompson Seedless vines compared to control.

According to data presented in Table (3) there is a slight increment of basal cane carbohydrate percentage as affected by applications of lime alone or $CaCl_2$ alone, but the increment was insignificant. On the other hand, spraying the vines with lime (3g/L) at two weeks after berry set followed by spraying with $CaCl_2$ at 3g/L one week later was significantly increased carbohydrate percentage of the basal nodes compared to untreated control and other treatments of the trail. These results are in harmony with Marawad et al. (2001) who sprayed vines with Ca at 750 ppm at full bloom and three weeks later to Thompson Seedless and found that wood ripening was increased compared to control.

Data regarding leaf contents of chlorophyll a and b are presented in Table (3).

Table (3): Effect of spraying lime and/or calcium chloride on some vine growth of Ruby Seedless grapevines seasons 2003 and 2004.

Character	Leaf area (cm^2)		Leaf specific weight ($g/100cm^2$)		Pruning weight (kg/vine)		Cane carbohydrate (%)		Chl. A (mg/g. fresh weight)		Chl. B (mg/g. fresh weight)	
Season\ treat	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Lime	205	217	2	1.93	0.86	0.86	11.9	13.1	0.47	0.42	0.36	0.35
$CaCl_2$	200	214	2.1	2.1	.089	0.90	12	13.2	0.42	0.39	0.33	0.33
Lime+$CaCl_2$	205	220	2.19	2.15	0.99	1.06	13.1	14	0.42	0.42	0.35	0.33
Control	201	222	1.9	1.85	0.84	0.80	11.8	12.9	0.41	0.40	0.34	0.33
LSD at 5 %	NS	NS	0.15	0.10	0.073	0.20	0.53	0.37	NS	NS	NS	NS

It is evident that all lime alone or/and $CaCl_2$ applications had no significant increase of both chlorophyll a and b. The increment was slightly in the all seasons of the study, the best increment was observed with lime

treatment alone. These results may be due to the lime content $Mg(OH)_2$ or $MgCO_3$, where chlorophyll molecule content Mg^{+2}.

Williams et al. (1996) used two dolomite liming materials $Ca(OH)_2$. $Mg(OH)_2$ or $CaCO_3.MgCO_3$ on Impatiens with both lime types, there was increase in tissue Ca and Mg as the applied concentrations of the various nutrient solutions.

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تأثير الجير والكالسيوم على جودة الثمار ونمو كروم العنب الروبى اللابذرى

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أجريت هذه التجربة فى منطقة الخطاطبة – محافظة المنوفية على كرمات عنب روبى سيدلس عمر ١١ سنة حيث تم رش الكرمات بالجير منفرداً بتركيز ٣ جم/لتر بعد العقد بأسبوعين أو كلوريد الكالسيوم بتركيز ٣ جم/لتر بعد العقد بثلاثة أسابيع أو كلاهما بالإضافة للكنترول.
وكانت أهم النتائج كالتالي :

- أظهر الرش بالجير منفرداً أو كلوريد الكالسيوم منفرداً أو كلاهما تحسناً فى وزن العنقود مع أنه لم يكن معنوياً فى الموسم الثاني مع الجير أو كلوريد الكالسيوم منفرداً ، وأفضل زيادة معنوية كانت مع معاملة الجير متبوعة بكلوريد الكالسيوم .
- عدد الحبات /عنقود لم يكن هناك فرق معنوي في الموسم الأول والثالث بالمقارنة مع الكنترول بينما في الموسم الثاني كانت هناك زيادة معنوية للمعاملات بالمقارنة مع الكنترول.
- وزن وحجم الحبات أظهر تحسناً بالرش بالجير منفرداً أو كلوريد الكالسيوم منفرداً وكانت الزيادة غير معنوية في الموسم الثاني بينما كانت معنوية في المواسم الثلاثة للرش بالجير متبوعاً بكلوريد الكالسيوم.
- أظهرت المواد الصلبة الذائبة الكلية بالحبات زيادة معنوية للرش بالجير منفرداً أو بكلوريد الكالسيوم منفرداً ولم تكن معنوية مع الجير منفرداً فى الموسم الثالث وكانت معنوية فى المواسم الثلاثة للرش بالجير متبوعاً بكلوريد الكالسيوم.
- أظهرت الحموضة الكلية نقصاً معنوياً مع الرش بالجير متبوعاً بكلوريد الكالسيوم وكان النقص معنوياً مع الجير منفرداً أو الكالسيوم منفرداً فى الموسم الأول والثالث بينما لم يكن معنوياً فى الموسم الثاني.
- صلابة الحبات أظهرت أفضل زيادة معنوية مع الرش بالجير متبوعاً بكلوريد الكالسيوم كما أظهر الرش بالجير أو كلوريد الكالسيوم زيادة معنوية في مواسم الدراسة ولم تكن معنوية مع الجير منفرداً في الموسم الثاني فقط.
- متوسط مساحة الورقة ومحتوى الأوراق من كلوروفيل ا ،ب لم تظهر فروق معنوية.وكانت هناك زيادة غير معنوية فى كلوروفيل ا ،ب مع الجير منفرداً
- أظهر الرش بالجير متبوعاً بكلوريد الكالسيوم زيادة معنوية فى كل من كثافة الورقة وزن خشب التقليم للكرمة (أفرغ الموسم الجاري) ونسبة الكربوهيدرات فى قواعد القصبات (٣عيون القاعدية) ، وكانت الزيادة غير معنوية مع الرش بالجير منفرداً أو كلوريد الكالسيوم منفرداً ،بينما كانت معنوية فقط في كثافة الورقة مع الرش بكلوريد الكالسيوم منفرداً .

ومما سبق يمكن القول بأن رش كرمات عنب الروبى سيدلس بالجير ٣جم/ لتر بعد العقد بأسبوعين متبوعاً بالرش بكلوريد الكالسيوم ٣ جم /لتر بعد الأسبوع الثالث من العقد أعطى أفضل جودة ثمار وأفضل نضج للخشب (٣عيون القاعدية) .