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EFFECT OF CALCIUM, LIME, WETTABLE SULFER AND COPPER OXICHLORIDE ON FRUIT QUALITY AND RESISTANCE TO FUNGUS DISEASES ON RUBY SEEDLESS GRAPEVINES

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ABSTRACT

This trial was carried out during 2005 & 2006 on Ruby Seedless vines grown at EL-Khatatba region. The vines were sprayed with, lime and wettable sulfer (Wt.S), $CaCl_2$ with wettable sulfer, lime and $CaCl_2$ and wettable sulfer, lime and wettable sulfer and copper ox chloride (Cu), $CaCl_2$ and wettable sulfer and Cu, and lime and $CaCl_2$ and wettable sulfer and Cu. (One concentration to each compound was used at (3 g/L), application lime after two weeks of berry set, $CaCl_2$ after three weeks, wettable sulfer weekly from full bloom until fourth week after berry set, copper ox chloride after four weeks of berry set. All the trial vines were sprayed in long interval with wt.s (15 days) after bud burst). Lime or/and $CaCl_2$ with wt.s or/and copper oxicloride applications did not significantly increase cluster weight in the two seasons of study. Berry weight, berry size, berry firmness, SSC and sugar content of berries juice were significantly increased compared to the control. The best increments were noted with the applications lime and $CaCl_2$ and wt.s or and with copper ox chloride. On the other hand, acidity percentage of berries juice was significantly reduced compared to the control. Pruning wood weight and leaf area were not greatly affected in the first season, but were significantly increased in the second season as a result of lime, $CaCl_2$, wt.s or/and copper ox chloride applications.

Spur thickness was not significantly different in the two seasons of the study. All treatments recorded a satisfactory control of both powdery and downy mildew diseases. The best treatment was spraying the vines with lime followed by $CaCl_2$ and wettable sulfer with copper ox chloride which gave good fruit quality and controlled both powdery and downy mildew.

INTRODUCTION

Ruby Seedless grape cv. is late-season table grape. It ripens in end-July in the sandy soil, while in the loamy soil it ripens at the beginning of August extends to the late of September. Ruby Seedless has high bud fertility, large clusters and heavy yield. The high cropping of this cv. leads to many problems as softening of berries and cluster rot. Thus, it is susceptible to both powdery and downy mildew.

To avoid or eliminate the establishment mildews and the disease should be menitored by using balanced nutrition to have good training and disease management to obtain good quality yield.

A primary factor driving the growth of this variety is the retail demand and has superior eating characteristics, berry texture is firm and crisp and its flavor is excellent and avoid disease.

At certain stages of vine growth, foliar nutrition of Ca, Mg and S as well as Cu is essential for plant growth. The role of different elements was applied by many workers.

The fungus which causes grape powdery mildew (*Uncinula necator*) is probably the most common disease on grapes. Some varieties are highly susceptible to this disease, it can stunt growth, defoliate leaves, delay color and greatly reduce the quality and quantity of the crop. A short interval for sulfur is 7 days while 10-14 days could be the longer interval. Water and good wetting agent in combination with wettable sulfur are often used to eradicate grape powdery mildew and its direct contact with the fungus.

Agosteo *et al.* (2003) noted that all the treatments on local grape cvs. recorded a satisfactory control of the disease (powdery mildew) as in the standard program (sulfer, myclobutanial, mono-potassium phosphate and A quesqualis (alternatively with sulfur).

Regarding downy mildew, Pertot *et al.* (2002) noted that, in organic viticulture the protection against downy mildew (*Plasmopara viticola*) is mostly based on copper compounds. Upon using the same copper rate, no differences were observed among the tested copper compounds (copper hydroxide, copper oxicloride, copper sulfate and Bordeaux mixture) only copper peptidates seemed to be useful in copper reduction in viticulture.

However, Sancassani (2003) reported that the use of sole copper at low rate, did not sufficiently protect the vines, however in all other cases, different copper compounds effectively controlled downy mildew and copper sulfate (copper oxicloride - copper hydroxide). Fungicides containing copper hydroxide were effective at the lowest rate.

The objective of this study were to 1) improve quality of Ruby Seedless clusters and firmness of berries and 2) improved vine nutrition status via foliar nutrition as a resistance management needs to be apart of every powdery mildew and downy mildew program.

MATERIALS AND METHODS

The trial was carried out during 2005-2006 seasons at EL-Khatatba district, Monofia governorate on 12-year-old "Ruby Seedless" grapevines, spaced at 2 x 3 meters apart in the sandy soil. The vines were quadrilateral trained and pruned in the dormant period by leaving 20 bearing units with two spurs of two buds each on all 80 buds/vine.

This study was to investigate the effect of foliar spraying of some nutrient compounds (lime, $CaCl_2$, wettable sulfur and copper oxicloride) on fruit quality and vines tolerance to fungal diseases (powdery and downy mildews).

The selected vines were divided into 7 treatments including the control. The experiment included 105 vines on 7 plots of 5 vines each in a complete randomized block design.

The treatments were as follows :

1- Lime (3g/L) + wt.s (3g/L) of each two weeks after berry set.
2- Calcium chloride ($CaCl_2$) + wt.s (3 g/L.) of each three weeks after berry set.
3- Lime (3 g/L) + calcium chloride ($CaCl_2$) + wt.s (3 g/L.) of each two weeks after berry set.
4- Lime (3 g/L.) + wt.s (3 g/L.) + copper oxicloride (3 g/L.).

5- $CaCl_2$ (3 g/L.) + wt.s (3 g/L.) + copper oxicloride (3 g/L.) of each three weeks after berry set.
6- Lime two weeks after berry set + $CaCl_2$ + wt.s (3 g/L.) + copper oxicloride (3 g/L.).
7- Control.

All vines were sprayed with wettable sulfer at (3 g/L) after bud burst in long interval 15 days and short interval 7 days from full bloom until fourth week of berry set. Control was sprayed with sulfer in long interval 15 days only (copper oxycloride) was sprayed once at (3 g/L.) 4 weeks after berry set as mixed with wettable sulfer when first symptoms of both powdery mildew and downy mildew were observed from full bloom until fruit maturity.

Reprehensive random samples of 9 clusters/treatment (3 clusters from each replicate) were picked at the harvest time and the following characteristics were measured :

1- Cluster weight (g).
2- Berry weight (g) and berry size (cm^3) as an average of 50 berries.
3- Berry firmness (g/0.018 cm^2).
4- Soluble solids content (SSC %) using a hand refracto-meter.
5- Total titratable acidity % according to A.O.A.C. (1975).
6- Total and reducing sugars content according to the A.O.A.C. (1975).
7- Pruning wood weight kg/vine (current season shoots).
8- Spur thickness (cm) as a diameter.
9- Average of leaf area of the mature 4^{th} and 5^{th} leaf was carried out by weighing 10 leaves and 10 sections from these leaves of 4 cm^2/section.

$$\text{Average leaf area (cm2)} = \frac{\text{Leaves weight (g)} \times 4}{\text{Sections weight (g)}}$$

Statistical analysis of the obtained data was carried according to Snedecor and Cochran (1972). Means were compared using the Duncan test.

RESULTS AND DISCUSSION

Data presented in Table (1), concerning cluster weight, show that all foliar spraying of lime (3 g/L) with wettable sulfer (3 g/L), $CaCl_2$ (3 g/L) with wettable sulfer and lime and $CaCl_2$ with wettable sulfer or with copper oxicloride (3 g/L) slightly increased cluster weight respectively compared to control. These results may be due to the effects of balanced nutrition with Ca, the various macro and micro elements.

The water soluble Ca^{2+} and Mg^{2+} concentration can be expected from the incorporation of dolomatic lime as mentioned by (Agro and Biernbaum, 1996). Moreover, Moon *et al.* (2003) recorded that cluster weight of Kyoho grapevines was increased by liquid calcium fertilizer treatment.

With regard to berry weight and size of berries, data presented in Table (1) showed that spraying the different compounds along with wettable sulfer and copper oxicloride significantly increased berry weight and berry size of Ruby Seedless grapevines compared to the control. These increments were

more pronounced with the treatments of lime and $CaCl_2$ with wettable sulfer or/and copper oxicloride. These results are in harmony with Chen *et al.* (1998) on blueberry. They recorded that application of Ca alone increased berry size. Moreover, Boselli *et al.* (1995) found that calcium and magnesium concentrations were increased after veraison independently as seed number per berry was increased and eventually berry size was increased.

Data about berry firmness are presented in Table (1), all treatments used significantly increased berry firmness compared to control. The treatments gave high berry firmness by using lime (3 g/L) and $CaCl_2$ (3 g/L) with wettable sulfer (3 g/L) or applications of vines with lime and $CaCl_2$ with wettable sulfer and one time of copper oxicloride (3 g/L) fourth week of berry set. Moreover, $CaCl_2$ alone (3 g/L) three weeks after berry set with wettable sulfer (3 g/L) or/and copper oxicloride (3 g/L), four weeks after berry set improved berry firmness compared the treatments of lime (3 g/L) with wettable sulfer (3 g/L) or/and copper oxicloride (3 g/L). These increments were significant compared to control. These results may be due to the role of Ca^{2+} with both lime and $CaCl_2$, since mineral (Ca) is a constituent of the middle lamella of cell walks (Weaver, 1976). Moreover, Song *et al.* (2003) noted that fruit of Kyoho grape bunches dipped in (N) and (K) showed water berry, but those dipped in (Ca) and (Mg) had low berry symptoms.

Table (1): Effect of foliar spraying of lime, $CaCl_2$, wettable sulfer and Cu on cluster characteristics of Ruby Seedless grapevines during 2005 & 2006 seasons.

Treatment	Cluster weight (g)		Berry weight (g)		Berry size (ml)		Berry firmness g/0.018 cm^2	
	2005	2006	2005	2006	2005	2006	2005	2006
Lime + Wet. sulfer	808	877	3.5 BC	3.4 BC	3.3 BC	3.2 BC	335 B	332 B
CaCl2 + Wet. sulfer	810	883	3.6 AM	3.4 BC	3.4 AB	3.2 BC	350 B	343 B
Lime + CaCl2 + Wet. sulfer	833	908	3.8 A	3.7 A	3.6 A	3.5 A	410 A	407 A
Lime + Wet. Sulfer + copper oxicloride	778	843	3.5 BC	3.3 C	3.3 BC	3.1 C	327 B	323 B
CaCl2 + Wet. sulfer + copper oxicloride	817	882	3.7 AB	3.5 AB	3.5 AB	3.3 AB	350 B	353 B
Lime + CaCl2 + Wet. sulfer + copper oxicloride	823	893	3.7 AB	3.7 A	3.4 AB	3.5 A	420 A	407 A
Control	720	788	3.2 C	3.0 D	3.0 C	2.7 D	250 C	210 C
L.S.D at 5 %	N.S	N.S	0.328 **	0.201 **	0.328 **	0.212 **	38.7 **	33.86 **

Data concerning total soluble solids are presented in Table (2). It can be observed that TSS of berry juice were significantly increased with lime (3 g/L) and $CaCl_2$ (3 g/L) with wettable sulfer (3 g/L) or/and copper oxicloride (3 g/L). The highest TSS values were recorded with the combined treatment of lime followed by $CaCl_2$ with sulfer or/and copper oxicloride (3 g/L). Moon *et*

al. (2003) reported that in Kyoho and Compbell Early grapevines the soluble solids content of the fruit after 15 days of storage was increased due to fruit dipping and vine spraying with calcium, but after 90 days TSS and acidity did not differ.

Titratable acidity were significantly reduced by all treatments compared to the control. The lowest acidity occurred with Ruby Seedless grapevines applications with lime (3 g/L) two weeks after berry set followed by $CaCl_2$ (3 g/L) three weeks after berry set and wettable sulfer (3 g/L) or/and copper oxicloride (3 g/L) in the fourth week of berry set in the two seasons of the study.

Total sugars and reducing sugars were in a parallel trend with total soluble solids. All applications of lime, $CaCl_2$, lime and $CaCl_2$ with wettable sulfer or/and copper oxicloride significantly increased total and reducing sugar content of berry juice. The highest total and reducing sugar content, resulted from the combined treatment of lime and $CaCl_2$ with wettable sulfer or/and copper oxicloride. These results may be due to improved vine nutrition via foliar application of the macro element Ca, Mg and sulfer and copper as a micro element.

Magnesium is a component of chlorophyll. Moreover, many plant proteins contain sulfer and copper (Cu) as a micro-element utilize protein (Weaver, 1976).

Table (2): Effect of foliar spraying of lime, $CaCl_2$, wet. s and Cu on TSS, acidity %, total and reducing sugar of Ruby Seedless grapevines during 2005 & 2006 seasons.

Treatment	TSS %		Acidity %		Total sugars %		Reducing sugars %	
	2005	2006	2005	2006	2005	2006	2005	2006
Lime + Wet. sulfer	18.5 B	17.7 BC	0.33 B	0.36 B	16.9 C	16.3 C	16.3 CD	15.8 BC
CaCl2 + Wet. sulfer	18.6 B	17.9 B	0.33 BC	0.35 B	17.2 C	16.6 B	16.6 C	15.9 B
Lime + CaCl2 + Wet. sulfer	19.1 A	18.8 A	0.30 D	0.31 C	17.7 B	17.4 A	17.1 B	16.7 A
Lime + Wet. Sulfer + copper oxicloride	18.3 B	17.5 C	0.33 B	0.35 B	16.9 C	16.1 C	16.3 D	15.5 C
CaCl2 + Wet. sulfer + copper oxicloride	18.4 B	17.7 BC	0.34 B	0.35 B	17.0 C	16.4 BC	16.4 CD	15.8 BC
Lime + CaCl2 + Wet. sulfer + copper oxicloride	19.4 A	18.5 A	0.31 CD	0.33 C	18.2 A	17.1 A	17.4 A	16.5 A
Control	17.2 C	16.3 D	0.36 A	0.39 A	15.8 D	15.0 D	15.3 E	14.5 D
L.S.D at 5 %	0.373 **	0.303 **	0.017 **	0.016 **	0.308 **	0.276 **	0.269 **	0.273 **

Data about wood pruning weight of the current season shoots are presented in Table (3). The obtained results indicated no significant differences of wood pruning weight in the first season, but in the second season, there are significant increase of pruning wood per vine of Ruby Seedless in all treatments compared to the control. The highest increment were obtained with the combined applications of lime followed by $CaCl_2$ with

wettable sulfer or/and copper oxicloride. These trend of the results of pruning weight were occurred with more leaf area, while spur thickness was not significantly different in the two seasons. Stefanini *et al.* (1994) noted that, Mg application increased plant vigour (expressed in terms of the weight of prunings) in Uva di Troia vines.

Table (3): Effect of foliar spraying of lime, $CaCl_2$, wet. s and Cu on wood pruning weight, leaf area and spur thickness of Ruby Seedless grapevines during 2005&2006 seasons.

Treatment	Wood pruning weight kg/vine		Leaf area cm^2		Spur thickness cm.	
	2005	2006	2005	2006	2005	2006
Lime + Wet. sulfer	0.8	1.1 A	203	210 A	0.7	0.9
CaCl2 + Wet. sulfer	0.8	1.1 A	203	203 A	0.8	0.9
Lime + CaCl2 + Wet. sulfer	0.8	1.2 A	198	210 A	0.7	1.0
Lime + Wet. Sulfer + copper oxicloride	0.9	1.1 A	207	212 A	0.8	0.9
CaCl2 + Wet. sulfer + copper oxicloride	0.9	1.1 A	200	203 A	0.8	0.9
Lime + CaCl2 + Wet. sulfer + copper oxicloride	0.8	1.2 A	200	210 A	0.8	1.0
Control	0.9	0.88 B	192	188 B	0.8	0.8
L.S.D at 5 %	N.S	0.205 *	N.S	10.45 **	N.S	N.S

Powdery mildew and downy mildew symptoms on Ruby Seedless grapevines were observed weekly from full bloom until fruit maturity. The use of the various materials (lime, $CaCl_2$, wettable sulfer and copper oxicloride) throughout the growth season is important. Protection management has to be a part of every powdery mildew and downy mildew program. The observations are in agreement with Gorge Leavitt, who reported that, water and good wetting agent in combination with wettable sulfer are often used to eradicate grape powdery mildew by direct contact with the fungus. However, Agrosteo *et al.* (2003) recorded a satisfactory control of the disease (powdery mildew as in the standard program (sulfer and A. quesqualis (alternative with sulfer). Moreover, Sancassani (2003) recorded that, different copper compounds effectively controlled downy mildew.

From these nutrition foliar spraying under the trial conditions, it is suggested that, if nutrition program of Ruby Seedless grapevines include, spraying vines with lime (3 g/L) two weeks after berry set followed by $CaCl_2$ (3 g/L) three weeks after berry set and wettable sulfer (3 g/L) weekly from full bloom until fourth week of berry set (additional long interval of wt.s from bud burst 15 days) or/and copper oxicloride (3 g/L) four weeks of berry set as mixed with the dose of wt.s of this week gave the best fruit quality and controlled both powdery and downy mildew disease of Ruby Seedless grapevines.

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تأثير الرش بالكالسيوم ، الجير ، الكبريت الميكرونى وأوكسى كلورالنحاس على جودة ثمار الروبى اللابذرى ومقاومته للأمراض الفطرية

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أجريت هذه التجربة فى أرض رملية خلال ٢٠٠٥ و ٢٠٠٦ على صنف عنب روبى سيدلس عمر ١٢ عام وكانت المعاملات كالاتى ، جير (٣ جم/لتر) مع كبريت ميكرونى (٣ جم/لتر) أو مع أوكسى كلورنحاس (٣ جم/لتر) ، كلوريد كالسيوم (٣ جم/لتر) مع كبريت ميكرونى (٣ جم/لتر أو مع أوكسى كلورنحاس ٣ جم/لتر ، جير + كلوريد كالسيوم + كبريت ميكرونى أو مع أوكسى كلورنحاس بالإضافة للكنترول).

تم رش الجير بعد العقد بأسبوعين ، وكلوريد الكالسيوم بعد العقد بـ٣ أسابيع والكبريت الميكرونى على فترات قصيرة مرة كل أسبوع بعد التزهير الكامل حتى الأسبوع الرابع بعد العقد. أوكسى كلور النحاس تم رشه مرة واحدة مخلوطاً مع الكبريت الميكرونى فى الأسبوع الرابع. كل كروم التجربة تلقت الرش بالكبريت الميكرونى على فترات طويلة كل ١٥ يوم إبتداء من بعد تفتح البراعم.

وقد أظهرت المعاملة بالجير أو كلوريد كالسيوم مع الكبريت الميكرونى أو مع أوكسى كلور النحاس زيادة غير معنوية فى وزن العنقود وكانت الزيادة معنوية لمتوسط وزن الحبة ، متوسط حجم الحبة ، صلابة الحبات ، TSS ، محتوى عصير الحبات من السكر (سكريات ذائبة – سكريات كلية) بالمقارنة بالكنترول.

أفضل زيادة فى الصفات السابقة تحققت مع المعاملة بالجير وكلوريد الكالسيوم مع الكبريت الميكرونى أو مع أوكسى كلور النحاس. ومن ناحية أخرى أظهرت المعاملتين السابقتين نقصا واضحا فى الحموضة الكلية بالمقارنة بالكنترول.

وزن خشب التقليم (أفرع الموسم الجارى) ، متوسط مساحة الورقة – سمك الدابرة لم تظهر فروق معنوية فى الموسم الأول نتيجة غياب تأثير المعاملات حيث أجريت بعد إختبار كرمات التجربة (المعرفة تماثل قوة النمو) ولكن فى الموسم الثانى أظهرت المعاملات زيادة معنوية فى تلك الصفات مع الجير والكالسيوم مع الكبريت الميكرونى أو مع أوكسى كلور النحاس ولم تكن الفروق معنوية مع سمك الدابرة.

تم ملاحظة أعراض كلا من البياض الدقيقى والزغبى أسبوعيا إبتداء من التزهير الكامل حتى النضج ولم تظهر أعراض الإصابة به فى موسمى الدراسة لكلا المرضين على كروم الروبى اللابذرى المعاملة.