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EFFECT OF MINERAL OR CHELATED CALCIUM AND MAGNESIUM ON GROWTH AND BUNCH AND BERRY CHARACTERISTICS OF FLAME SEEDLESS GRAPEVINES GROWN IN SANDY SOILS

1- EFFECT ON GROWTH AND CHEMICAL COMPOSITION OF LEAVES AND CANES

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ABSTRACT

This experiment was carried out during 1997 and 1998 seasons on Flame seedless grapevines grown in a sandy soil to throw some light on the effect of spraying mineral or chelated compounds of Ca and Mg on growth and chemical composition of leaves and canes. Nine treatments i.e control, calcium chloride at 0.5 and 1.0 %; Ca-EDTA at 0.15 and 0.30%, magnesium sulphate at 0.5 and 1% and Mg- EDTA at 0.15 and 0.3 % were involved. The vines received three sprays of Ca and Mg (i.e March 15^{-th} ; May 1^{-st} and June15th)

Results showed that foliar application of chelated compounds at 0.15 to 0.30% as well as mineral compounds at 0.5 to 1.0 % from Ca and Mg was favourable in improving all growth parameters, leaf pigment content, leaf content of Ca and Mg and cane content of total carbohydrates compared to unsparing. Chelated form of each macronutrients was surpassed the mineral one in enhancing most of the studied characteristics. Shoot length, internode length, leaf area, cane thickness, chlorophyll A and B and cane total carbohydrate contents were positively affected by the application of Mg-EDTA at 0.30%. Application of Ca-EDTA at 0.3% had a promising effect on number of leaves per shoot and weight of pruning wood.

The best results with regard to growth and nutritional status of Flame Seedless vines were obtained by spraying 0.3% Mg-EDTA or 0.3% Ca-EDTA three times during the growing season .

INTRODUCTION

In the past two decades, the Egyptian Ministry of Agriculture imported a number of grape cvs. which widely vary in their ripening time. Flame Seedless is one of these cultivars, which proved to be promising as early ripening cultivar even more than the local cultivar Thompson Seedless.

Efforts have always been exerted to improve the growth and production of grapevines through a better understanding of the various horticultural practices particularly nutrition with calcium and magnesium. Calcium and magnesium play an important role in improving growth, nutritional status of the trees. Calcium has received considerable attention in the recent years due to its favourable effects in delaying senescence (Poovaiah, 1979), controlling physiological disorders in fruits and prolonging the shelf life of the fruits. Also, it is essential for strengthening cell walls and membranes (Poovaiah, 1986). Magnesium plays several important roles

especially in activating many plant enzymes and stimulating the biosynthesis of chlorophylls and carbohydrates (Devlin, 1972).

Foliar application of calcium compounds particularly at the optimum concentrations substantially improved growth of various grapevine cvs (Bergman *et al*., 1960; Al-Saidi and Alawi, 1986; Spiers and Braswell, 1994 and Rizk and Rizk, 1994b) and vine nutritional status (Poovaiah and Leopold, 1973).

Previous studies showed that spraying magnesium compounds considerably hastened growth aspects of different grapevine cvs (Wolf *et al.*, 1983, Kilany, 1992 and Rizk and Rizk, 1994a) and stimulated vine nutritional status (Hagler, 1957; Bucher, 1978 and Kilany, 1992).

The first part of this study was designed to throw some light on the beneficial effects of spraying mineral or chelated calcium and magnesium compounds on the growth and nutritional status of Flame Seedless grapevines grown in sandy soil.

MATERIALS AND METHODS

The present study was carried out during 1997 and 1998 seasons on 8 years-old Flame Seedless grapevines, grown in a private vineyard located at 63 Kilometers from Cairo on Cairo-Alexandria desert road. The double-cordon system was used in training the vines. Vines were pruned during the last week of December 1996 and 1997, to leave about 60-65 buds per vine. Vines were planted at 2x3 meters in a sandy soil and irrigated according to the drip irrigation system.

One hundred and eight uniform Flame Seedless grapevines were chosen and devoted for achieving this experiment.

The following nine treatments were applied:-

1- Control (water spraying)
2- Calcium chloride ($CaCl_2$) at 0.5 %
3- Calcium chloride at 1.0 %
4- Calcium-EDTA at 0.15 %
5- Calcium-EDTA at 0.30 %
6- Magnesium Sulphate ($MgSO_4$) at 0.5 %
7- Magnesium Sulphate at 1.0 %
8- Magnesium-EDTA at 0.15 %
9- Magnesium-EDTA at 0.30 %

Magnesium sulphate ($MgSO_4 .7H_2O$, 9.8% Mg), Calcium chloride ($CaCl_2$, 8% Ca), Calcium-EDTA (12% Ca in the form of calcium ethylene diamine tetra acetate) and Magnesium-EDTA (12% Mg in the form of magnesium ethylene diamine tetra acetate) were applied. Sprays of both calcium and magnesium compounds were done three times in each season on March 15th, May 1st and June 15th. Triton B as a wetting agent was added to all sprayed solutions and the vines were sprayed till runoff.

The present experiment was set in a randomized complete block design with three replicates per each treatment and each replicate consisted of four vines.

All vines received the regular horticultural practices already applied in the vineyards except those included in the experimental work.

1- **Vegetative growth**

The following growth aspects were measured in both seasons

- Shoot length : Shoot length was measured monthly from 1st April to the 1st of September.
- Ultimate shoot length was recorded by measuring the length of ten shoot/vine at the first week of September.
- Number of leaves/shoot in the first week of September
- Internode length
- Leaf area was measured in the middle part of the shoot during the first week of July according to Jain and Misra (1966).
- Cane thickness
- Weight of prunings in the last week of December

2- **Chemical composition**

Chlorophylls A and B as well as carotenoids in the leaves at the middle part of the shoots (on July 7th in both seasons) were determined according to Wettstein (1957). Leaf petiol content of Ca and Mg (on dry weight basis) was determined according to Piper (1950). Total carbohydrates in the basal parts of the canes (on dry weight basis) were determined using phenol-sulphuric acid method, described by Smith *et al.* (1956).

All the obtained data were tabulated and subjected to the new L.S.D. analysis according to Snedecor and Cochran (1972) .

RESULTS AND DISCUSSION

1- Vegetative growth

1-1 Shoot length:

Data in Table (1) clearly show that the growing shoots exhibited an active and significant continuous increase in their length with extending the periods of growth season with special reference to the first growth period from April 1st to May 1st. Kilany (1992) reported that shoot length increased gradually especially from mid-April up to mid-June.

1-2 Ultimate shoot length:

All Ca and Mg treatments significantly increased shoot length compared to the control treatment. Chelated form of both Mg and Ca at 0.3 % significantly gave the highest length of shoot, followed in a descending order by Mg-EDTA and Ca-EDTA at 0.15 %. The mineral forms of Mg or Ca had the lowest value of shoot length compared to chelated forms of both macronutrients. The minimum shoot length was detected on the vines which did not receive any form of Ca or Mg. These results were confirmed in both seasons of the study.

The positive influence of Ca on increasing the shoot length of grapevines was previously reported by the results of Bergman *et al.* (1960) on Concord grapevines.

Moreover, Wolf *et al.* (1983) and Kilany (1992) who working on Serval Blanc and Thompson Seedless grapevines, respectively showed the striking effect of using Mg on growth of vines.

Table (1): Effect of mineral or chelated calcium and magnesium sprays on current shoot growth of Flame Seedless grapevines (1997 and 1998 seasons).

Treatments	1997							1998						
	1 / 4	1 / 5	1 / 6	1 / 7	1 / 8	1 / 9	Mean	1 / 4	1 / 5	1 / 6	1 / 7	1 / 8	1 / 9	Mean
1- Control	53.8	122.6	127.3	140.3	152.0	156.3	125.3e	61.6	121.6	127.6	141.0	153.3	160.6	127.6e
2- $CaCl_2$ 0.5 %	53.8	139.0	145.0	156.6	166.6	170.3	138.5d	67.6	147.3	153.3	165.6	177.3	182.6	148.9d
3- $CaCl_2$ 1.0 %	53.8	159.3	165.3	174.3	182.3	186.0	153.4c	65.6	165.0	171.0	182.3	193.0	201.3	163.03c
4-Ca-EDTA 0.15%	55.4	180.0	187.6	197.0	205.0	208.3	172.2b	61.6	183.0	189.3	203.0	217.6	227.6	180.3b
4-Ca-EDTA 0.3%	58.2	218.3	224.3	232.3	240.3	243.3	202.8a	63.6	206.3	213.0	227.6	242.0	251.0	200.5a
6-$MgSO_4$ 0.5 %	55.4	141.6	145.0	157.3	167.0	171.6	139.6d	63.6	147.3	152.6	162.6	176.3	185.6	148.0d
7-$MgSO_4$ 1.0 %	55.5	159.6	163.0	173.6	184.0	188.0	153.9c	63.0	163.0	168.6	180.0	191.6	197.3	160.5c
8-Mg-EDTA 0.15%	55.5	180.6	185.0	197.3	207.3	212.6	173.05b	68.0	188.0	194.3	207.3	220.0	231.6	184.8b
9-Mg-EDTA 0.3%	58.1	220.6	225.6	234.6	243.6	247.0	204.9a	68.3	208.3	214.0	227.3	240.3	247.6	200.9a
Mean	55.5d	169.1c	174.3c	184.9b	194.3a	198.2a		64.8d	170.0c	176.0c	188.5b	201.2a	209.5a	

Values with the same letter (s) in common do not differ significantly at 5% level

1-3 Number of leaves/shoot:

It is evident from the data presented in Table (2) that foliar application of Ca and Mg significantly raised the number of leaves/shoot comperd to control. Spraying Ca-EDTA at 0.3 % gave the highest number of leaves/shoot followed by Mg-EDTA at both concentrations. Chelated form of both Ca and Mg was preferable than using mineral form in increasing the number of leaves /shoot. Shoots of check vines had the least number of leaves and where as mineral nutrient treatments were in between in this respect. Ca application at 1, 3 or 10 mμ increased number of leaves per shoot of blueberry plants (Wright *et al.,* 1992).

Table (2): Effect of mineral or chelated calcium and magnesium sprays on some vegetative growth aspects of Flame Seedless grapevines (1997 and 1998 seasons).

Treatments	1997						1998					
	Ultimate shoot length (cm)	Number of leaves /shoots	Inter-node length (cm)	Leaf area (cm^2)	Cane thick-ness (cm)	Weight of pruning wood (kg)	Ultimate shoot length (cm)	Number of leaves /shoots	Inter-node length (cm)	Leaf area (cm^2)	Cane thick-ness (cm)	Weight of pruning wood (kg)
1- Control	156.3 f	17.3 f	9.04 ab	155.1 l	0.73 c	3.2 c	160.6 e	19.0 e	8.46 ab	179.0 l	0.73 c	3.0 c
2- $CaCl_2$ 0.5 %	170.3 e	19.3 e	8.0 abc	163.7 h	0.93 b	5.3 b	182.6 d	21.0 d	8.7 a	180.32h	0.86 b	5.06 b
3- $CaCl_2$ 1.0 %	186.0 c	24.3 d	7.65 de	172.95 f	1.0 b	5.3 b	201.3 c	26.0 c	7.74 cd	183.3 g	0.90 ab	5.06 b
4- Ca-EDTA 0.15%	208.6 b	25.0 c	8.35bcd	193.95d	1.03 b	6.4 a	227.6 b	26.6 c	8.54 ab	193.68 f	0.93 ab	6.16 a
5- Ca-EDTA 0.3%	243.3 a	30.0 a	8.1 cde	201.3 c	1.06 b	6.8 a	251.6 a	31.6 a	7.92 cd	187.71e	0.93 ab	6.5 a
6- $MgSO_4$ 0.5 %	171.6 e	19.6 d	8.73abc	167.6 g	0.93 b	5.0 b	185.6 d	21.3 d	8.69 a	215.96d	0.90 ab	4.7 b
7- $MgSO_4$ 1.0 %	188.0 c	25.0 c	7.52 e	188.41e	0.96 b	5.0 b	197.3 c	26.6 c	7.39 d	217.14c	0.90 ab	4.7 b
8- Mg-EDTA 0.15%	212.6 b	27.0 b	7.89 de	205.9 b	1.03 b	5.3 b	231.6 b	28.6 b	8.08 bc	219.42b	0.93 ab	5.06 b
9- Mg-EDTA 0.3%	247.0 z	27.0 b	9.14 a	212.9 a	1.1 a	6.0 ab	247.0 a	28.6 b	8.63 a	249.56a	0.96 a	5.7 ab

Values with the same letter (s) in common do not differ significantly at 5% level

1-4 Internode length:

Results of Table (2) clearly show that using Mg-EDTA at 0.3 % increased internode length in both seasons, but the increase was not statistically different from the control. Also, $CaCl_2$ at 0.5 % and Mg 504 at 0.5 % in the second season raised the values of this parameter. Other Ca and Mg treatments tended to give the shortest internodes in both seasons.

The promoting influence of Mg on growth was supported by the results of Kilany (1992) on Thompson Seedless grapevines.

1-5 Leaf area:

Spraying Flame Seedless grapevines with chelated or mineral forms of Ca and Mg was very effective in increasing the leaf area as compared to the control. Chelated compounds of both Ca and Mg surpassed the mineral ones in increasing the leaf area. Foliar application of Mg-EDTA at 0.30 %, Mg-EDTA at 0.15, Ca-EDTA at 0.30 and Ca-EDTA at 0.15 % increased significantly the leaf area in a descending order, respectively. Leaves of the control vines had significantly the smallest leaf area. The other treatments were in between in this connection.

Promotive effect of magnesium application in response to leaf area was confirmed by the results of Kilany (1992) on Thompson Seedless grapevines.

1-6 Cane thickness:

It is clear from the data shown in Table (2) that all Ca and Mg treatments where found to increase significantly the cane thickness compared to the check treatment. Chelated compounds were more effective than mineral ones in increasing cane thickness. The maximum values were obtained on vines receiving three sprays of Mg-EDTA at 0.15 to 0.30 %. While the check vines produced the thinner canes. These results were true in both seasons.

1-7 Weight of prunings:

Data in Table (2) clearly show that spraying Ca or Mg three times from all sources was significantly very effective in increasing weight of pruning wood as compared to unspraying. The increase in such growth parameters was observed in vines treated with Ca-EDTA at 0.30, Ca-EDTA at 0.15 %, Mg-EDTA at 0.3 % and Mg-EDTA at 0.15 % in a descending order. The maximum and minimum values were detected on vines receiving Ca-EDTA at 0.3% and those untreated, respectively. These results were true in both seasons.

2-Chemical composition

2-1 Leaf content of pigments:

As shown in Table (3), it is worthy to mention that all Ca and Mg treatments had a higher content of announced chlorophyll A and B than control treatment. Leaves borne on vines receiving magnesium treatments either as mineral or chelated form seemed to contain more chlorophylls than those borne on untreated vines or calcium treatments. This can be explained in the light of magnesium role as a part of the chlorophyll molecule. Concerning the carotene content, all Mg treatments in both seasons and calcium treatments in the second season significantly increased the leaf content of carotenoids.

These results are in harmony with those obtained by Bucher (1978) and Kilany (1992) on Thompson seedless grapevines.

Table (3): Effect of mineral or chelated calcium and magnesium sprays on leaf content of pigments (mg /g fresh weight) of Flame Seedless grapevines (1997 and 1998 seasons).

Treatments	1997			1998		
	Chl A	Chl B	Carotene	Chl A	Chl B	Carotene
1- Control	0.51 c	0.24 d	0.7ab	0.83 bc	0.31 c	0.43 b
2- $CaCl_2$ 0.5 %	0.65 bc	0.31 c d	0.55 b	0.78 c	0.42 c	0.73 a
3- $CaCl_2$ 1.0 %	0.63 bc	0.49 bcd	0.54 b	0.801 c	0.47 c	0.80 a
4-Ca-EDTA 0.15%	0.95 ab	0.40 bcd	0.47 b	0.77 c	0.41 c	0.90 a
5-Ca-EDTA 0.3 %	0.54 c	0.45 abcd	0.55 b	0.87abc	0.46 c	0.83 a
6-$MgSO_4$ 0.5 %	0.82 abc	0.61 abcd	0.79 a	1.12 ab	0.71 c	0.83 a
7-$MgSO_4$ 1.0 %	1.22 a	0.78 ab	0.93 a	1.20 a	0.82 c	0.92 a
8-Mg EDTA 0.15%	1.02 ab	0.69 abc	0.91 a	1.21 a	0.49 b	0.90 a
9-Mg-EDTA 0.3%	1.14 a	0.80 a	0.86 a	1.12 ab	0.77 a	0.84 a

Values with the same letter (s) in common do not differ significantly at 5% level

2-2 Leaf content of Ca and Mg:

It is clear from the data in Table (4) that all Ca and Mg treatments significantly increased leaf content of Ca as compared to the check treatment. Calcium-treatments greatly surpassed magnesium treatments in increasing the leaf content of Ca. All Ca treatments either in mineral or chelate form significantly increased the leaf content of Ca and the increment reached more than 5 % in both seasons. The maximum value of Ca was presented in vines receiving three sprays of Ca-EDTA at 0.3%. Magnesium treatments had a slight effect on increasing the leaf content of calcium. However, control leaves had the lowest values of calcium content.

Table (4): Effect of mineral or chelated calcium and magnesium sprays on leaf content of Ca (mg /100 g D.W.) of Flame Seedless grapevines (1997 and 1998 seasons).

Treatments	1997				1998			
	1 / 4	15 / 5	1 / 7	Mean	1 / 4	15 / 5	1 / 7	Mean
1- Control	0.64	0.62	0.67	0.64 e	0.65	0.69	0.73	0.69e
2-$CaCl_2$ 0.5%	0.86	0.85	0.94	0.88 c	0.83	0.84	0.87	0.85c
3-$CaCl_2$ 1.0%	0.88	0.97	1.05	0.97 c	0.90	0.94	0.97	0.94b
4-Ca-EDTA 0.15%	0.89	0.89	1.04	0.94b	1.01	1.04	1.13	1.06a
5-Ca-EDTA 0.3%	0.92	1.10	1.17	1.06 a	1.08	1.12	1.20	1.13a
6-$MgSO_4$ 0.5 %	0.80	0.66	0.65	0.70 e	0.74	0.78	0.75	0.75d
7-$MgSO_4$ 1.0 %	0.79	0.74	0.65	0.73d	0.69	0.75	0.73	0.72d
8-Mg EDTA 0.15%	0.78	0.68	0.71	0.72d	0.76	0.75	0.74	0.75d
9-Mg EDTA 0.3%	0.80	0.68	0.68	0.72d	0.69	0.71	0.73	0.71d

Values with the same letter (s) in common do not differ significantly at 5% level

As far as leaf content of Mg, in this concern, it is clear that Mg treatments generally gained the highest significant values. The maximum values were detected on leaves picked from vines receiving Mg-EDTA at

0.30%. The minimum values were detected on leaves of the untreated vines. These results were similar in both seasons (Table 5).

Obtained results concerning the effect of Mg on leaf Mg content are in the same line with those obtained by Rizk and Rizk (1994a)on Thompson Seedless grapevines.

Table (5): Effect of mineral or chelated calcium and magnesium sprays on leaf content of Mg (mg /100 g D.W.) of Flame Seedless grapevines (1997 and 1998 seasons).

Treatments	1997				1998			
	1 / 4	15 / 5	1 / 7	Mean	1 / 4	15 / 5	1 / 7	Mean
1- Control	0.68	0.72	0.75	0.71g	0.65	0.65	0.75	0.69f
2-$CaCl_2$ 0.5%	0.80	0.76	0.79	0.78f	0.81	0.69	0.83	0.78e
3-$CaCl_2$ 1.0%	0.80	0.80	0.84	0.81d	0.84	0.70	0.84	0.79de
4-Ca-EDTA 0.15%	0.82	0.79	0.82	0.81e	0.81	0.73	0.83	0.79de
5-Ca-EDTA 0.3%	0.79	0.80	0.82	0.80e	0.84	0.73	0.84	0.80d
6-$MgSO_4$ 0.5 %	0.91	0.87	0.90	0.89b	0.88	0.80	0.91	0.86c
7-$MgSO_4$ 1.0 %	0.93	0.86	0.87	0.89b	0.91	0.80	0.92	0.87c
8-Mg EDTA 0.15%	0.88	0.87	0.91	0.89c	0.97	0.85	0.96	0.93b
9-Mg EDTA 0.3%	0.98	0.89	1.11	0.99a	1.01	0.83	1.33	1.06a

Values with the same letter (s) in common do not differ significantly at 5% level

3. Cane carbohydrate content:

It is obvious from the data presented in Table (6) that all Ca and Mg treatments were found to increase cane total carbohydrate content as compared to the control treatment. Spraying of magnesium compounds was more than calcium compounds in increasing total carbohydrates in the cane. The maximum values were detected on canes from vines receiving three sprays of Mg-EDTA at 0.30 % while canes from untreated vines had the lowest values.

Table (6): Cane content of total carbohydrates (%) of Flame Seedless grapevines as affected by mineral or chelated calcium and magnesium sprays (1997and 1998 seasons).

Treatments	1997	1998
1- Control	14.98 g	21.69 c
2-$CaCl_2$ 0.5%	17.6 f	21.93 bc
3-$CaCl_2$ 1.0%	22.16 de	22.33 abc
4-Ca-EDTA 0.15%	22.44 cde	24.38 abc
5-Ca-EDTA 0.3%	24.59 abc	24.97 ab
6-$MgSO_4$ 0.5 %	20.5 e	22.18 bc
7-$MgSO_4$ 1.0 %	22.91 bcd	22.67 abc
8-Mg EDTA 0.15%	25.07 ab	22.78 abc
9-Mg EDTA 0.3%	26.56 a	25.45 a

Values with the same letter (s) in common do not differ significantly at 5% level

Our findings go in line with those of Devlin (1972) who mentioned that Mg plays two roles in the plant, i.e., process of photosynthesis and carbohydrate metabolism. The same conclusion was mentioned by Kilany (1992) on Thompson Seedless grapevines.

As a conclusion, three sprays of 0.30 % Mg-EDTA or 0.30 % Ca-EDTA are recommended for gaining the best results with regard to growth and vine nutritional status of Flame Seedless vines.

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تأثير الكالسيوم والماغنسيوم المعدني أو المخلبي على نمو وصفات عناقيد وحبات كرمات العنب الفليم سيدلس النامي في الأراضي الرملية

1- التأثير على النمو الخضري والتركيب الكيماوي للأوراق والقصبات

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**** قسم العنب- معهد بحوث البساتين- مركز البحوث الزراعية- الجيزة- مصر**

أجريت هذه التجربة خلال موسمي 1997 ،1998 على كرمات العنب الفليم سيدلس النامي في الأراضي الرملية وذلك لالقاء المزيد من الضوء على تأثير رش بعض مركبات الكالسيوم والماغنسيوم المعدني أو المخلبي على النمو والتركيب الكيماوي للورقة.

ولقد تضمنت التجربة تسعة معاملات هى معاملة المقارنة ، كلوريد الكالسيوم بتركيز 5,. ، 1 % كالسيوم مخلبي بتركيز 15,. ، 30,. % كبريتات الماغنسيوم بتركيز 5,. ، 1 % ، الماغنسيوم المخلبي بتركيز 15,. ، 30,. %. ولقد تم رش الكرمات بالكالسيوم والماغنسيوم ثلاثة مرات.

ولقد أشارت نتائج الدراسة الى أن الرش الورقي للمركبات المخلبية بتركيز 15,. ، 30,. % أو استخدام المركبات المعدنية بتركيز 5,. ، 1 % كان مفيدا في تحسين جميع الصفات الخضرية ومحتوى الورقة من الصبغات النباتية والكالسيوم والماغنسيوم كذلك محتوى القصبات من الكربوهيدرات الكلية وذلك بالمقارنة بعدم الرش. ولقد تفوقت الصورة المخلبية للكالسيوم والماغنسيوم عن تلك المعدنية في تحسين جميع الصفات تحت الدراسة. ولقد تأثرت صفة طول النموات الخضرية وطول السلامية ومساحة الورقة ومحتواها من كلورفيل أ ، كلورفبل ب والكاروتينات وسمك القصبات مع استخدام الماغنسيوم المخلبي بتركيز 30,. % كما كان لاستخدام الكالسيوم المخلبي تأثير واضح على عدد الأوراق على النمو الخضري الواحد ووزن خشب التقليم.

ولقد أمكن الحصول على أفضل النتائج بخصوص النمو والحالة الغذائية لكرمات العنب الفليم سيدلس عند رش الماغنسيوم المخلبي بتركيز30,. % أو الكالسيوم المخلبي بتركيز 30,. % ثلاث مرات خلال موسم النمو (في منتصف مارس ، أول مايو ، منتصف يونيو).