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STUDIES ON POTASSIUM FERTILIZATION AND SUMMER PRUNING ON THOMPSON SEEDLESS GRAPES

Samra, N.R.; M.I. El-Kady; A.H. Hassan and O.S. Mattar
Pomology Dept., Fac. of Agric., Mansoura Univ.

ABSTRACT

This study was carried out during the seasons of 2000 and 2001 to evaluate the effect of potassium fertilization, each alone or with summer pruning on vine growth, yield, berry quality and changes in N, P, K, Ca and Mg in leaf petioles of Thompson Seedless grape.

The data revealed that, potassium fertilization at 150 g/vine each alone or with summer pruning significantly increased leaf area, yield per vine, cluster and berry weight than adding potassium at 100 or 50 g/vine. Also, this treatment presented a somewhat increment in SSC/acid ratio in berry juice and NPK, but reduced the values of both Ca and Mg in leaf petioles.

INTRODUCTION

Grape (*Vitis vinifera*, L.) is considered the first deciduous fruit crop in both area and production all over the world, and the second major fruit grown in Egypt after citrus. Vineyards have increased in the last few years especially in the newly reclaimed lands. The total area of grapes reached about 142241 feddans producing about 1075105 metric tons according to the last statistics of (Ministry of Agriculture, 2001).

Thompson Seedless grape is the most important table grape cultivar grown in Egypt. Since, its acreage is about 93031 feddans, producing about 697732 metric tons according to the last statistics of (Ministry of Agriculture, 2001).

Potassium is very mobile element in the plant, since it transports directly towards the meristematic tissues. Moreover, potassium concentration in younger grapevine leaf petioles moves towards the shoot apex. Furthermore, potassium is most important cation not only in regard to its amount in plant parts, but also to its physiological and biochemical functions (Mengel and Kirkby, 1987).

Summer pruning includes head suckering, pinching and topping, maintaining laterals, removal of laterals and topping laterals. The majority of grape growers in Egypt either do not apply summer pruning practices in their vineyards or carry out them incorrectly at improper time with the result that most of the current season shoots do not ripen well. Perhaps due to the consumption of assimilates manufactured in the leaves for the continuity of shoot growth instead of being stored in some vine parts as canes for the subsequent winter pruning.

This investigation aimed to study the effect of potassium fertilization either alone or with summer pruning on vegetative growth, yield, berry quality and mineral content in leaf petioles of Thompson Seedless grapevines.

MATERIALS AND METHODS

This study was carried out during the seasons of 2000 and 2001 on Thompson Seedless grapevines growing at El-Dear Village near Aga, Dakahlia Governorate, Egypt. The vines were spaced at 2 x 2.5 m using cane-pruning system and trained to head trellis with three upward wires (normal trellis system).

The aim of this investigation was to study the effect of potassium fertilization and summer pruning each alone or in combination on vegetative growth, yield, berry characteristics and changes in mineral content in leaf petioles of Thompson Seedless grapevines.

At the beginning of this experiment, soil samples were taken from (0-30 and 30-60 cm depths) at 5 different sites representing major portion of the root zone at March 5th, 2000. The samples of each layer were completely mixed to measure physical and chemical characteristics of the soil. The obtained results are presented in Table (1).

Table (1) : Soil physical and chemical analysis.

Soil properties	Soil depth	
Physical analysis	(0 – 30 cm)	(30 – 60 cm)
Clay %	43.75	43.34
Silt %	40.33	40.05
Sand %	10.67	11.26
Organic matter%	2.35	1.14
$CaCo_3$%	2.90	4.21
Texture class	Silty – clay	Silty – clay
Chemical analysis		
Available K meq/100 gm soil	0.035	0.033
pH	7.6	7.7
E.C. (m mohs/cm)	3.1	4.1

For this study, 72 vines of about 9 year old were almost similar in vigor and productivity received to the normal horti-cultural practices were used in this vineyard.

Factorial experimental design with Complete Randomized Block Design. Since the vines were chosen in 4 replicates each one contained 3 vines represented one of these treatments. Guard vines and also borders were made between each replicate and block. All applications were made during the summer growth period.

Potassium fertilization was applied in the soil as potassium sulphate [48-52% K_2O] at bud burst stage on April 5th, 2000 and April 1st, 2001 and at fruit set stage on May 15th 2000, May 11th 2001 with three rates (50, 100 and 150 gm K_2O/vine) divided into two equal doses. The treatments are presented in Table (2).

Table (2) : The applied treatments used.

No.	Treatment
1	K_2O at 50 g/vine
2	K_2O at 50 g/vine with summer pruning.
3	K_2O at 100 g/vine
4	K_2O at 100 g/vine with summer pruning.
5	K_2O at 150 g/vine
6	K_2O at 150 g/vine with summer pruning.

Super phosphate [15.5% P_2O_5] was applied at [200 gm super phosphate/vine] before bud burst. Yet, Potassium fertilization was added at two equal doses one at bud burst and the other after fruit set.

Nitrogen (60 units) was applied in the soil as ammonium nitrate [33.5 % N] in three equal doses (20 g N/vine/dose) with the second addition of potassium fertilization at fruit set stage June 10th 2000 and June 5th 2001, after harvesting time at August 10th 2000 and August 1st 2001respectively.

After fruit set, the leaves under the clusters were removed, pinching the main shoots after reaching 120 cm. from the base by cutting off 1-2 cm of the shoot tip and tied at the third wire with polyethylene. Topping the laterals was carried out when ever found after 30-40 cm, from the base.

The following measurements and analysis were carried out :

1- Trunk growth:

It was determined at the beginning of the experiment 2000 and 2001 seasons before the bud burst by using a vernier caliper, and the increment during the seasons was calculated in cm.

2- Average Leaf area:

It was determined (cm^2) by using a planimeter.

3- Yield and berry contents :

At August 1st /2000 and July 21st /2001 when SSC/acid ratio ranged about 20-21%, number of clusters was recorded for individual vines. Samples of 24 cluster/treatment (6 clusters from each replicate) were taken to the Laboratory of Pomology Dept., Mansoura Univ. to estimate average clusters weight and yield/vine.

Samples of 100 berries were taken from each replicate to determine:

1- **Soluble solids content** : It was determined by using hand refractometer.
2- **Titratable acidity** : It was expressed as gm tartaric acid/100 ml juice according to A.O.A.C. (1980).
3- **Soluble solids/acid ratio** in berry juice.

4- Leaf mineral content:

At full bloom, samples of 24 leaf petioles from the opposite side from the cluster were taken, dehydrated and grinded to determine N, P, K, Ca and Mg contents.

1- **Total nitrogen content** : was determined according to the Methods described by, Pregle (1945) using micro Kjeldahl.

2- **Phosphorus %** : was determined colourmetrically using the method described by, Jackson and Volk (1968).
3- **Potassium %** : was determined using flame photometer according to **Black (1960).**
4- **Calcium & Magnesium %** : were determined by titration against Versen solution (Na-EDTA) as described by U.S. salinity laboratory staff (Anonymous, 1954).

Statistical analysis of the present data was carried out according to, Snedecor and Cochran (1972). The data were subjected to analysis of variance. Means were compared using LSD test at 5% level of probability.

RESULTS AND DISCUSSION

This investigation aimed to study the effect of potassium fertilization under different levels with or without summer pruning on yield, berries quality and mineral contents of Thompson Seedless grapes .

Effect of Potassium fertilization and summer pruning on vine growth :

It is obvious from Table (3) that average trunk thickness increased during the second season more than the first one under different level of potassium fertilization either alone or with summer pruning. The increment in trunk thickness was higher by increasing the level of potassium fertilization. Potassium fertilization at 150 gm/vine gave a higher values than at 50 or 100 gm potassium/vine. Thus, potassium fertilization at 50 gm/vine, gave the lowest increment in trunk thickness. Similar results were obtained by, Morris *et al.*, (1980) they found that the vine size was significantly increased with increasing the level of potassium fertilization.

Whereas, summer pruning gave no clear effect on trunk thickness under different level of potassium fertilization. Thus, the increment in trunk thickness could be mainly due to potassium fertilization not to summer pruning. In this respect, Reynolds (1989) mentioned that, cluster and shoot thinning with balanced pruning and base shoot removal resulted in the best growth of vines.

Table (3): Effect of potassium fertilization and summer pruning on trunk thickness and leaf area of Thompson Seedless grapes.

Treatment	Trunk thickness (cm)		Leaf area (cm^2)	
	2000	2001	2000	2001
50 g K_2O/vine	5.53	6.22	139.7 c	141.2 c
50 g K_2O/vine with SP.	5.22	5.92	140.2 c	144.2 c
100 g K_2O/vine	5.17	6.00	144.8 b	142.3 c
100 g K_2O/vine with SP.	5.68	6.40	148.9 a	149.5 b
150 g K_2O/vine	5.77	6.78	150.3 a	152.0 b
150 g K_2O/vine with SP.	5.00	6.33	151.8 a	157.9 a
L.S.D 5%	N.S	N.S	3.70	3.66

Leaf area (cm^2):

It is clear from Table (3) that average leaf area of Thompson Seedless grape was increased by increasing the amount of potassium fertilization. In this respect, potassium fertilization at 150 g/vine produced higher values of leaf area than 50 or 100 g/vine. Yet, the lower level of potassium 50 g/vine, gave a lower leaf area than the two levels of potassium on both seasons under the study. These results agree with the findings of, Ahmed (1991) which concluded that adding 139.5 g N, 54 g P_2O_5 and 144 g K_2O per fed. achieved the maximum leaf area of Thompson Seedless grapevines.

On the other hand, summer pruning gave a little effect in this respect. Since, the average of leaf area was increased in the first season but the effect was not significant in the second one. In this respect, Ryabchun (1975) disclosed that, topping resulted in decreasing total leaf area, assimilation and stimulation of the remaining leaves.

Effect of potassium fertilization and summer pruning on yield, cluster weight and berry quality :

Yield per vine :

Data in Table (4) Indicated that, yield per vine (kg) was significantly increased by increasing the amount of potassium fertilization. The higher level of potassium fertilization (150 g per vine) gave a higher and significant yield per vine than using 50 or 100 g per vine. Whereas, potassium fertilization at 100 g/vine with summer pruning produced a higher yield than those left without summer pruning. Yet, potassium fertilization at 50 g per vine produced a lower significant yield than from the two higher levels of potassium fertilization.

Table (4) : Effect of potassium fertilization and summer pruning on yield, cluster and berry weight of Thompson Seedless grapes.

Treatments	Yield/vine (kg)		Cluster weight (g)		Berry weight (g)	
	2000	2001	2000	2001	2000	2001
50 g K/vine	7.98 d	7.91 d	390.4 cd	416.3 d	1.31	1.23 e
50 g K/vine with SP.	8.86 c	9.99 bc	393.4 d	423.1 d	1.32	1.45 d
100 g K/vine	8.94 c	8.99 c	395.6 d	528.8 c	1.37	1.48 d
100 g K/vine with SP.	9.28 c	10.37 b	407.6 bc	432.0 d	1.32	1.61 b
150 g K/vine	10.41 b	12.71 a	419.4 b	605.0 a	1.52	1.53 c
150 g K/vine with SP.	11.41 a	13.2 a	438.0 a	573.8 b	1.52	1.73 a
L.S.D 5%	0.850	0.680	12.02	26.65	N.S	0.039

Concerning the effect of summer pruning, the data show that summer pruning with potassium fertilizer increased the yield per vine than potassium fertilization alone. In this respect potassium, fertilization at 150 g per vine with summer pruning gave about 11.5 kg/vine as a mean of two seasons. Thus, potassium fertilization at 50 g per vine gave lower yield 7.9 kg/vine as a mean of two seasons under the study. Also, Ahmed (2000) found that the yield was significantly increased by increasing K fertilization of Thompson Seedless

grape from (50 - 125 Kg/feddan), and the most effective treatment was (125 Kg K_2O/feddan).

It is interesting to note that, the increase in yield due to summer pruning treatments can be attributed to the increase of bunch weight in the first season. Yet, in the second one, yield can be ascribed to the increase in the average number of bunches per vine, as a result from the increase in both bud burst and bud fertility, furthermore, to their effect on increasing bunch weight (El-Gendy, 1997).

Cluster weight (g) :

Data from Table (4) show that cluster weight was significantly increased with increasing potassium fertilization at 150 g/vine, each alone or with summer pruning than treated vines with potassium at 50 or 100 g/vine in both seasons. Whereas, the effect of potassium fertilization at 100 g/vine gave insignificant effect than potassium fertilization at 50 g/vine in the first season but significantly increased cluster weight in the second one. Concerning the effect of summer pruning, the data also reveal that this treatment increased cluster weight when applied to the vines under different levels of potassium fertilization. These results are in agreement with the findings of, Abdel-All (1991) found that cluster weight of Thompson Seedless grape-vines was increased significantly by increasing potassium levels. Likewise, Reynolds *et al.* (1992) found that the weight of cluster was increased with shoot positioning + hedging after flowering to 12 leaves/shoot compared with control.

Berry weight (g) :

It is obvious from Table (4) that potassium fertilization at 150 g/vine, each alone or with summer pruning significantly increased the berry weight (g) than potassium fertilization at 50 or 100 g/vine each alone or with summer pruning during both seasons under the study. Also, potassium fertilization at 100 g/vine with summer pruning significantly increased average berry weight than 50 g K_2O/vine.

With regard to the effect of summer pruning, the data reveal that no clear effect was obtained with summer pruning under different levels of potassium fertilization in the first season. Yet, the values of berry weight during the second season were higher. So, adding 150 g K_2O/vine with summer pruning gave a higher berry weight than the other treatments. Similarly, Conradie and Saayman (1989) and Abdel-All (1991) mentioned that increasing potassium levels increased the berry weight and size significantly.

The increase in berry weight could be due to the fact that these treatments lead to increasing the photosynthetic activity in the leaves. (Ryabchun, 1975). Moreover, El-Gendy (1997) found that, head suckering + pinching the main shoots + maintaining laterals gave significant increase in berry weight and size of Thompson Seedless grapevines.

Soluble solid content :

It is clear from Table (5) that SSC in berry juice of Thompson Seedless grape was increased by increasing the amount of potassium fertilization. In this aspect, the data show that potassium fertilization at 100 or 150 g/vine gave higher values of SSC than potassium at 50 g/vine during both seasons under the study. These results agree with Abdel-All (1991) who

studied the influence of potassium on the SSC % of Thompson Seedless grapevines and found that SSC % was increased significantly by increasing potassium level. In addition, Ahmed (2000) mentioned that SSC % was increased by increasing number and level of potassium application to Thompson Seedless grape.

Regarding the effect of summer pruning, the data disclosed no clear effect on SSC in berry juice under different levels of potassium fertilization during the two seasons under the study.

Table (5) : Effect of potassium fertilization and summer pruning on SSC, acidity and SSC/acid ratio of Thompson Seedless grapes.

Treatment	SSC %		Acidity %		SSC/acid ratio	
	2000	2001	2000	2001	2000	2001
50 g K/vine	17.6	20.8	0.729	0.730 b	24.1	28.4
50 g K/vine with SP.	17.6	21.0	0.740	0.770 a	23.8	27.3
100 g K/vine	18.4	21.2	0.710	0.715 bc	25.9	29.7
100 g K/vine with SP.	18.4	21.5	0.711	0.755 a	25.9	28.4
150 g K/vine	18.4	21.5	0.659	0.715 bc	27.9	30.1
150 g K/vine with SP.	18.5	21.6	0.673	0.695 c	27.5	31.1
L.S.D 5%	N.S	N.S	N.S	0.031	N.S	N.S

Total acidity :

Data from Table (5) reveal that, increasing potassium fertilization reduced the percentage of total acidity in berry juice. Since, potassium fertilization at 150 g/vine produced lower acidity than obtained form 100 or 50 g/vine. Also, potassium fertilization at 100 g/vine produced lower total acidity than 50 g/vine. So, potassium fertilization at 50 g/vine, gave higher acidity in berry juice than the other treatments used during both seasons of the study. Similarly, Soyer *et al.*, (1992) mentioned that increasing potassium fertilization reduced the values of total acidity in berry juice. Whereas, summer pruning under different levels of potassium fertilization gave no significant effect in this respect. In addition, Ahmed (2000) found that total acidity was decreased significantly by increasing K_2O amount of Thompson Seedless grapevines.

SSC/acid ratio :

Table (5) indicated that SSC/acid ratio in berry juice was increased by increasing the amount of potassium fertilization. Since, potassium fertilization at 150 g/vine, gave higher values of SSC/acid ratio in berry juice than potassium fertilization at 100 or 50 g/vine. Also, potassium fertilization at 100 g/vine significantly increased the SSC/acid ratio than added 50 g/vine, since this treatment gave lower values than the other treatments used. Similar results were obtained by, El-Sese *et al.*, (1988) which found that potassium fertilization increased SSC/acid ratio, the highest rate of potassium (200 g/vine) increased the SSC/acid ratio than the control. Furthermore, Ahmed (2000) found that SS/acid ratio in berry juice of Thompson Seedless grapes was increased significantly by increasing K_2O amount.

The effect of summer pruning on SSC/acid ratio was not obvious, since the data presented no significant effect on SSC/acid ratio in berry juice when applied under different level of potassium. This is not astonishing since the effect on both SSC % and total acidity in berry juice during both seasons of the study was not significant.

Effect of Potassium fertilization and summer pruning on mineral content in leaf petioles:

Nitrogen

It is clear from Table (6) that total nitrogen in leaf petioles of Thompson Seedless grapevines was increased by increasing the amount of potassium fertilization each alone or with summer pruning. In this respect, the data show that potassium fertilization had no significant effect on total nitrogen, but gave a somewhat increment in nitrogen content in leaf petioles. Since, potassium fertilization at 150 g/vine each alone or with summer pruning produced higher values than the other levels of potassium. Whereas, summer pruning presented no clear effect in this aspect. So, combined treatment with potassium and summer pruning produced significant effect in this respect. Also, Omar (2000) working on Thompson Seedless grapevines, found a gradual and significant increase in the leaf nitrogen content due to raising K application rates from 0 to 125 Kg K_2O/fed.

Table (6) : Effect of potassium fertilization and summer pruning on NPK content in leaf petioles of Thompson Seedless grapes.

Treatment	Nitrogen %		Phosphorus %		Potassium %	
	2000	2001	2000	2001	2000	2001
50 g K/vine	1.657	1.36	0.130	0.148	1.000 d	1.37 b
50 g K/vine with SP.	1.661	1.52	0.128	0.130	1.025 cd	1.09 c
100 g K/vine	1.762	1.96	0.261	0.253	1.050 c	1.39 b
100 g K/vine with SP.	1.959	2.19	0.260	0.254	1.025 cd	1.35 b
150 g K/vine	1.881	2.43	0.423	0.424	1.200 a	1.54 a
150 g K/vine with SP.	2.048	2.59	0.415	0.447	1.125 b	1.35 b
L.S.D 5%	N.S	N.S	N.S	N.S	0.042	0.0490

Phosphorus :

It is obvious from Table (6) that increasing potassium fertilization increased the percent of phosphorus content in leaf petioles of Thompson Seedless grapevine. The data reveal that potassium fertilization at 150 g/vine gave a somewhat increment in phosphorus percentage than the two levels of potassium. Also, potassium fertilization at 100 g/vine gave a higher effect on phosphorus content than using 50 g K_2O/vine.

Whereas, summer pruning gave no clear effect during the two seasons under the study. In this respect, Lohnertz (1988) reported that there are no significant differences between leaf P values in all K. Also, Ahmed (2000) found that the P fertilization levels uptake was not affected by increasing K_2O amount of Thompson Seedless grapevine.

Potassium :

Data from Table (6) indicated that, the percentage of potassium in leaf petioles of Thompson Seedless grapevine was significantly increased by increasing the amount of potassium fertilization each alone or with summer pruning. The percent of potassium in leaf petioles when adding K at 150 g/vine was significantly higher than at 50 or 100 g/vine each alone, during both season under the study. Also, potassium fertilization at 100 g/vine significantly increased the percentage of potassium in leaf petioles than at 50 g K_2O/vine.

The data also disclose that no significant effect on potassium content was obtained with summer pruning under different levels of potassium fertilization during the first season, but in the second one, summer pruning under different levels of potassium fertilization gave a significant effect in this respect. Similar result was obtained by Huang *et al.*, (1992) which suggested that K content in Muscat Hamburg grape and leaf increased by applying potassium chloride alone or combined with N and P.

Ca and Mg contents :

From Table (7) its clear that the percent of both Ca and Mg in leaf petioles of Thompson Seedless grapevines was decreased significantly by increasing the amount of potassium fertilization each alone or with summer pruning. The data also reveal that adding 150 g K_2O/vine gave a significant decrease in Ca and Mg in leaf petioles than with 50 or 100 g K_2O/vine. Also, potassium fertilization at 100 g K_2O/vine gave a significant decrease in Ca and Mg in leaf petioles than 50 g K_2O/vine. Whereas, summer pruning significantly decreased the content of Ca in leaf petiole in the first season under different levels of potassium fertilization, but in the second one summer pruning presented significant effect on Ca percent in leaf petioles. Yet, summer pruning alone had no effect on the percent of Mg in leaf petioles. In the second season, the data reveal that summer pruning gave a significant decrease in the percent of Mg under different levels of potassium. Similar effect was obtained by, Ahmed (2000) who studied the effect of potassium sulphate at 0, 50, 75, 100 and 125 Kg K_2O/feddan on Thompson Seedless, and showed that Ca and Mg were decreased by K application.

Table (7): Effect of potassium fertilization and summer pruning on Ca and Mg content in leaf petioles of Thompson Seedless grapes.

Treatments	Ca %		Mg %	
	2000	2001	2000	2001
50 g K/vine	1.315	1.325	0.314 a	0.460
50 g K/vine with SP.	1.315	1.553	0.287 b	0.245
100 g K/vine	1.130	1.250	0.270 bc	0.400
100 g K/vine with SP.	1.315	1.375	0.287 b	0.230
150 g K/vine	1.069	1.157	0.260 c	0.325
150 g K/vine with SP.	1.288	1.225	0.265 c	0.210
L.S.D 5%	N.S	N.S	0.019	N.S

From this study it is clear that adding potassium fertilization at 100 or 150 g./vine with or without summer pruning increased both yield and cluster weight due to their effect on increasing berry weight significantly. Also, these treatments increased the values of SSC/acid ratio in berry juice. So, it improved berry quality of Thompson Seedless grape. Thus, potassium fertilization increased the values of NPK, but reduced both Ca and Mg in leaf petioles.

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دراسات على التسميد البوتاسى والتقليم الصيفى فى العنب البناتى

نبيل رشاد السيد سمره ، محمود إبراهيم القاضى، عبد العال حجازى حسن و أسامة سمير مطر
قسم الفاكهة – كلية الزراعة – جامعة المنصورة

أجريت هذه الدراسة خلال عامين ٢٠٠٠ & ٢٠٠١ لتقييم أثر التسميد البوتاسى سواء بمفرده أو مع التقليم الصيفي على نمو الكرمات والمحصول وصفات الحبات وكذا التغير فى محتوى أعناق الأوراق من NPK وكذا Ca , Mg .

ولقد أوضحت الدراسة أن التسميد البوتاسى بمعدل ١٥٠ جم للكرمة سواء بمفرده أو مع إجراء التقليم الصيفى أدى إلى زيادة المساحة الورقية وكذا محصول الكرمة ومتوسط وزن العنقود وكذا الحبات معنويا مقارنة بالتسميد البوتاسى بمعدل ٥٠ أو ١٠٠ جم للكرمة.

كما أظهرت النتائج أن التسميد البوتاسى بمعدل ١٥٠ جم للكرمة مع التقليم الصيفى أدى إلى زيادة بعض الشيء فى محتوى عصير الحبات من المواد الصلبة الذائبة للحموضة وكذا محتوى أعناق الأوراق من NPK. بينما أدت هذه المعاملة لخفض محتوى أعناق الأوراق من كلا من Ca , Mg.