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POTASSIUM APPLICATION TO THOMPSON SEEDLESS GRAPEVINES IN CLAY SOIL

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ABSTRACT

Thompson Seedless grapevines grown in clay soil were used in this work to determine the amount of potassium to be added per feddan and the proper time for its application. Potassium was added as potassium sulphate (48% K_2O) at 0, 50, 75, 100 and 125 Kg K_2O/feddan. The assigned amount/treatment was divided into two or three parts applied in the first week of March, May and in August after harvesting. The application of potassium significantly increased K content in the leaf petioles during bloom, veraison and maturation stages. The highest values were in bloom stage than the other stages. Potassium increased N percentage in leaf blades and starch in the canes. Ca and Mg were decreased and P% was not affected. TSS, TSS/acidity, cluster weight and yield/vine were significantly increased, while acidity was significantly lowered by increasing K_2O amount. The most effective treatment was 125 Kg K_2O.

INTRODUCTION

Potassium is one of the essential elements in plant nutrition. Since the construction of the high dam in Aswan, the total suspended matter deprived the Egyptian soils from about 91% of the annual replenishment of mineral potassium (Fiazy, 1980). Thus, potassium application is needed regularly for the nutrition of almost all plants.

The absorption of potassium by plants has two peacks, the first at fruit setting and the second during berry maturation (Yu *et al.,* 1984). During the four weeks before veraison there is a little or no uptake of nitrogen and phosphorus, while potassium uptake continued throughout veraison (Lohnerz, 1988). The petiole levels at veraison are probably the most important as they indicate the cultivars status at the beginning of maturation when the demand for K increases greatly (Christensen, 1984).

Potassium intensifies the synthesis of carbohydrates, catalize the activity of some enzymes, promotes the synthesis and accumulation of thiamin and riboflavin and is essential for the activity of guard cells. (Yagodin, 1984).

The aim of this work is to determine the effective amounts of potassium which meet the needs of Thompson Seedless grapevines and the proper time of addition.

MATERIALS AND METHODS

This study was conducted for two years (1996 and 1997) on 10-year-old Thompson Seedless grapevines supported by three wires at a private vineyard located in Tanta region, Gharbiya governorate.

Analysis of the soil

Mechanical analysis		**Chemical analysis**	
Clay %	44.3	pH	8.1
Silt %	27.1	E.C	0.98
Fine sand %	20.2	Total N %	0.140
Coarse sand %	3.1	Available K %	0.020
Textural class	Clay	Available Zn (ppm)	1.200

According to Cottanie, 1980 the amount of available K is classified as medium (0.015 – 0.03%).

Seventy two vines of similar vigour, grown in clay soil were chosen. The vines spaced at 2 X 2.5 m. Five canes with 12 buds each were left per each vine. The canes were horizontally oriented and tied to the first and second wire. Number of clusters were adjusted to 15/vine. All vines were subjected to the same horticultural practices usually followed in the region.

Super phosphate (15.5% P_2O_5) was applied at 150 Kg./feddan at the end of January. Ammonium sulphate (20.5% N) was applied at a rate of 100 Kg./feddan in March, then 100 Kg. Of ammonium nitrate (33.5% N) was added in May and 100 Kg./feddan of ammonium sulphate was added after harvest.

The randomized complete block design was adopted with three replicates per treatment. Each replicate contained four vines.

Potassium sulphate (48% K_2O) was applied as surface placement because it gives more immediate vine K uptake response than in furrow placement (Christensen, 1975). Treatments of the experiment were :

1- Control
2- 50 Kg K_2O (25 Kg in March + 25 Kg in May)
3- 75 Kg K_2O (25 Kg in March + 50 Kg in May)
4- 100 Kg K_2O (50 Kg in March + 50 Kg in May)
5- 100 Kg K_2O (25 Kg in March + 50 Kg in May + 25 Kg in August after harvest)
6- 125 Kg K_2O (50 Kg in March + 50 Kg in May + 25 Kg in August after harvest)

The following data were recorded :

1- Potassium was estimated in leaf petioles opposite to cluster collected at bloom (April), veraison (June) and (August) when TSS reached 16-17%.
2- Phosphorus, calcium and magnesium were determined in leaf petioles, while total nitrogen was determined in leaf blades at bloom time. The mineral composition was determined according to A.O.A.C (1970) and expressed as % on dry weight basis.
3- Berry TSS, acidity and TSS/acidity were determined when TSS of the control reached 16-17%.
4- Starch in the fruitful canes was determined in December according to the method of Dubois *et al.,* 1956.

5- Cluster weight and yield per vine.

Duncan's multiple range test as outlined by Snedecor and Cochran (1967) was used to compare means of treatments. Means with the same small letters in common did not differ significantly at p = 0.05.

RESULTS AND DISCUSSION

1-Potassium :

Percentage of K in leaf petioles was significantly increased as K application increased. It is obvious from Table (1) that the most effective amount of K was (100 Kg K_2O) added in March and May or 125 Kg K_2Oadded in March, May and August. This amount of K induced a significant increase in K percentage in the leaf petioles than other treatments in the three stages of analysis (bloom, veraison and maturation) in both years of the study. Despite of high level of K in treatments 4 and 6 in all stages, there was no significant differences between them. The obtained data reveal the importance of applying potassium with proper dosages in the suitable time.

In comparison with the quantities of potassium in leaf petioles in the three stages (bloom, veraison and maturation) it is noticed that it decreased about 10-15% in veraison than bloom stage, and about 15-20% in maturation than bloom stage.

Table (1): Effect of potassium application on K content as percentages in leaf petiole of Thompson Seedless grape

K_2O Kg/feddan	Bloom		Veraison		Maturation(TSS 16-17)	
	1996	1997	1996	1997	1996	1997
1- Control	1.29 c	1.25 c	1.08 d	1.08 d	1.03 d	1.06 d
2- 50 Kg (25* + 25**)	1.40 b	1.42 b	1.20 c	1.19 c	1.11 c	1.15 c
3- 75 Kg (25* + 50**)	1.41 b	1.45 b	1.32 b	1.35 b	1.20 b	1.25 b
4- 100 Kg (50* + 50**)	1.63 a	1.64 a	1.47 a	1.48 a	1.39 a	1.42 a
5- 100 Kg (25*+50**+25***)	1.43 b	1.45 b	1.28 b	1.32 b	1.22 b	1.27 b
6- 125 Kg (50*+50**+25***)	1.69 a	1.65 a	1.50 a	1.52 a	1.42 a	1.45 a

Values with a small letter in common do not differ significantly at p = 0.05 (Duncan's multiple range test)

Note: * Applied in March ** Applied in May * Applied in August**

Christensen (1984) observed that the petiole levels of potassium tended to decrease between bloom and veraison.

1-Leaf mineral percentages (N, P, Ca and Mg) Nitrogen :

Application of potassium at all dosages, generally increased leaf percentage of nitrogen than control in both seasons of the experiment (Table 2). It worth mention that the addition of 50 Kg K_2O to grapevines in March was very effective for increasing N% in leaf blades at bloom stage significantly than other treatments (treatments 4 and 6). This positive response can be explained on the basis of increasing the supply of a mobile ion of one sign can enhance the uptake of ions of the other sign (Russell, 1982). So, K+ increases the uptake of NO_3^-. Another possibility is K function as a carrier for NO_3^- during its absorption by plants (Ben-Zioni *et al.,* 1971).

Phosphorus

In both seasons of the experiment, there were no significant differences between P values in all treatments as affected by potassium application. These findings are in thee same trend with those of Lohnerz (1988) and Omar (1994).

Calcium and magnesium:

All potassium applications induced a significant decrease in calcium and magnesium percentages in both seasons. The more

Table (2): Effect of potassium application on mineral elements in leaves of Thompson Seedless grapes

K_2O Kg/feddan	N%		P%		Ca%		Mg%	
	1996	1997	1996	1997	1996	1997	1996	1997
1- Control	1.57 c	1.52 c	0.314 a	0.319 a	1.68 a	1.69 a	0.64 a	0.62 a
2- 50 Kg (25* + 25**)	1.70 b	1.68 b	0.315 a	0.320 a	1.55 b	1.58 b	0.51 b	0.51 b
3- 75 Kg (25* + 50**)	1.68 b	1.66 b	0.317 a	0.320 a	1.60 b	1.55 b	0.52 b	0.50 b
4- 100 Kg (50* + 50**)	1.78 a	1.76 a	0.318 a	0.320 a	1.42 c	1.40 c	0.41 c	0.40 c
5- 100 Kg (25*+50**+25***)	1.69 a	1.68 b	0.318 a	0.319 a	1.61 b	1.54 b	0.53 b	0.52 b
6- 125 Kg (50*+50**+25***)	1.82 a	1.85 a	0.321 a	0.324 a	1.40 c	1.42 c	0.40 c	0.42 c

Values with a small letter in common do not differ significantly at p = 0.05 (Duncan's multiple range test)

Note: * Applied in March ** Applied in May * Applied in August**

effective dosage of K_2O was 50 Kg applied in March (treatments 4 and 6) which achieved the lowest values of Ca and Mg% in leaf petioles. This due to the competition of uptake among K, Ca and Mg ions. Also, because these are cations and the plant's internal "charge balance" is expected as one cause of competition among those cations (Miller and Donahue, 1990). The absorption of potassium induced by adding that ion to the soil, induced in a concomidant reduction in the uptake of Ca and Mg (Hoagland and Martin, 1933).

These results are in agreement with those of Morris and Cawthon (1982), Ahlawat and Yamdagni (1982), Shikhamany *et al.,* (1989), Conradie and Saayman (1989) and Omar (1994).

1-Berry TSS, acidity, TSS/acidity and starch in canes :

TSS :

Potassium application significantly increased TSS than control in Thompson Seedless grapes. The increment is in parallel with the increment of K_2O added to the vines in both seasons (Table 3). It is noticeable, again, that the amount of potassium (50 Kg K_2O) applied at March was very effective to increase TSS (treatments 4 and 6).

Acidity :

Concerning acidity, a reverse trend was observed. Potassium application significantly lowered acidity compared to control. The more potassium added, the more reduction in acidity was occurred. The lowest values of acidity were observed specially when potassium 50 Kg (K_2O) was applied in March and 50 Kg K_2O in May (treatments 4 and 6). It achieved a significant decrease in acidity than other treatments.

This is due to the consumption of K in the synthesis and translocation of carbohydrate (Weaver, 1976). The lowering of berry acidity due to the formation of potassium salts of tartaric acid which is relatively insoluble (Ranson, 1965).

These results agreed with Yu et al., (1984) and Christensen *et al.,* (1991).

TSS/acidity :

TSS/acidity followed the same trend as in TSS. The best results were found under treatments 4 and 6 which received 50 Kg K_2O in March and 50 Kg K_2O May.

Table (3): Effect of potassium application on berry TSS, acidity, TSS/acidity and starch in canes of Thompson Seedless grapes

K_2O Kg/feddan	TSS %		Acidity %		TSS/acidity		Cane starch g/100g dry wt	
	1996	1997	1996	1997	1996	1997	1996	1997
1- Control	16.1 d	16.0 d	0.81 a	0.80 a	19.9 d	20.0 d	10.3 d	10.2 d
2- 50 Kg (25* + 25**)	16.6 c	16.6 c	0.73 a	0.73 a	22.7 c	22.7 c	10.5 d	10.7 d
3- 75 Kg (25* + 50**)	17.2 b	17.4 b	0.66 b	0.65 b	26.1 b	26.8 b	11.3 c	11.6 c
4- 100 Kg (50* + 50**)	17.9 a	18.0 a	0.60 c	0.59 c	29.8 a	30.5 a	11.4 c	11.7 c
5- 100 Kg (25*+50**+25***)	17.3 b	17.3 b	0.65 b	0.67 b	26.6 b	25.8 b	12.3 b	12.8 b
6- 125 Kg (50*+50**+25***)	18.0 a	18.2 a	0.60 c	0.59 c	30.0 a	30.8 a	13.5 a	14.1 a

Values with a small letter in common do not differ significantly at p = 0.05 (Duncan's multiple range test)

Note: * Applied in March ** Applied in May * Applied in August**

Starch content:

The starch storage in the cane as affected by potassium is illustrated in Table (3). The more increasing the amount of potassium, the more increasing in storage starch in canes of Thompson Seedless. The application of 125 Kg K_2O was the best amount of K_2O achieving the significant increase in storage starch in the two seasons.

Winkler *et al.,* (1974) reported that the rapid growing of the vegetative and fruiting growth of the vines required more sugars. Potassium increased the uptake of nitrogen (Table 2) which increase chlorophyll content and stimulate photosynthesis (Omar, 1994) and promotes the translocation of photosynthesis products (Reinhold, 1971) that increase TSS in grapes when potassium applied in March and May. Also, it increases starch synthesis (Follet *et al.,* 1981) and consequently increase wood ripening in the canes, especially when potassium was applied in August after harvest.

The monovalent metal cations, in particular potassium, enters berry cells in direct exchange for protons derived from the organic acids. This exchange leads to juices which have lower titratable acidities and higher pH values than would be expected from the acid anion composition (Boulton, 1980). Thus potassium tartarate, which is relatively insoluble, is formed, that decrease acidity and increase TSS/acidity as mentioned by Ranson, 1965.

Similar results were found by Ahlawat and Yamdagni (1988) and Omar (1994).

1-Cluster weight and yield per vine :

Generally, application of potassium at all levels significantly increased cluster weight and yield per vine in both years of the experiment (Table 4). Since the number of clusters were adjusted to 15 clusters per vine, it supposed that any increase in cluster weight should be parallel with the increase in yield weight. Increasing potassium amount in March or May significantly induced an increment in both cluster weight and yield per vine than other treatments (treatments 4 and 6). These results agreed with those of Conradie and Saayman (1989) and Omar (1994).

Table (4): Effect of potassium application on cluster weight and yield/vine of Thompson Seedless grapes

K_2O Kg/feddan	Cluster wt.(g)		Yield/vine(Kg)	
	1996	1997	1996	1997
1- Control	310 d	325 d	4.7 d	4.9 d
2- 50 Kg (25* + 25**)	365 c	372 c	5.5 c	5.6 c
3- 75 Kg (25* + 50**)	419 b	430 b	6.3 b	6.5 b
4- 100 Kg (50* + 50**)	488 a	520 a	7.3 a	7.8 a
5- 100 Kg (25*+50**+25***)	437 b	455 b	6.6 b	6.8 b
6- 125 Kg (50*+50**+25***)	495 a	542 a	7.4 a	8.1 a

Values with a small letter in common do not differ significantly at p = 0.05 (Duncan's multiple range test)

Note: * Applied in March ** Applied in May * Applied in August**

From our results, it could be concluded that the application of 125 Kg K_2O per feddan (50 Kg in March + 50 Kg in May + 25 Kg in August after harvest) is recommended to increase yield per vine, cluster weight, TSS, nitrogen uptake and storage of starch in the canes.

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إضافة البوتاسيوم إلي العنب طومسون سيدلس المزروع في تربة طينية

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أجريت التجربة علي العنب طومسون سيدلس (البناتي) مزروع في تربة طينية بمحافظة الغربية بغرض تحديد كمية البوتاسيوم اللازم إضافتها وكذلك المواعيد المناسبة للإضافة. أضيف البوتاسيوم علي صورة K_2O كالأتي : صفر ، 50 كجم (25 + 25) ، 75 كجم (25 + 50) ، 100 كجم (50 + 50) في الأسبوع الأول لكل من مارس ومايو ، 100 كجم (25 + 50 + 25) و 125 كجم (50 + 50 + 25) في الأسبوع الأول لكل من مارس و مايو وأغسطس (بعد الجمع).

أدت إضافة البوتاسيوم إلي حدوث زيادة معنوية في النسبة المئوية للبوتاسيوم في أعناق الأوراق ، وازدادت هذه النسبة بزيادة كمية البوتاسيوم المضافة وكانت إضافة البوتاسيوم في مارس ذات أثر كبير في زيادة هذه النسبة. أعلي نسبة من K وجدت في أعناق الأوراق وقت التزهير ثم إنخفضت في مرحلة التلوين Veraison ثم إنخفضت مرة أخري عند النضج عندما وصلت TSS إلي (16-17%). إزدادت نسبة النتروجين معنوياً بزيادة كمية البوتاسيوم المضافة في مارس ، بينما انخفضت معنوياً نسبة Ca و Mg ولم يتأثر الفوسفور. إزداد TSS و TSS/acidity والنشا المخزن في القصبات، ووزن العنقود ومحصول الكرمة معنوياً بزيادة البوتاسيوم بينما إنخفضت الحموضة معنوياً. وكانت أفضل المعاملات هي إضافة البوتاسيوم 125 كجم K_2O (50 كجم في مارس + 50 كجم في مايو + 25 كجم في أغسطس بعد الجمع).