Effect of Potassium Fertilization Regimes on Petiole Nutrient Contents, Yield and Fruit Quality of Table Seedless Grapes

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ABSTRACT

The response of vine grapes to graded doses of potassium fertilizer (0, 500, 1000 and 5000 Kg/ha) in relation to fruit yield, quality and petiole-nutrient status of mineral nutrients was studied. Grape vines cv. Thompson Seedless (*Vitis vinifera* L.) of 15-year-old were grown in a sandy soil under semi-arid environmental conditions. Leaf petiole chemical composition (N, P, K, Ca, Cu, Fe, Cl and Na), total yield, and fruit quality were studied. Leaf petiole analyses indicated that K applied at high levels caused a significant increase in leaf petiole contents of N, P, K, Ca, Cu, Cl and Na, but reduced Fe compared with the control. Both the increments and the reductions, which occurred in the chemical composition of the leaf petiole contents, varied according to K doses. K level increased significantly under all K doses. However, the level of petiole content of N, P, Ca, Cu, Cl and Na increased up to 1000 kg/ha treatment and was maintained constant with the higher concentrations. Higher levels of K fertilization increased total yield significantly. Total soluble solids percentage in fruit juice increased with the enhancement of K levels. The total acidity percentage in fruit juice was decreased compared with the control treatment.

Key words: (*Vitis vinifera L.*), potassium sulfate, K element, TSS, petiole, chemical analysis, fertigation.

1. Introduction

Grapes are very important fruit crop in Saudi Arabia as well as it is widely grown in the Middle East and other countries. The production of grapes in Saudi Arabia increased rapidly during the last two decades. Grapes are usually grown in sandy to sandy loam soils and drip system irrigated, (Ministry of Agriculture and Water, 2000). Under Qassim conditions, no potassium fertilization regime is used by farmers, without considering the requirements of the cultivars.

In terms of the importance of potassium fertilization for grape vines, it is well known that potassium fertilization is very essential especially in low organic matter soils, such as Qassim conditions. Even with optimum levels of nitrogen and phosphorus, poor vegetative growth, yield and fruit quality could be attributed to low levels potassium, (Ahlawat and Yamdagni, 1988). An excess amount of potassium can lead to a deficiency of some other nutrients such as magnesium (Mg), accordingly, special attention should be paid to avoid unnecessary excessive amount of potassium. Grapes require a larger quantity of potassium compared with some other fruit trees. In the absence of petiole analysis, 400 kg/ha of muriate of potash (0-0-60) every 2^{nd} year on clay soil and 200 kg/ha every year on sandy soil may be adequate, (Klen *et al.,* 2000).

Many investigators such as Hillebrand (1978), Kilani (1979), Haeseler *et al.* (1981), Boidron (1986), El-Sese *et al.* (1988), Dhillon (1999) and Klen *et al.* (2000), reported that potassium fertilization increasing the yield of vine as a result of increasing fruit set, number of cluster and cluster's weight. Moreover, potassium fertilization improved fruit quality as indexed by increasing both T.S.S. and sugar content, Gopalswamy and Rao (1972), Hillebrand (1978), Morris *et al.* (1987), Kilani (1979) and Ahlawat and Yamdagni (1988).

The aim of this investigation is to throw light on the effect of potassium as a fertigation application on growth, yield and petiole composition of grapes cv. Thompson seedless and fruit quality under the semi arid condition of Al-Qassim area, Central Saudi Arabia.

2. Materials and methods

This study was carried out during spring seasons of 2002 and 2003 at the vineyard of Research Station of the College of Agric. and Veterinary Medicine, Al-Qassim University, Saudi Arabia. The experimental soil was sandy with chemical and physical properties shown in Table 1. This study was carried out in an area located at an altitude of 724m.a.s.l., latitude of 26°, 4 and longitude of 43°, 59. The climate of Al-Qassim region is characterized by very hot dry summer and mild to cool winter (Abd el- Rehman & Balegh, 1974). Al-Qassim region has a maximum annual mean temperature range of 19.5-33°C, an overall maximum mean (15 years) of 29°C, the minimum annual mean temperature range of 7.5-17.3°C. The maximum annual mean RH% range is 33-62% and the overall (15 years) maximum RH% is 43.3%. The minimum annual mean RH% range is 15-30% and the overall minimum mean (15 years) RH% is 18.3%. The mean annual of precipitation range is 47.8-349 mm, and the overall mean (15 years) precipitation is 123.7 mm. The mean annual evaporation range is 3257-4664 mm, and the overall mean (14 years) evaporation is 3859 mm. Irrigation water has an average pH of 7.11 and the total soluble salts were 945ppm.

This experiment included 4 potassium fertilization treatments arranged in a randomized complete block design with three replicates. Seedless table grape vines were planted at spacing of 2 X 3 m and trained to a Y-shaped trellis. All vines were annually winter pruned at mid of February so that every vine had 12 fruit spurs of 6-buds each.

Four potassium levels (0, 500, 1000 or 1500 kg/ha) were added as sulfate of potash with irrigation water (fertigation). The fertilizers were applied in split doses in March, May and July 2002 and 2003.

Table 1. Chemical and physical analyses of the experimental soil.

Chemical properties		Physical properties	
PH:	8.20	Fractions (%):	
ECe (ms):	2.06	Sand:	5.30
Soluble cations ($meq.L^{-1}$):		Silt:	3.60
Na^{+}	11.00	Clay:	1.10
Ca^{2+}	4.35		
Mg^{2+}	2.50		
Soluble anions ($meq.L^{-1}$):		Texture:	Sandy soil
$CO_3^{2-} + HCO_3^{-}$	2.99		
SO_4^{2-}	11.70		
Cl^{-}	7.60		
$CaCO_3$	4.00%		
Organic matter:	0.23%		

* pH of H_2O (soil : water = 2.5 : 1).

** ECe = Electric conductivity of the extract.

3. Measurements

In order to find out the seasonal variation of the concentration of different macro and microelements in leaf petiole tissues, samples were collected starting from May to September 2002 and 2003**.** In established plantings, petiole analysis in grapes is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the crop, (Shikhamany *et al.,* 1988, Dhillon *et al.,* 1999, and Patel and Chadha, 2002).

Harvesting of clusters (yield) was done when T.S.S. of the fruit juice reached 20:1 as recommended by Abdelal *et al.* (1978) and El-Sese *et al.* (1988). The gross yield in Kg/vines was recorded. Total soluble solids contents (T.S.S.) were measured using a hand refractometer.

All data were statistically analyzed according to Snedecor and Cochran (1980) with the aid of COSTAT computer program for statistics. Differences among treatments were tested with LSD at 5% level of significance. Compiled data for the two years, 2002 and 2003 is reported.

4. Results and discussion

Data presented in Figures 1, 2 and 3 indicate that there was a positive proportional relationship between leaf petiole contents of nitrogen, phosphorus and potassium and the applied amount of potassium fertilizer. A significant increase in leaf petiole content of N, P and K was observed as potassium fertilizer rate was increased. The data revealed that there were two clear peaks in May and July. These increments could be occurred due to the time of K fertilizer application (the 2nd and the 3rd doses in early May and early July, respectively). The Leaf petiole analysis showed that the highest values of the major macro elements (N, P and K) were achieved in mid July. This could be ascribed to the high temperature during that month which can cause a high evapotranspiration and lead to increase the concentration of solid elements in leaves and petioles. Element values were declining towards the end of the experiment when the temperature getting cooler. This is in an agreement with findings by Dhillon *et al.* (1999).

The concentration of nitrogen in leaf tissues increased significantly by increasing potassium dose application (Fig. 1). The highest value of nitrogen concentration was observed at the middle of July, then a reduction occurred towards the harvest period. This may be due to the activity of photosynthesis in summer and to senesces of the leaves at the end of the season. Similar to this finding was reported by Hunter *et al* (1994) and by Patel and Chadha (2002).

Leaf petiole content of Ca, (Fig. 4), increased consistently with the advancement of the season which might be as a result of increased requirement of Ca for cell wall synthesis (Shikamany and Salyanaraayana, 1972 and Patel and Chadha, 2002), or might be due to the high transpiration (Bertamini *et al.*, 1995).
The greatest yield was obtained potassium sulfate was applied at the rate of 1500 Kg/ha (Fig. 5). Total soluble solids, also increased with the enhancement of K levels (Fig. 5). Tzolova and Christov (1996) reported that the applied K fertilizers even in stock form significantly increased grape yield.
Like other elements, as k rate increased, the concentration of chloride content in petioles increased (Fig. 6), as Cl rose sharply at the middle of July and started to decline towards the end of harvesting time. No significant variation in concentration of chloride content in petioles at the middle of August and September. That's could be ascribed to the low photosynthetic activity of the old grape leaves.
Petiole Cu content increased significantly as potassium fertilization doses increased (Fig. 7). No significant differences were observed between 1000 and 1500 levels. There is a slight reduction in Cu concentration thereafter with the advancement of the season.

On the other hand, Iron is the only element in this study showed an opposite response with potassium application (Fig. 8). As potassium fertilization level increased, the concentration of iron content in petioles decreased. On the other hand and in relation to potassium application and sampling time, the concentration of Fe decreased throughout the season. This result is in agreement with the observation made by Shikhamany *et al* (1988), who found that high levels of K fertilization were associated with reduced Mg and Fe content in Thompson Seedless grape. A large variation is noticeable in concentration of sodium content in grapevine petioles between the control treatment and other treatments (Fig. 9). In relation to potassium application and sampling time, the highest level of Na was observed at the middle of July and started to decline towards the end of the season.

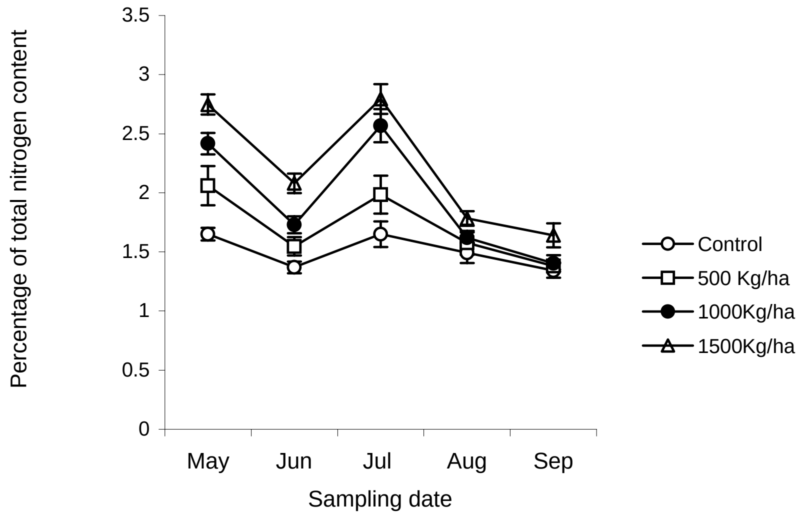

Figure 1. Variation in concentration of nitrogen content in petioles in relation to potassium application and sampling date.

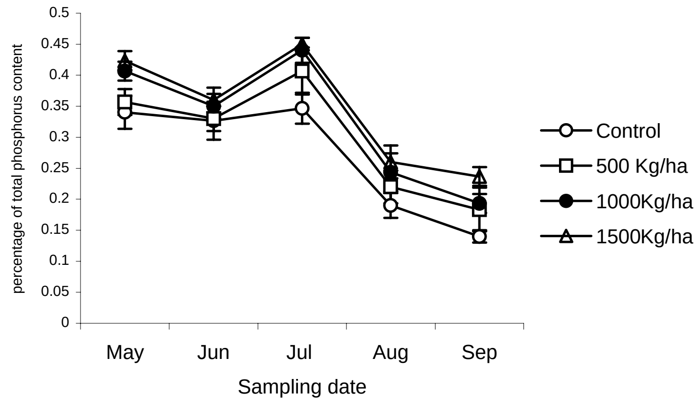

Figure 2. Variation in concentration of phosphorus content in petioles in relation to potassium application and sampling time.

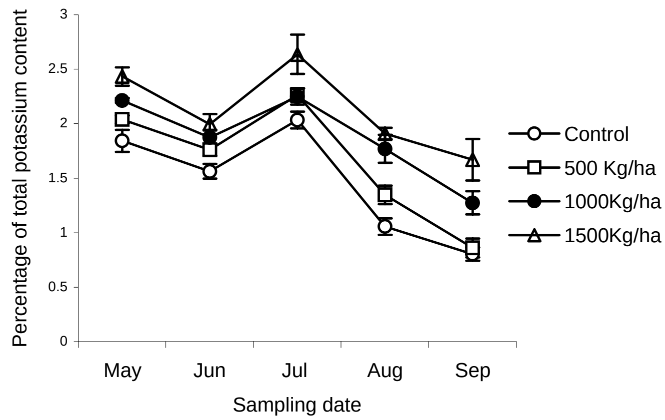

Figure 3. Variation in concentration of potassium content in petioles in relation to potassium application and sampling time.

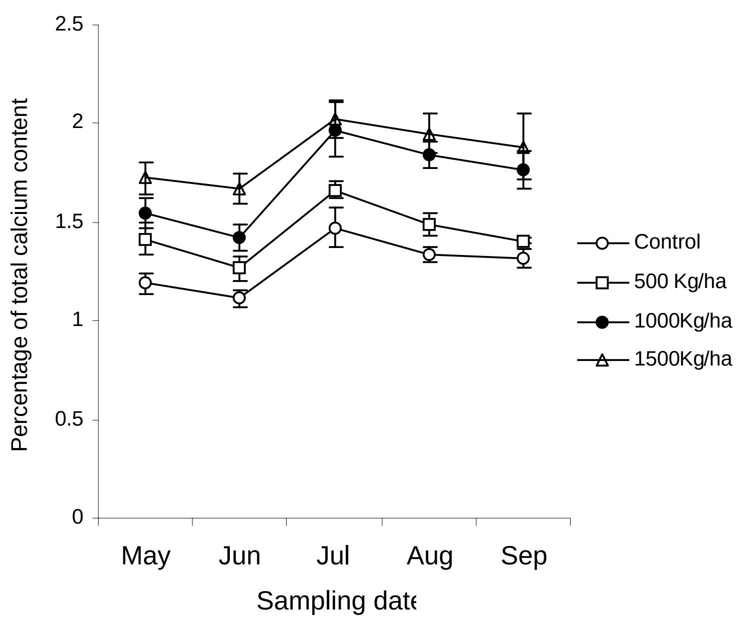

Figure 4. Variation in concentration of calcium content in petioles in relation to potassium application and sampling time.

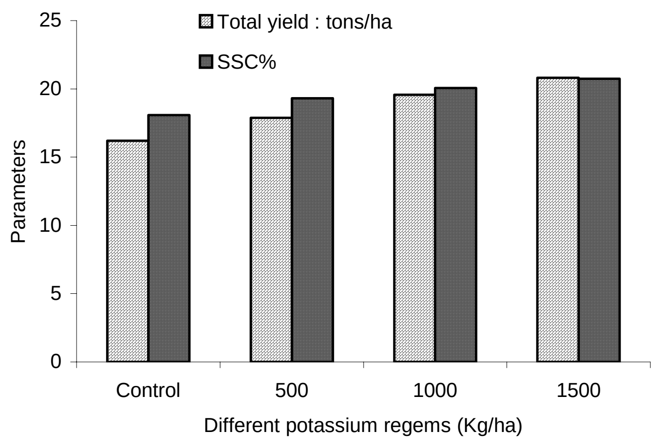

Figure 5. Effect of different potassium fertilization regimes on total yield and percentage of soluble solid contents in fruit of Thompson seedless grapes.

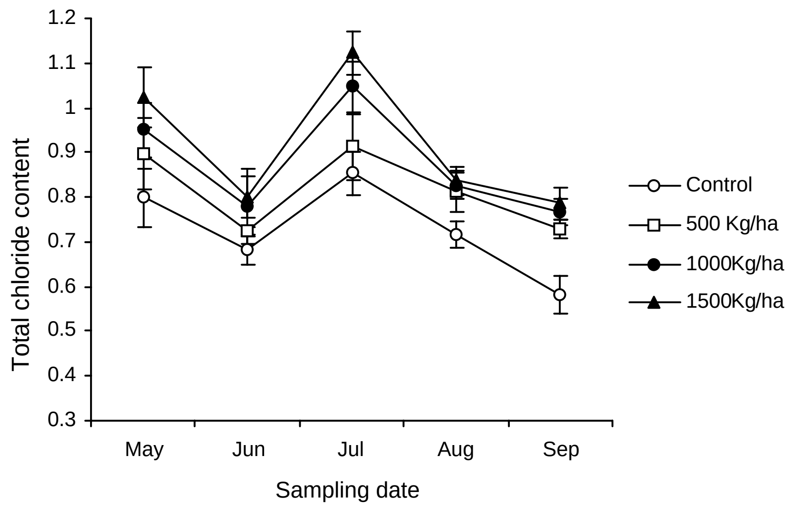

Figure 6. Variation in concentration of chloride content in petioles in relation to potassium application and sampling time.

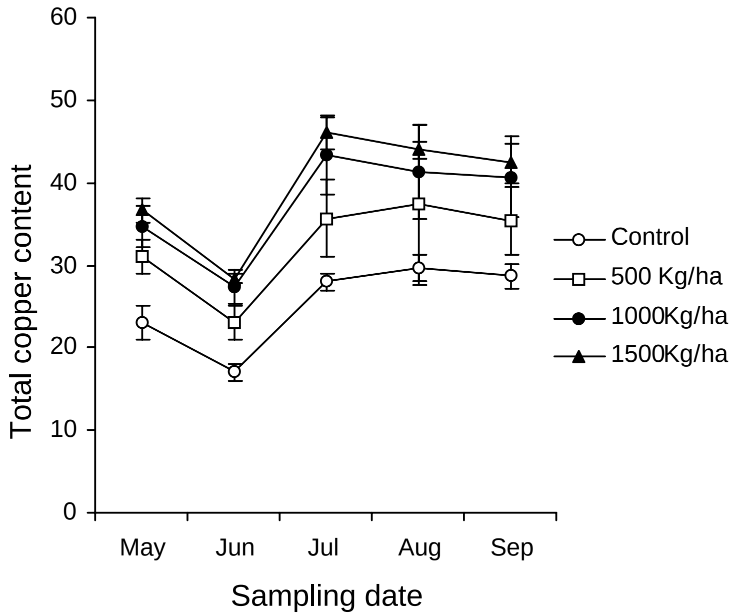

Figure 7. Variation in concentration of copper content in petioles in relation to potassium application and sampling time.

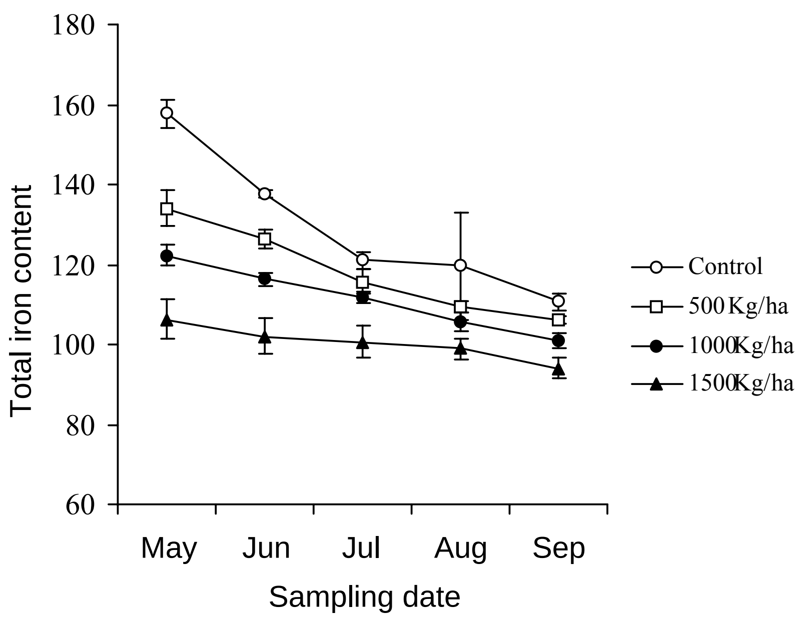

Figure 8. Variation in concentration of iron content in petioles in relation to potassium application and sampling time.

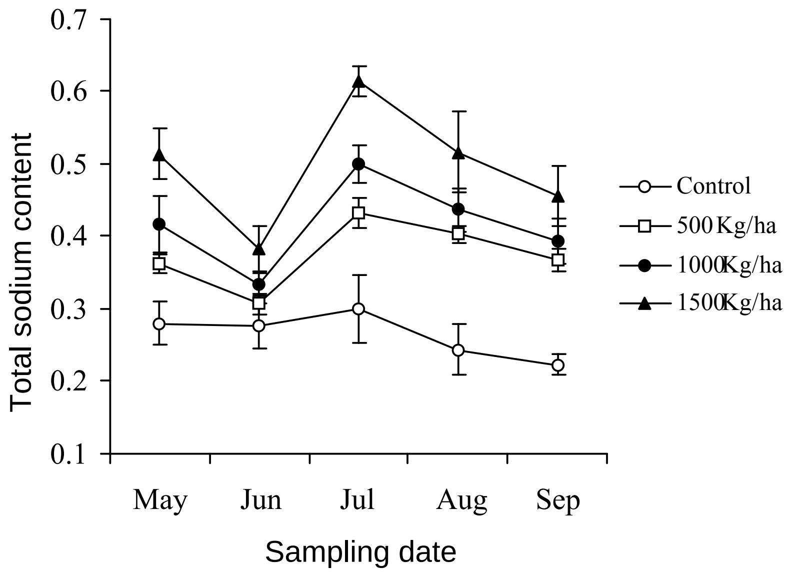

Figure 9. Variation in concentration of sodium content in petioles in relation to potassium application and sampling time.

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