Impact of the Nutritional Status on Yield of Some Grape (*Vitis vinifera* L.) Cultivars Fertilized Through Drip Irrigation and Grown on Sandy Soil

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Abstract: The study was carried out on 6 years old grapevine grown in private farm, located at Kilo 64 Cairo-Alexandria desert road. Evaluation of nutrient status of two table grape cultivars (*Vitis vinifera* L. cv. Thompson Seedless and Early Superior) were studied at three growth stages over two years; 2008 – 2009. Soil was sand in texture. The pH of soil was alkaline (8.00 –8.40). It was non saline. The organic content of the soil was very low. The soil was low in available nitrogen, phosphorus, potassium, magnesium and micronutrients. Total N in blades ranged between normal and above normal level. Levels of P, K and Ca were low and Mg content was between the end of sufficient and high values. P levels did not change with time. The level of K in the leaf blades was widely differing between the two cultivars and declined significantly between bloom and ripening. Zn levels were below normal or were in the beginning of sufficiency range, leaves Mn content was in the beginning of the normal range levels. Fe, in the end of sufficiency range while, copper levels were low or in the beginning of sufficiency in the two cultivars. Production of Thompson Seedless and Early Superior increased in the second year by 9% and 10%, respectively. This may be because there was improvement in the N/K ratio where N decreased against K concentration in the second season as compared with the first season; Also, Mg, Fe, Mn, Zn and Cu values were improved in the second season as compared with the first season.
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1. Introduction

Land located belongs to Cairo-Alexandria desert road, is sandy soil. The greatest portion of these areas is cultivated with fruit trees, among them grapes, grown for table consumption. It is known that table grapes (*Vitis vinifera* L.) are an important crop traditionally produced in Egypt.

According to **Horticulture Research Institute, Egypt 2010,** the area cultivated with grape reached to total of 70188 ha including fruiting areas 64687 ha producing 1531418 ton (average 23.67 ton/ha). This area divided between old lands in the Delta and valley reached 35646 ha including fruiting areas 30539 ha producing 564288 ton (average 18.48 ton/ha**)** and area in the desert and reclaimed land (out of the Delta), reached 34542 ha including fruiting areas 34148 ha producing 967130 ton (average 28.32 ton /ha). It's considered the second fruit crop and one of the promising export commodities (the export of grape increased from 52071.11 ton in 2008 to 75586.12 ton in 2009. The cultivars "Thompson Seedless and Early Superior" grapes occupy most of the vineyard area. It's the most profitable fruit in Egypt.

The productivity and quality of Thompson Seedless and Superior variety mainly depends on the cultural practices like management of nutrients and water, which have impact on fertility status of soil and plant. Most vineyard soils in the desert areas in Egypt contain insufficient amounts of the essential mineral elements to grow and produce fruit (**Rezk, *et al*., 1980).** Grapevines require adequate supplies of nutrients for growth and fruiting. Nutrient deficiencies affect the quantity and quality of grape. Grapes grown under sandy soil conditions have a problem of low productivity due to poor fertility of such soils; It is the grower's objective to increase the availability of naturally occurring soil nutrients and to supplement deficient nutrients when needed, thus, it is highly needed to use the appropriate methods that lead to proper evaluation of the nutritional status of the crop. Fertilizer needs can be determined by 3 ways: observing visual symptoms, using soil tests and or tissue analysis **(El-Fouly *et al*., 1982).** Because each method had advantages and limitations, all 3 should be checked on a regular basis. Tissue analysis is one of the best tools available to monitor the nutrient status of grape. Leaf blade analysis at bloom seems to be best to represent vine's nutrient status and its need for fertilizer since substantial nutrient uptake from the soil occurred after bloom and leaf blades indicate overall status of nutrients **(Pradubsuk, 2008)**. **Davenport *et al*., 2003** found that leaf blade nutrient concentration was more closely related to grape yield than petiole. Many previous studies revealed that analyzing plant tissue provides an objective means of determining the nutrient status of grapevines **(El-Moursi *et al*., 1980, Fawzi *et al*., 1980)**

This study aims to assess the fertility status of vineyards as well as leaf blades nutrients compositions at the growth stages of vineyards (cv. Thompson

Seedless and Early Superior). This can help to provide a precise scientific basis for planning fertilizer program for grape orchards.

2. Materials and Methods

Field practices:

This study was carried out in a private vineyard situated in Cairo-Alexandria desert road, Giza Governorate, Egypt, on 6 years- old Thompson Seedless and Early Superior grapevines, during two successive years, 2008 and 2009. The vines were grown 1.5 X4.0 meters apart in sandy soil under drip irrigation. The vines received the usual and recommended agriculture practices. The diagnostic tools used to identify the nutrient needs were soil test and leaf blades analysis.

Trees are drip irrigated from underground water. Fertilization through drip irrigation system is applied. Annual rates of fertilizers application were as following: (650 g) ammonium nitrate (33.5%N) /tree in equal doses between February to September, (300 g) calcium superphosphate (15.5% P_2O_5) /tree at January, (1000 g) potassium sulphate (48% K_2O) /tree in equal doses between April to September. Three doses every week were done for every fertilizer. The trees received micronutrient in foliar forms of, iron (Fe), manganese (Mn), zinc (Zn), as chelated compounds three times during the growing period, before flowering; after fruit set; and at ripping. Total doses /year were 320,215,110g/ha for Zn, Mn and Fe, respectively.

Soil chemical properties and texture as well as chemical analysis of irrigation water were tested (Tables 1, 2).

Chemical analysis

Soil:

Soil samples were taken for each variety at depth of 0 - 60 cm, in late March 2007. Soil was air-dried and sieved through 2mm pores sieve and analyzed for texture, pH and electrical conductivity (EC) using water extract (1:2.5) method, for total calcium carbonate ($CaCO_3$%): calcimeter method and for organic matter (O.M%) using potassium dichromate **(Chapman and Pratt, 1978).** Phosphorus was extracted using sodium bicarbonate **(Olsen *et al*., 1954).** Potassium, calcium, Magnesium and sodium were extracted using ammonium acetate **(Jackson, 1973).** Iron, Manganese, Zinc and Copper were extracted using DPTA **(Lindsay and Norvell, 1978).**

Leaves:

Leaves were sampled under natural growth conditions. To monitor the nutrient status of orchard grapes, the leaf blades were sampled at the three stages of bloom, fruit set, and ripening and analyzed for nutrient contents. Sample includes the most recently mature leaves from 20 to 25 locations in the field.

Leaf samples were washed once with tap water and with 0.001 M HCl, and then washed with distilled water. Thereafter, leaf samples were air-dried for 1-2 hr, and then dried in a ventilated oven at 70^o C for 48 hrs. Dried samples were ground in a stainless steel mill with 0.5 mm sieve.

Plant material was digested using an acid mixture consisting of nitric, perchloric and sulfuric acids in the ratio of 8:1:1 (v/v), respectively **(Chapman and Pratt, 1978).** Nitrogen (N) was determined in the dry plant material using the boric acid modification described by **Ma and Zuazage (1942),** and distillation was done using a Buechi 320- N2-distillation unit. Phosphorus was photometrically determined using the molybdate vanadate method according to **Jackson (1973).** Potassium, calcium and sodium were determined using flame photometer (Genway). Mg, Fe, Mn, Zn and Cu were determined using the Atomic absorption spectrophotometer (Perkin Elemer 1100 B).

Data of soil evaluated using the criteria mentioned by **Ankerman & Large, 1974,** as well as **Silvertooth, 2001),** whereas data of leaf analysis were evaluated according to criteria mentioned by **Reuter and Robinson (1997).** Statistical analysis was carried out according to the procedure of **Snedecor and Cochran (1990).**

3. Results and Discussion

Soil Testing:

According to the tentative values of soil characteristics and available nutrient concentrations, by **Ankerman and Large (1974), Silvertooth (2001)** data presented in Table (1) indicate that the soils of the two varieties was sandy in texture, medium in calcium carbonate content and electric conductivity. Organic matter is very low, tended to alkalinity in reaction (pH > 8.0). Under such soils availability of most nutrients is reduced. Nitrogen is generally lacking in sandy soils and most of nitrogen is removed by leaching and by higher rate of mineralization due to high temperature and for this reason we depend on the level of organic matter to recognize on N status. Where organic matter is low, the mean value of available nitrogen is as expected in the lower range. Also, the soil was low in phosphorus, potassium and magnesium as well as micronutrients. On the other hand, calcium was in the high range in both soils of the two varieties. A high availability of a nutrient in the soil does not necessarily mean that the plant can extract enough of that nutrient to meet its need.

Water analysis:

Data in Table 2. Show that salinity in water irrigation is in suitable range; however the dissolved nutrients can partially contribute in the amendment of some nutrient deficiencies like K, Ca, Mg and Mn.

Table 1: Soil physico- chemical characteristics

Variety	Thompson Seedless	Early Superior	Available nutrient	Thompson Seedless	Early Superior
Physical Character			Macronutrients (mg/100g)		
Sand %	89.00	88.80	P	0.43VL	0.42 VL
Silt %	4.00	4.00	K	16.3L	16.4L
Clay %	07.00	7.20	Mg	15.0L	15.0L
Soil Texture	Sandy	Sandy	Ca	740.0H	800H
pH (1: 2.5)	8.0H	8.4H	Na	42.0H	42.00H
E.C dS/m (1: 2.5)	0.32M	0.32M	Micronutrients (mg/Kg)		
$CaCO_3$ %	5.50M	5.50M	Fe	2.20 VL	2.50 VL
O.M %	0.95VL	0.65 VL	Mn	2.60 VL	1.6 VL
			Zn	0.40 VL	0.50L
			Cu	0.40L	0.20 VL

VL = very low L = Low M = Moderate H = High

Table 2. Chemical analysis of irrigation water

Component	Content	Suitable range	Component (ppm)	Content	Suitable range
pH	7.75	6.5-7.5	K	7.03	10
E.C.dS/m	1.48	<1.5	Ca	40	50
SO4-- (ppm)	27		Mg	4.24	25
Cl- (ppm)	178		Na	43.88	<70
HCO3- (ppm)	224		Fe	Trace	<0.01
			Mn	1.06	<0.05

Macronutrient contents

Total macronutrients in leaf blades of Thompson Seedless and Early Superior are presented in Figures 1- 4. It is observed that there are different nutrient amounts of N, P, and K of both grapes. The variation of different genotypes in their ability to absorb, translocation and utilize nutrients from soil was mentioned by some authors **(e.g. Brown, 1979, Zaharieva, 1982, Mengel & Kirkby, 1987).** Compared with critical levels for nutritional status of grapevines, N content ranged between normal and above normal level. There is concern that N rates should not exceed grape requirements. Although, in general N values were less in ripening stage; whenever N required decreased, this result is agreement with **Schreiner *et al*., 2006**. Total nitrogen was significantly higher than potassium at every growth stage. Application excessive nitrogen can produce grape that are excess vigorous, reduced bud formation, delayed fruit maturity and reduction of its quality **(Martín *et al.*, (2004)).**

Levels of P contents was low, the harmful effects of phosphorus deficiency include a reduction in the fruiting capacity of vines **(Skinner and Matthews, 1989).** Also, levels of K contents were low. A large crop load induces potassium deficiency because grape use large amounts of potassium during maturation **(Makirhara *et al*., 1999).** Harmful effects of potassium deficiency is delayed grape maturation and reduced yield. Results indicated that using potassium as a foliar spray had a positive effect on leaf mineral content; yield weight and fruit quality of grapevines **(Saleh, *et al*., 2007).** Also, Ca concentration in leaf blades was low, particular in bloom stage. Calcium concentration increased from bloom to ripening in the second season, in the two grapes. Calcium deficiency can reduce the shelf life of table grapes; **Salisbury and Ross, 1992** mentioned that deficiency symptoms include twisted and deformed tissues at the growing tips. Cell wall strength and thickness are increased by calcium addition. The cell wall contained it. **(Demarty *et al*., 1984, Bakshi *et al*., 2005).** Excess vegetative vigour, may results in a dilution of the calcium contents. Adequate calcium levels are required to maintain bunch quality. Calcium deficiency can correct by applying foliar sprays or application fertilizer containing calcium. On the other hand, magnesium concentration was between the end of sufficient and high values. Magnesium concentration increased from bloom to ripening in the second season, in Thompson seedless grape.

Year 2008

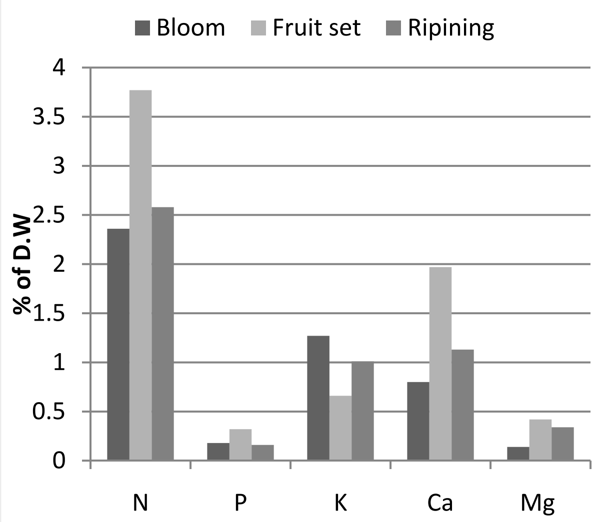


Figure1. Leaf blades

Year 2009

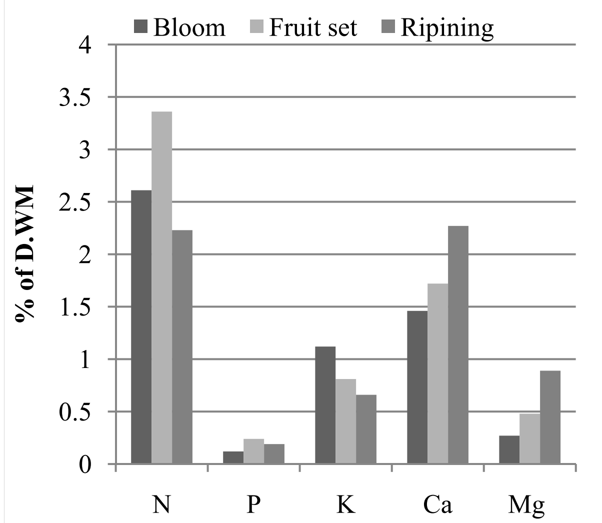


Figure 2. Leaf blades

Figures 1 and 2 Seasonal changes in N, P, K, Ca and Mg contents in leaf blades of Thompson Seedless

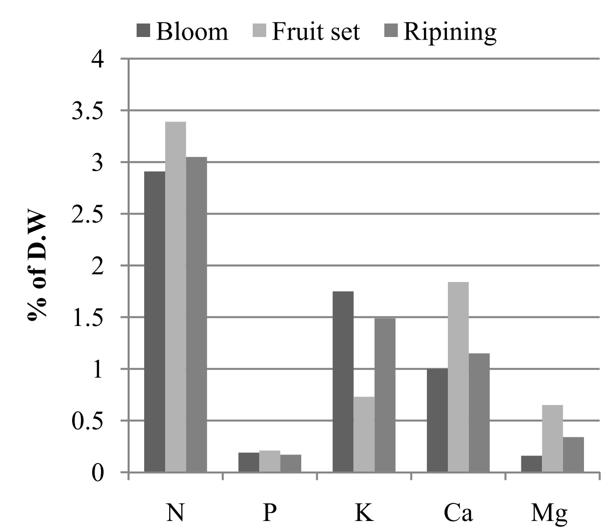


Figure 3. Leaf blades

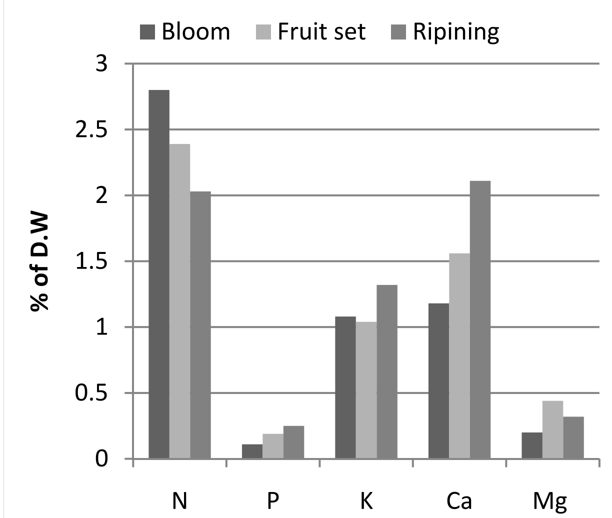


Figure 4. Leaf blades

Figures 3 and 4 Seasonal changes in N, P, K, Ca and Mg contents in leaf blades of Early Superior

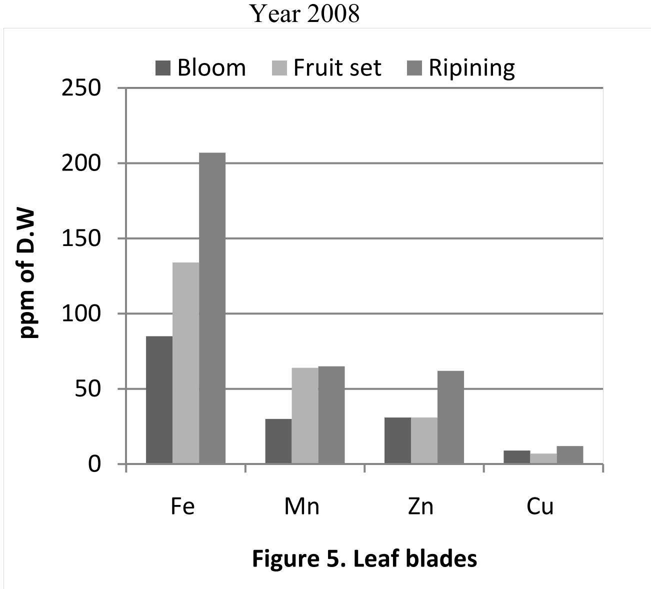
Micronutrient contents

Data in Figures 5-8 showed that iron concentrations in leaf blades were at the end of sufficient range in most samples, it increased from bloom to fruit set and ripening stages at the two seasons of the two grapes. **Chapman and Pratt, 1961** pointed out that iron level in grape leaves is not a reliable indicator of iron status; the best indicators of iron deficiency are symptoms in young leaves. Also, manganese leaves content was found at in the beginning of the normal range levels, and it showed lowest concentrations at bloom stage. In this respect **Bergmann (1972)** mentioned that the nutrient element contents should lie as far as possible in the middle or even better in the upper half of the satisfactory or optimal range. These might lead to more requirement of manganese early. **Shehata and Kamilia, 1989a** found that a significant increase in yield vine, number of clusters, average of cluster's weight and the quality of vines as a result of foliar application of 0.25% $MnSO_4$ $3H_2O$. They found that Mixing Fe, Zn & Mn in the spray has led to an increase in the concentration of Mn & Fe when compared with spray treatments of Mn individually. In respect of zinc concentrations, levels were below normal or were in the beginning of sufficient range in comparison with those mentioned by **Reuter and Robinson (1997).**

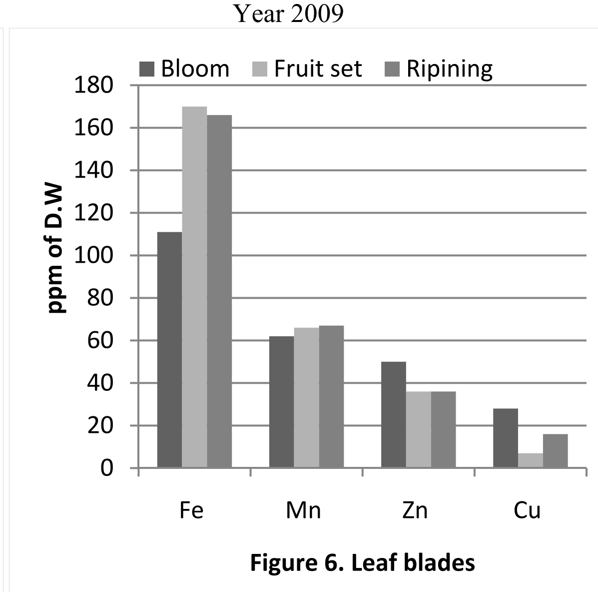
Deficiency of zinc of grape leaves can occur under soil alkaline with a pH of about 8, whereas zinc deficiency can reduce fruit-set and decrease the crop load. Also, excess nitrogen led to excessive vegetative growth and this increasing the vegetative demand for zinc and other micronutrients.

It can be corrected by applying zinc sprays before flowering and after fruit set. It's a rapid method to correct a deficiency. **Moretti, 2002** found that shoot elongation and lignifications in the nursery generally were improved at the higher Zn foliar application rate. **Christensen (1980)** investigated the effects of Zn foliar sprays on grapevines (Thompson seedless, Petite Sirah and Muscat of Alexandria). He mentioned that Zn is best applied from 2 weeks pre flowering through to fruit set. Some studies indicate the importance of foliar application of zinc on grape leaves even if the symptoms of its deficiency didn't appear **(Shehata and Kamilia, 1989b).** On the other hand, zinc fertilizers applied to the soil are unlikely to be effective because the high soil pH would fix zinc in the soil. Also, the figures showed that there were a few problems with copper, such as marginal levels in some samples and however, copper levels were low or were in the beginning of sufficient in the two grapes. This may have been due to the lack of copper sprays. Copper deficiency can be corrected by using copper fungicides at least once early in the season. Similar results were found by and **Bhargava and Raghupathi, 2001** and **Yogeeshappa, 2007**.

Year 2008



Year 2009



Figures 5 and 6. Seasonal changes in Fe, Mn, Zn and Cu contents in leaf blades of Thompson Seedless

Year 2008

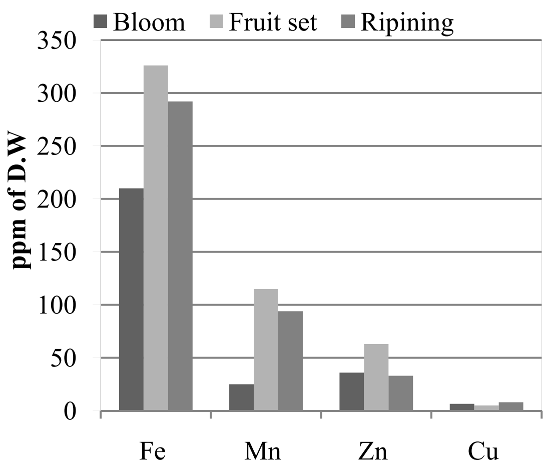


Figure. 7 Leaf blades

Year 2009

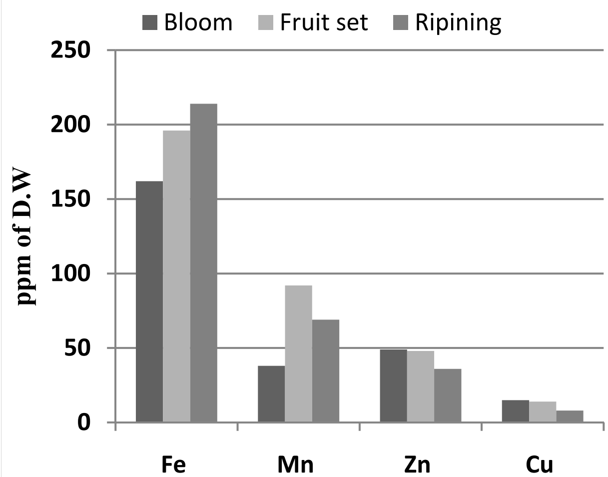


Figure 8. Leaf blades

Figures 7 and 8. Seasonal changes in Fe, Mn, Zn and Cu contents in leaf blades of Early Superior

The ratio between N/K and K/Mg

The data in Table 3. Show that there is improvement in the second season in the N/K ratio where N decreased against K concentration in the second season as compared with the first season; It was found that when N increased always raises the concern of encouraging excessive vigor that can result in shading and reduced fruit quality. Grapevines, however, do not have as high a nitrogen requirement as many other crops, but have a relatively high need for potassium (K), comparable to nitrogen. It was found that much of the potassium is removed from the vineyard in the fruit. Also, in the second season the ratio between K and Mg was improvement, where the ratio of K/Mg increased in the second season as compared with the first season. On the other hand, extremely high K levels may induce a magnesium deficiency. **Leonhardt (1987)** recommended maintaining a 2:1 ratio of K to Mg. In this **context**, **Rezk, *et al*., 2008a** found that the K/Mg ratio was significantly increased as a result of potassium spray and decreased as a result of magnesium spray.

Data of the level of K in the leaf in both cultivars showed that the level of K widely differing between the two cultivars, **Schaller and Löhnertz, 1990** and decreased from bloom stage until ripening stage when translocation of ion from vegetative to reproductive organs is more common, **Brancadoro, *et al*., 1994**, **Schaller, 1999**.

This suggests that the levels of K should be considered for each individual cultivar besides the sample timing and to meet demands at these times, under low K available in soil. K nutrition must add to soil and as foliar application to make K concentration not decline in leaves.

Table 3.The Ratio between N/K and K/Mg content in leaf blades of grape

Variety / Ratio	Thompson Seedless	Early Superior
	Season 2008	
N/K	5.71	4.64
K/Mg	1.57	1.12
	Season 2009	
N/K	3.38	2.88
K/Mg	1.69	2.36

Yield

The unsuitable fertilizer program was reflected as low fruit yields of the two cultivars, Thompson Seedless and Early Superior (Table 4). Yield is about 73% of that achieved by some farms (2009) for the same cultivars. On the other hand, there was increase in the trees production in the second year (2009) by 9% and 10% for Thompson Seedless and Early Superior, respectively compared to the first year (2008). This may be due to the improvement in the N/K ratio where N decreased against K concentration in the second season as compared with the first season;**.** Also, Mg, Fe, Mn, Zn and Cu values were improvement in the second season as compared with the first season. **Rezk , *et al*., 2008b** concluded that, fertilization of grapevines with 100g K_2O + 10g MgO/vine significantly increased the petioler concentration of both potassium and magnesium to an optimum levels (1.76% K and 0.47% Mg) and improving the nutritional balance between them which affected on increasing chlorophyll content and all were associated with maximizing the grape yield with good quality. In this **context Rezk, *et al*., 1983, Rezk and El-Moursi, 1985**, **Prabhu, and Singaram, 2001, Shaaban, *et al*., 2007** found that foliar micronutrients application, led to improvement in grape yield. However, the highest production under such conditions was achieved by Thompson Seedless cultivar followed by Early Superior.

Table 4. Grape production (Kg/tree) under the trial condition

Variety	Season 2008	Season 2009
	Yield (kg/tree)	
Thompson Seedless	11	12
Early Superior	10	11

Conclusion

The yield of grape orchards is directly dependent upon the soil fertility status and nutrient concentration in the blade of the grape, so regular soil test, blade sampling each season, is necessary. Applied correct fertilizers at correct times will make nutrient values at optimum levels. Moreover, improve the balance ratio between nutrients will be led to maximize the yield.

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References

1. **Ankerman, D. and Large, R. (1974)**: Soil and plant analysis. Tech. Bull. A&L. Agricultural laboratories. Inc., New York, USA, pp. 42-44 and 74-76.
2. **Bakshi, P., M. Fa, C. Gs and S. Ta (2005):** Role of Calcium in post-harvest life of temperate fruits: A review. J. Food Sci. Technol. Myso., 42: 1-8.
3. **Bergmann, W. (1972):** Möglichkeiten und Grenzen der Pflanzenanalyse bei der Ermittlung der
4. Nährstoff. bzw Düngerbedürftigkeit Landwirtschaftlicher Kulturpflanzen. Arch. Acker-u Pflanzenbau u. Bodenkd. Berlin, 16: 71-87.
5. **Bhargava, B. S. and Raghupathi, H. B. (2001):** Soil and plant diagnostic norms of perlette grape. Haryana J. Hort. Sci., 30(3-4): 165-167.
6. **Brancadoro, L., L. Valenti, A. Reina, and A. Scienza (1994)**: Potassium content of grapevine during the vegetative period: The role of the rootstock. J. Plant Nutr., 17:2165-2175.
7. **Brown, J. C. (1979):** Genetic improvement and nutrient uptake in plants. Bioscience, 29:289.
8. **Chapman, H. D. and P. F. Pratt (1961):** Methods of Analysis for Soils, Plant and Water, Univ. Calif., Div. of Agric. Sci., Priced Publication 4034, 309 p.
9. **Chapman, H. D. and P. F. Pratt (1978):** Methods of Analysis for Soils, Plant and Water, 50: 309.Univ. Calif., Dept. Agric. Sci., Priced Publication, 4034, USA.
10. **Christensen, P.L. (1980):** Timing of Zinc Foliar Sprays. I. Effects of Application Intervals Preceding and During the Bloom and Fruit-Set Stage. II. Effects of Day vs Night Application. American Journal of Enolology and Viticulture. 31 (1), pp.: 53-59.
11. **Davenport, J.R., J.M. Marden, L.J. Mills, and M.J. Hattendorf (2003):** Response of Concord Grape to Variable Rate Nutrient Management. *American Journal of Viticulture and Enology,* 54(4):286-293.
12. **Demarty, M., C. Morvan, and M. Thellier (1984):** Calcium and the cell wal. Plant Cell Environ. ,7: 441-448.
13. **El-Fouly, M.M.; Fawzi, A.F.A. and Rezk, A.I. (1982):** Soil and leaf analysis as a measurement for micronutrients supply and uptake in Grape. Abstract, Vol. II of XXI Inter. Hort. Cong., Hamburg, 29 Aug.-4 Sept., p. 2186.
14. **El-Moursi, A.; Fawzi, A.F.A. and Rezk, A.I. (1980):** Diagnosis and improvement of nutritional status of grapevine in newly reclaimed areas of West-Nubaria, I. Gianaclis. Proc. 2nd Workshop "Micronutrients and plant Nutrition", 22-27 June, Mariut-Egypt, Ed. M.M. El-Fouly, National Res. Centre, Cairo, pp. 151-168.
15. **Fawzi, A.F.A.; Rezk, A.I. and El-Moursi, A. (1980):** Diagnosis and improvement of nutritional status of grapevine in newly reclaimed areas of West-Nubaria, III. Morth-Tahrir. Proc. 2nd Workshop "Micronutrients and Plant Nutrition", 22-27 June 1979, Mariut-Egypt, Ed. M.M. El-Fouly, National Research Centre, Cairo, pp. 183-194.
16. **Horticulture Research Institute, Egypt (2010)**: Economy-low yield of grapes increased by 35%. www.ahram.org.eg
17. **Jackson, M.L. (1973)**: Soil Chemical Analysis. Prentice-Hall of India Private Limited, New Delhi, India, pp: 82-86.
18. **Leonhardt, A. (1987):** Stiellähmebekämpfung im Markgräflerland aufgrund der Prognose nach
19. Theiler. Mitt. Klosterneuburg, 37: 130-134.
20. **Lindsay, W.L. and W.A. Norvell (1978)**: Development of DTPA micronutrient soil tests for zinc, iron, manganese and copper. Soil Sci. Soc. Am. J., 42: 421-428.
21. **Ma, T.S. and Zuazaga, C. (1942):** Micro-kjeldahl determination of nitrogen, a new indicator and an improved rapid method. Indust. Eng. Chem. Anal. Ed. 14, 280-286
22. **Makirhara, D., Tsuda, M., Hirai, Y., and Kuroda, T. (1999):** Effects of saline irrigation at various growth stages on rice yield. Japanese Journal of Crop Science, 68: 487-494.

23. **Martín, P., Delgado, R., González, M.R.,and Gallegos, J.I. (2004):** Colour of 'Tempranillo' Grapes as Affected by Different Nitrogen and Potassium Fertilization Rates. Acta Horticulturae 652, pp.: 153-159
24. **Mengel, K. and E.A. Kirkby (1987):** Nutrient uptake and assimilation. In "Principles of Plant Nutrition". 136. Intern. Potash Institute, Bern.
25. **Moretti, G. (2002):** Effect of foliar treatments of magnesium, manganese and zinc on grafted vines in the nursery. Acta Hort. 594, 647-652.
26. **Olsen, S.R.; C. V. Cole; F.S. Watanabe and L.A. Dean (1954):** Estimation of phosphorus in soil by extraction with sodium bicarbonate. US Dept. Agric., Circular No. 939: 1-19.
27. **Pradubsuk, S. (2008):** Uptake and Partitioning of Mineral Nutrients in Concord Grape. Ph.D. dissertation, Department of Crop and Soil Sciences, Washington State University.
28. **Prabhu, P. C. and Singaram, P. (2001):** Effect of micronutrients on growth and yield of grapes cv. Muscat. *Madras Agric. J.*, 88(1-3): 45-49.
29. **Reuter, D.J., and Robinson, J.B. (1997):** Plant Analysis: An Interpretation Manual 2nd Edition. CSIRO Publishing.
30. **Rezk, A.I.; Fawzi, A.F.A. and El-Moursi, A. (1980):** Diagnosis and improvement of nutritional status of grapevine in newly reclaimed areas of West-Nubaria, 11-Mariut. Proc, 2nd Workshop-Micronutrients and Plant Nutrition", 22-27 June 1979, Mariut-Egypt, Ed. M.M. El-Fouly, National Res. Centre, Cairo, pp. 169-181.
31. **Rezk, A.I.; El-Moursi, A.; Fawzi, A.F.A. and Nofal, O.A. (1983):** Response of seedless grapes to NPK and micronutrients supply in relation to dose, ratio and time of application in Nubariya. Egypt. J. Bot., 26 (1-3): 19-35.
32. **Rezk, A.I. and El-Moursi, A. (1985):** Effect of foliar application of urea and chelated micronutrients on seedless grape vine. J. Agric. Res. Tanta Univ., 12 (1): 228-240.
33. **Rezk, A.I., S.S.Elnwehy and A.A. Abd Elsalam (2008a):** Response of grapevines to foliar application of potassium and magnesium. The 4th Scientific Conference of Agriculture & Biological Research Division " Safe Agriculture Product for Health & Environment by using Recent Technologies " . Cairo, Egypt. 5-6 May 2008.
34. **Rezk, A. I., S. S. Elnwehy and A. A. Abd El salam (2008b):** Study the interaction effect of potassium and magnesium on yield and quality of grapevines in calcareous soils. The 4th Scientific Conference of Agriculture & Biological Research Division "Safe Agriculture Product for Health & Environment by using Recent Technologies ". Cairo, Egypt. 5-6 May 2008.
35. **Saleh, M.M.S., N.E. Ashour, M.H. El-Sheikh and M.A.A. El-Naggar (2007):** Foliar sprays of potassium Dihydrogen phosphate and their impact on yield, fruit quality and controlling powdery mildew disease of Thompson Seedless grapevines. American-Eurasian J. Agric. & Environ. Sci., 2(2): 133-140
36. **Salisbury F.B. and Ross C.W. (1992):** Plant Physiology 4th Edition. Wadsworth Publishing Company, USA.
37. **Schaller, K., and Löhnertz, O. (1990)**: Investigations on the nutrient uptake efficiency of different grape rootstock species and cultivars. In: N. El Bassam *et al.* (Eds.), Genetic Aspects of Plant Mineral Nutrition 42. Kluwer Academic Publishers. Netherlands. Pp 85-91.
38. **Schaller, K. (1999):** Influence of different soil tillage systems on uptake of N, P, K, Mg, Ca, and organic Ncompounds by grape berries during growth and development of the variety "White Riesling". Bulletin - Office International de la Vigne et du Vin. 72:823/824, pp602-629
39. **Schreiner, R.P., C.F. Scagel, and J. Baham. (2006):** Nutrient uptake and distribution in a mature 'Pinot Noir' vineyard. Hort Science, 41(2): 336-345.
40. **Shaaban, M. M., Loehnertz, O., El-Fouly, M. M. (2007):** Grapevine genotypic tolerance to lime and possibility of chlorosis recovery through micronutrients foliar application. *Int. J. Botany*, 3(2): 179–187.
41. **Shehata El-Azab El-Kassas and Kamilia Ibrahim Amin (1989a)**: Response of white seedless grapes to manganese fertilization. Proc. 5th Micronutrients Workshop, 16-21 Dec., 1989, Cairo-Ismailia, Egypt
42. **Shehata El-Azab El-Kassas and Kamilia Ibrahim Amin (1989b):** Comparative study between soil and foliar fertilization with zinc compounds in grape vine. Proc. 5th Micronutrients Workshop, 16-21 Dec., 1989, Cairo-Ismailia, Egypt
43. **Silvertooth, J.C. (2001):** Soil fertility and soil testing guidelines for Arizona cotton. The University of Arizona. USA.
44. **Skinner, P. W. and Matthews, M. A. (1989):** Reproductive development in grape (Vitis vinifera L.) under phosphorus-limited conditions. Scientia Horticulturae, 38: 49-60.
45. **Senedcor, G.W. and W. Cochran (1990):** Statistical methods 7th. Ed. Iowa State Univ., press. Ames,. Iowa, U.S.A
46. **Yogeeshappa, H. (2007):** Yield and quality of grapes (cv. Thompson seedless) in relation to soil fertility status of vineyards in bijapur taluk of Karnataka. M.Sc., Thesis. Department of soil science and agricultural chemistry College of agriculture, Dharwad University of agricultural sciences, Dharwad – 580 005.
47. **Zaharieva, T. (1982):** Effect of genotype and iron applied on the chemical composition and yield of corn plants. In " Gentic specifity of Mineral Nutrition of Plant. Vol XIII No. 3. Serbia Acadamy of Science and Arts, Belgrade. Ed. Saric, M.A, 141.

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