Journal of Genetic and Environmental Resources Conservation, 2022, 10(2):138-145.
www.gercj.com Print ISSN: 2306-8663, Online ISSN: 2306 – 8280

The effect of compound fertilizer (NPK) and gibberellic acid on the growth of two transplants grape cultivars Zarik and Thompson seedless (*Vitis vinifera* L.)

Nabil M. Ameen Abdullah Alimam* and Manar Ghanem Sheit Al-Qasim
Dep. of Horticulture & Landscape Design, College of Agriculture and Forestry, University of Mosul, Iraq.
***Corresponding author: nabemo56@uomosul.edu.iq**
***Received: June 13th 2022; Accepted: July 16th 2022**

Abstract

The experiment has been conducted on grape seedlings (*Vitis vinifera* L.) in the nursery of College of Agriculture and Forestry, University of Mosul, Mosul, Iraq. During the growing season 2020, to study the effect of fertilization of compound fertilizer (NPK) 20 : 20 : 20 with three levels (0, 200 and 400 mg.l-1), Spraying with two concentrations of Gibberellic acid (0 and100 mg.l-1) on two grape cultivars Zarek and Thompson Seedless, and study the interaction between all factors and its effect on the vegetative growth characters of grape seedlings. A factorial experiment with three replications was carried out by split - plot system in a Randomized Complete Block Design (RCBD). Data obtained were statistically analyzed Duncan's Multiple Range test at 0.05 level. Results showed that Fertilization with (NPK) specially at 400 mg.l-1 level caused a significant increase in stem height, chlorophyll concentration, vegetative and root dry weight of grape seedlings. Foliar spray with Gibberellic acid especially at 100 mg.l-1 concentration caused a significant increase in stem height, vegetative dry weight of grape seedlings. The characters studied were different according the cultivars, Zarek was significantly superior compared with Thompson Seedless cultivar in the height and diameter of main stem. While Thompson Seedless cultivar was significantly superior compared with Zarek grape cultivar in seedling leaves area, vegetative and root dry weight. Results of triple interaction between all factors showed a significantly effect in stem height of grape seedlings in (400 mg NPK.l-1 + 100 mg GA3 .l-1) for the Zarek grape cultivar. As well as the response of the grape Thompson Seedless cultivar and fertilizer with 400 mg NPK.l-1 + 100 mg GA3 .l-1 in the characteristics of the chlorophyll content, seedling leaves area and vegetative dry weight of grape seedlings.

Keywords: Fertilizer, Gibberellic acid, Growth, Grape cultivars.

Introduction

Grape *Vitis vinifera* L. is belong Vitaceae family, it is excused climbing plants and deems the first in the world in terms of production and cultivated area in the world. Mineral and organic nutrition is one of the horticultural service operations that must be performed in grape orchards, to meet the requirements for growth and production of grapes and to compensate for the deficiency of nutrients as a result of absorption by the roots of grape vines and their exposure to depletion and deficiency of soil, so it is necessary to carry out fertilization operations by adding organic and chemical fertilizers in nurseries and orchards grapes to achieve the desired goal to increase the growth and productivity of grapes. Nitrogen, phosphorous and potassium are among the essential and necessary elements for plant growth and development and a component of organic matter and their entry into enzymatic processes (Mengel et al, 2001). Gibberellins are compounds that cause elongation in healthy stem cells. One of the most important gibberellin compounds used in agricultural lands is the GA_3 compound, which is called Gibberellic acid. Gibberellins biosynthesis in the growing tops of the stems, Leaf primordia, chloroplast,the seeds during their formation and also the immature seeds are a center for the formation of gibberellins. (Abo Zaid, 1990 and Jundia, 2003).

The study aimed to increase the vegetative and root growth of grape seedlings and the response of the two grape cultivars Zarek and Thompson Seedless to chemical fertilization with (NPK) and foliar spraying with gibberellic acid (GA_3).

Material and Methods

This experiment was conducted in the nursery of the Department of Horticulture and Landscaping of the College of Agriculture and Forestry at the University of Mosul, Iraq, in the growing season of 2020 to study the effect of chemical fertilization with NPK compound fertilizer (20:20:20) and spraying with Gibberellic acid (GA_3) on the growth of seedlings of two table grape Zarek and Thompson Seedless cultivars. A physical and chemical analysis was carried out for the soil of the nursery in which the seedlings were grown and shown in Table (1).

Table (1): Some of the physical and chemical properties of the soil used in this study.

Soil Texture	pH	Ec ($ds.m^{-1}$)	Om ($g.Kg^{-1}$)	$CaCo_3$ (g/Kg)	N (ppm)	P (ppm)	K (ppm)
Sandy loam	7.69	3.05	1.47	261	36.56	4.66	76.82

*The analysis was carried out in the central laboratory of the College of Agriculture and Forestry, University of Mosul.

Experiment design is the split-plot system was followed in the Randomized Complete Blocks Design (R.C.B.D) for factorial trials with three factors. The first factor is three levels of compound fertilizer were used 0, 200 and 400 mg NPK.l-1.The second factor is 0 , 100mg GA3. The third factor two grape cultivars were used, namely Zarek and Thompson Seedless and study the interaction between these three factors mentioned Above, 2 x 2 x 3 with three replications, using five seedlings per replicate. After planting the seedlings in black bags with a capacity of 8 kg per bag with river soil in mid-February 2020, they were pruned on two buds. The compound fertilizer NPK (20:20:20) dissolved in water was added to the soil at an amount of 200 cm3 for each seedling and for each irrigation and in three times, the first on April 1, the second on April 22, and the third on May 13, 2020. The foliar spraying was carried out with gibberellic acid until completely wet, with two sprays, the first on April 3, and the second on April 25, 2020. At the primary of August twenty five mature leaves takes off the shoots were picked for calculating the leaf area utilizing the following equation outlined by (Ahmed and Morsy,1999) and multiplied by the number of leaves to calculate the leaf area of the seedling. The relative content of total chlorophyll was estimated in fully expand leaves on the first of September by a portable chlorophyll meter of the type Minolta SPAD-502 of Japanese origin (Felixloh and Bassuk, 2000) and calculated as an arithmetic mean of ten readings from each seedling of adult leaves with Integrated space. Grape seedlings were uprooted at a rate of 5 seedlings per experimental unit and root system were placed separately in perforated paper bags and then placed in an electric oven at a temperature of 70°C ±1 until the weight is proven.

Results and Discussion

Height of the main stem of grape seedlings (cm): The data in Table (2) show that the grape variety Zarek was significantly higher in the rate of height of the main stem (21.167 cm) than the Thompson Seedless variety, it reached (18.111 cm). The variation in the height of the main stem of the seedlings of grape varieties may be attributed to the different genetic factors controlling on growth through the size of the leaves and their expended and the genetic susceptibility of the varieties in terms of giving the number of produced leaves and the length of the internodes, which results in a variation in the rate of height of grape seedlings according to the varieties, and these results are in agreement with (Galet, 1971, Al-Imam, 1998 and Mezrag, 2005). Fertilizing with NPK compound had a significant and clear effect in increasing the height of the main stem of grape seedlings; The treatment of 400 mg NPK.l-1 was significantly superior (24.500cm) to the treatments 0, 200mg NPK.l-1, while the control treatment was recorded the lowest values of stem height rate (15.667 cm).

The reason for the increase in the height of grape seedlings may be due to the addition of compound fertilizer (NPK) to the soil, which increases its fertility, availability and absorption by the roots of grape seedlings, that increase the efficiency of the photosynthesis process and its products, especially carbohydrates, which it used in growth and biosynthesis of plant hormones, especially auxin IAA (Mengel et al., 2001; Hopkins and Huner, 2004 and Alimam and Abbasi, 2020).

It was noted that the foliar spraying with gibberellic acid at a concentration of 100 mg.l-1 led to obtaining the largest significant values of the stem height (21.0cm) of grape seedlings. while this value decreased significantly to 18.278cm for the comparison treatment. This is attributed to an increase in height due to spraying with gibberellic acid to its vital role to encourage growth and elongation of the stem through its effect on the division or expanded of the intermediate cells. A rapid elongation occurs after treatment with gibberellins, accompanied by a significant increase in the number of dividing and elongation cells in the sub apical meristem (Singh, 2003, Hopkins and Huner, 2004), as well as the vital role of gibberellins that it activates and forms natural auxins that encourage growth (Abu Zaid, 1990).

The results of the statistical analysis especially at the triple interaction between the studied factors showed that spraying with 100 mg GA3.l-1 + 400 mg NPK. l-1 of the grape variety Zarek gave the highest values in the average height of the main stem of grape seedlings, which was significantly superior to the rest of the treatments, while the lowest values of the average height of the main stem of grape seedlings were recorded when spraying with 0 mg GA3. l-1 + 0 mg NPK. l-1 of the grape variety Zarek.

Table 2. Effect of NPK fertilization and GA_3 alone or a combined on stem height of seedlings of Thompson Seedless and Zarek grape cultivars (cm).

Cultivars	NPK Fertilizer mg.l^{-1}	GA_3 mg.l^{-1}		Cv.×NPK	
		0	100		
Thompson Seedless	0	15.67 ef	16.00 ef	15.83 c	18.111 b
	200	18.0 ed	19.00 d	18.500 b	
	400	18.0 ed	22.00 c	20.00 b	
Zarek	0	15.00 f	16.0 ef	15.50 c	21.167 a
	200	18.0 ed	20.0 cd	19.00 b	
	400	25.00 b	33.00 a	29.00 a	
Cv.×GA_3	Thompson Seedless	17.22 c	19.00 b	Mean of NPK	
	Zarek	19.33 b	23.00 a		
NPK × GA_3	0	15.33 d	16.00 d	15.67 c	
	200	18.00 c	19.50 c	18.75 b	
	400	21.50 b	27.50 a	24.50 a	
Mean of GA_3		18.27 b	21.00 a		

*Mean separation within columns and rows by Duncan's new multiple range tests at ($p \leq 0.05$) significant level of propalitiy.

The main stem diameter of grape seedlings: The results shown in Table (3) indicate that the cultivars significantly affected the increase in the diameter of the main stem of grape seedlings; The highest rate of main stem diameter for Zarek grape seedlings was 0.944 mm, which was significantly superior to Thompson Seedless cultivar in stem diameter. Perhaps the reason for the superiority of Zarek cultivar is the genetic susceptibility of the variety in terms of cambium activity and cytokinins which potent stimulators of cell division (Opik and Rolfe,2005)in giving new cells of the Zarek variety. It is noted the triple interaction between the factors under study, especially when the comparison treatment of the variety Zarek, which achieved the largest values in the diameter of the main stem, which amounted to 1.803 mm was significantly superior to the rest of the treatments, while the comparison treatment was recorded for Thompson Seedless variety, which recorded the lowest values for the average main stem diameter, which is 0.553 mm.

Table 3. Effect of NPK fertilization and GA_3 alone or a combined on stem diameter of seedlings of Thompson Seedless and Zarek grape cultivars (cm).

Cultivars	NPK Fertilizer mg.l^{-1}	GA_3 mg.l^{-1}		Cv.×NPK	Mean of cultivar
		0	100		
Thompson Seedless	0	0.553 c	0.773 b c	0.663 b	0.757 b
	200	0.567c	1.187 b	0.877 b	
	400	0.783b c	0.677 c	0.730 b	
Zarek	0	1.803a	0.717 c	1.260 a	0.944 a
	200	0.863 b c	0.667 c	0.765 b	
	400	0.867 b c	0.747 b c	0.807 b	
Cv.×GA_3	Thompson Seedless	0.634 c	0.879 b	Mean of NPK	
	Zarek	1.178 a	0.710 b c		
NPK × GA_3	0	1.178 a	0.745 b	0.962 a	
	200	0.715 b	0.927 ab	0.821 a	
	400	0.825 b	0.712 b	0.768 a	
Mean of GA_3		0.906 a	0.794 a		

*Mean separation within columns and rows by Duncan's new multiple range tests at ($p \leq 0.05$) significant level of propalitiy.

The chlorophyll content in the leaves (SPAD): It is clear from the data of Table (4) that there are no significant differences between the cultivars.While the compound fertilizer (NPK) was significantly increased the chlorophyll content of the leaves, especially at the levels of 400 and 200 mg of NPK.l^{-1} 7.933 and 7.525 SPAD mm) respectively, while the comparison treatment recorded the lowest values for the chlorophyll content of leaves, which is 6.200 mm (SPAD).

The data of the same table showed significant superiority of 400 mg NPK.l^{-1} + 100 mg GA_3 l^{-1} for Thompson Seedless grape variety (SPAD 9.00) compare with some treatments, while the comparison treatment recorded the lowest values of chlorophyll content in leaves (SPAD 5.80) for Thompson Seedless grape variety.

The increase in chlorophyll content is attributed to the physiological role of the added nutrients NPK in synthesis chlorophyll pigment and increasing the number and sizes of chloroplasts that increase the chlorophyll content of leaves (Delcroix, 1979 and Marschner, 1986 and Imam 1998). In addition to the genetic variance between the two studied cultivars, The characteristic of the chlorophyll concentration in the leaves is a hereditary trait according to the varieties, especially in terms of the thickness of the leaves (Branas, 1971).

Leaf area of grape seedlings cm^2.seedling^{-1}: The results in Table (5) show that the leaf area of grape seedlings was significantly affected by the nature of the variety, as Thompson Seedless cultivar significantly outperformed the average leaf area of seedlings (1852.49 cm^2. Seedlings $^{-1}$) on the leaf area of seedlings of the cultivar Zarek, whose leaf area reached the lowest average and amounted to 1489.76 cm^2. seedlings $^{-1}$ It is also evident from the data of the same table that the leaf area of grape seedlings was significantly affected by mineral nutrition using the levels of compound fertilizer (NPK), especially at the concentration of 400 mg NPK.l^{-1}, as the leaf area of seedlings was 1882.75 cm^2. seedlings $^{-1}$, which significantly superior the treatments with 0 and 200 mg NPK. $l^{-1.}$ The leaf area of grape seedlings reached the lowest when compared to the control treatment (1503.78 cm^2. seedlings $^{-1}$).The data of the interaction between the factors under study indicate a significant effect in increasing the leaf area of grape seedlings, especially when the triple interaction between the factors studied, the largest values were obtained when the fertilization was treated with 400 mg NPK.l^{-1} + spraying at a concentration of 100 mg GA_3. l^{-1} for Thompson Seedless grape variety, it reached 3037.0 cm^2. seedlings $^{-1}$, which significantly superior to the rest of the treatments, especially with the treatment 200 mg NPK. l^{-1} + 0 mg GA_3. l^{-1} for the Thompson Seedless grape variety, which recorded the lowest values 1066.6 cm^2.Seedling^{-1}. The increase in the leaf area of grape seedlings is attributed to the positive interaction of the biological benefits of mineral nutrition of the compound fertilizer NPK and spraying with gibberellic acid, especially by increasing the number of leaves and increasing the area of one leaf which led to an increase in the leaf area of grape seedlings.

Table 4. Effect of NPK fertilization and GA_3 alone or a combined on chlorophyll content in the leaves (SPAD) of Thompson Seedless and Zarek grape cultivars (cm).

Cultivars	NPK Fertilizer mg.l^{-1}	GA_3 mg.l^{-1} 0	100	Cv.×NPK	Mean of cultivar
Thompson Seedless	0	5.800 b	5.87 b	5.833 b	7.078 a
	200	6.60 ab	7.97 ab	7.283 ab	
	400	7.23 ab	9.00 a	8.117 a	
Zarek	0	6.233 b	6.90 ab	6.57 ab	7.361 A
	200	7.567ab	7.967ab	7.767a	
	400	7.40 ab	8.10 ab	7.75 a	
Cv.×GA_3	Thompson Seedless	6.544a	7.611a	Mean of NPK	
	Zarek	7.067a	7.656a		
NPK × GA_3	0	6.017c	6.38 bc	6.200 b	
	200	7.08 abc	7.97ab	7.525a	
	400	7.32 abc	8.550a	7.933a	
Mean of GA_3		6.806 a	7.633 a		

*Mean separation within columns and rows by Duncan's new multiple range tests at ($p \leq 0.05$) significant level of probability.

Table 5. Effect of NPK fertilization and GA_3 alone or a combined on leaf area of Thompson Seedless and Zarek grape cultivars (cm^2.seedling).

Cultivars	NPK Fertilizer mg.l^{-1}	GA_3 mg.l^{-1} 0	100	Cv.×NPK	Mean of cultivar
Thompson Seedless	0	1737.3 c	1667.8c d	1702.5 b	1852.49 a
	200	1066.6e f	2366.4 b	1716.5 b	
	400	1239.8e d	3037.0 a	2138.4 a	
Zarek	0	1364.8 c d e	1245.2 de	1305.0 c	1489.76 b
	200	1752.7 c	1321.6 cde	1537.1 b c	
	400	2454.7 b	799.5 f	1267.1 b	
Cv.×GA_3	Thompson Seedless	1347.9 c	2357.1 a	Mean of NPK	
	Zarek	1857.4 b	1122.1 c		
NPK × GA_3	0	1551.1 b	1456.5 b	1503.78 b	
	200	1409.7 b	1844.0 a	1626.85b	
	400	1847.3 a	1918.2 a	1882.75 a	
Mean of GA_3		1602.67 a	1739.58 a		

*Mean separation within columns and rows by Duncan's new multiple range tests at ($p \leq 0.05$) significant level of probability.

Dry weight for the vegetative growth: The data in Table (6) indicate that Thompson Seedless grape cultivar was superior than Zarek cultivar in the dry weight of vegetative growth, and the results of the same table showed that treated with 400 mg.l^{-1} it reached 2.785g. seedlings^{-1}, which was significantly superior to 200 and 0 mg NPK.l^{-1} treatments. while the comparison treatment recorded the lowest values for this trait it reached 2.035g. seedlings^{-1}.

Spraying with gibberellic acid led to a significant increase in the dry weight of the vegetative growth, spraed with 100 mg $GA_3.l^{-1}$ was recorded the largest values for this trait it reached 2.625 g. $seedlings^{-1}$ which

Table 6. Effect of NPK fertilization and GA_3 alone or a combined on the dry weight of the vegetative growth of Thompson Seedless and Zarek grape cultivars (cm).

Cultivars	NPK Fertilizer $mg.l^{-1}$	GA_3 $mg.l^{-1}$		Cv.×NPK	Mean of cultivar
		0	100		
Thompson Seedless	0	1.910 ef	2.5 cb	2.220 c	2.520 a
	200	2.130 d	2.950 a	2.540 b	
	400	2.590 b	3.010 a	2.800 a	
Zarek	0	1.780 f	1.92 ef	1.850 d	2.272 b
	200	1.980 de	2.410 c	2.195 c	
	400	2.610 b	2.930 a	2.770 a	
Cv.×GA_3	Thompson Seedless	2.210 c	2.830 a	Mean of NPK	
	Zarek	2.123 c	2.420 b		
NPK × GA_3	0	1.845 e	2.225 c	2.035 c	
	200	2.055 d	2.68 b	2.368 b	
	400	2.600 b	2.970 a	2.785 a	
Mean of GA_3		2.167 b	2.625 a		

*Mean separation within columns and rows by Duncan's new multiple range tests at ($p \leq 0.05$) significant level of probability.

Significantly outperformed the control treatment, which recorded the lowest values for this trait (2.167g. $seedlings^{-1}$).

The results of the interactions between the studied factors show a significant increase in the dry weight of the vegetative growth, especially in the data of the triple interaction between the studied factors, which recorded the largest values of the dry weight of the vegetative growth of Thompson Seedless grapes fertilized with 400 mg $NPK.1^{-1}$+100 mg $GA_3.l^{-1}$ gave a value of 3.010g.$Seedlings^{-1}$ .The value of this trait decreased and reached the lowest in the comparison treatment of grape variety Zarek which averaged 1.780 g. $Seedlings^{-1}$.

The variation in the dry weight of the vegetative growth of seedlings of the two grape cultivars may be due to the variation in the height of the main stem, diameter and leaf area of seedlings (Table, 2, 3 and 5), according to the strength of the variety as a result of the variation of genetic factors of growth grape cultivars in addition to the biosynthesis of NPK to protoplasm cells of seedling, in addition of increase the activity of some enzymes to reach their maximum activity in the biological processes inside the plant (Al-Shazly, 1999, and Mengel et al., 2001), and also due to the foliar spraying of gibberellic acid to an increase in plant strength and elongation by activating the division and increasing the size of plant stem cells.

Dry weight for the roots system: The data of the results of Table (7) indicate that the variety has a clear effect in increasing the dry weight of the root system the Thompson Seedless cv. was significantly outperformed the dry weight of the root system of the Zarek cv., and the results of the same table showed that 400$mg.l^{-1}$ of NPK fertilization had a significant effect in increasing the dry weight of the root system, compared with other treatments. The data of the interaction between all factors especially showed in triple interaction That treatment with 400mg $NPK.l^{-1}$ + 0mg $GA_3.l^{-1}$ for Thompson Seedless cv. had the highest values (3.397g.$seedlings^{-1}$)nfor the dry weight of the root system, while the control treatment for Zarek cv. recorded the lowest values (. 1.983g. $seedlings^{-1}$) for this trait.

The increase in the dry weight of the root system of the Thompson Seedless cv. is attributed to the genetic factors controlling growth and the increase of the vegetative growth of seedling (Table,6) and affect the strength of the cultivar's growth, in addition on the vital role of NPK fertilization which works to increase the vegetative growth of grape seedlings (Table, 6) by increasing the efficiency of the photosynthesis process and its vital products, which is reflected to increase the growth of the root system of grape seedlings.

Table 7. Effect of NPK fertilization and GA_3 alone or a combined on the average dry weight of the root system of Thompson Seedless and Zarek grape cultivars (cm).

Cultivars	NPK Fertilizer $mg.l^{-1}$	GA_3 $mg.l^{-1}$ 0	100	Cv.×NPK	Mean of cultivar
Thompson Seedless	0	2.130 ef	2.18 def	2.155 c	2.651 a
	200	2.51cde	2.66 bcd	2.585 b	
	400	3.397 a	3.03 ab	3.213 a	
Zarek	0	1.983 f	2.150 ef	2.067 c	2.439 b
	200	2.310 def	2.33 def	2.320 bc	
	400	2.963ab c	2.900 b c	2.932 a	
Cv.×GA_3	Thompson Seedless	2.679 a	2.623 a	Mean of NPK	
	Zarek	2.419 a	2.460 a		
NPK × GA_3	0	2.057 c	2.165 b c	2.111 c	
	200	2.410 b	2.495 b	2.453 b	
	400	3.180 a	2.965 a	3.073 a	
Mean of GA_3		2.549 a	2.592 a		

*Mean separation within columns and rows by Duncan's new multiple range tests at ($p \leq 0.05$) significant level of probability.

Conclusions

There was a clear response to the NPK fertilizer fertilization, especially when adding $400mg.l^{-1}$ in stem height, chlorophyll percentage, leaf area of seedling and dry weight of vegetative and root system. Spraying with gibberellic acid with $100mg.l^{-1}$ which led to an improvement in the height of the seedling, and the dry weight of the shoot.Varieties varied according to response to compound fertilizer and gibberellic acid spray, especially that Thompson Seedless than Zarek grape seedlings for most vegetative and root growth parameters.

References

Abo Zaid, A. N.(1990). Plant hormones and agricultural applications, Second Edition - Arab House for Publishing and Distribution. The Egyptian Arabic Republic. Cairo, Arab Republic of Egypt.

Ahmed, F. F. and M. H. Morsy (1999): A new method for measuring leaf area in different fruit species. Minia J. Agric. Res. & Devolop. Vol. (19), pp 97-105.

Al-Imam, N.M.A. (1998) Study on the effect of foliar application of iron, zinc and NPK fertilization on the growth and yield of Halwani Lebanon and Kamali grape cultivars (*Vitis vinifera* L.), Ph.D. Thesis, College of Agriculture and Forestry, University of Mosul, Iraq.

Al-Imam, N.M.A. and Al-Abassy, L.B.H. (2020) Effect of foliar application of chelated zinc, gibberellic acid GA_3 and kinetin on growth of Zaghinia apricot seedlings. Diyala Journal of Agricultural Science. A special issue of the proceedings of the Third and First International Scientific Conference on Agricultural Research. July 15-16, 2020.pp.585-598.

Branas, J. (1971). Sur La fumures de la Vigne. Le progress Agricole et Viticole 1 and 2: 21 – 27.

Delcroix, R. (1979). La fertilization azote et La vigne. Rev. Vititechique, 24: 6 – 7.

El-Shazly, Said Abdel-Aty (1999). Technology of fertilization and irrigation of fruit trees in desert lands. Academic Library, Cairo, Arab Republic of Egypt.

Felixloh, J.G. and N. Bassuk (2000). Use of the minolata SPAD 502 to determine chlorophyll concentration in *Ficus benjamina* L. and *Populus deltoids* Mash leaf tissue.HortSci.,35(3): 423.

Galet, P. (1971). Precis d' ampelographie pratlque. Imprimerie Dehan, Montpellier.

Hopkins, W. G. & N. P. A. Hüner (2004). Introduction of plant physiology. 3rd Edition. John Wiley & Sons, Inc. U.S.A.

Jundia, Hassan (2003). Physiology of fruit trees . First Edition - Arab House for Publishing and Distribution. The Egyptian Arabic Republic.

Marschner, H. (1986). Mineral Nutrition of Higher Plant. Academic Press Harcourt Brace Jovanovich, Publishers. L. London.

Mengel, K; E. A. Kirkby; H. Kosegavten and T. Apple (2001). Principles of Plant Nutirtion Kluwer Academic Publishers.

Mezrag, A.C. (2005). Comparison of growth kinetics and leaf mineral composition of some local grape cultivars (*Vitis vinifera* L.). Master Thesis. Faculty of Science, Department of Natural and Life Sciences. Mentouri University. Algeria.

Opik,H. and S. Rolfe (2005).The Physiology of Flowering Plants.4th Edition. Academic Consultant Editor .Cambridge.

Singh, A. (2003). Fruit physiology and production. Kalyani publishers, Ludhianna, Scince 125: 1144 – 45.