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Effect of Fulvic Acid and Some Nutrient Elements on King Ruby Grapevines Growth, Yield and Chemical Properties of Berries.

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ABSTRACT

The present investigation was carried out during 3 successive seasons from 2013 to 2015. The work in the first year was considered as a preliminary trial. This investigation was conducted on 16-year-old King Ruby grapevines cultivar growing at a private vineyard called Chycheny located at Meniet Samanood village near Mansoura city, Dakahlia Governorate, Egypt. The study aimed to evaluate the effect of fulvic acid and some macro-elements (Mg and K) as foliar application on vegetative growth, yield and chemical characteristics of berries.Most tested treatments gave generally a significant increase of different studied parameters, where, (Fulvic acid +Mg + K) gave the highest significant increase in bud burst and fertility (86.75 & 87.50 %) and (65.83 & 69.17 %) as compared with that of control (48.67 & 52.00 %) and (54.50 & 50.00 %) in 2014 and 2015 seasons, respectively. In addition, (Fulvic acid +Mg + K) gave a significant increase of vegetative growth such as shoot length, leaf surface area and total chlorophyll content (151.17 & 152.97 cm), (114.96 & 115.70 cm^2) and (12.40 & 13.10 mg/g FW) as compared with that of control (104.70 & 107.37 cm), (94.08 & 94.37 cm^2) and (7.088 & 7.207 mg/g FW) in 2014 and 2015 seasons, respectively. Also, this treatment gave a pronounced increment in yield/vine (15.29 and 15.85 kg/vine) as compared with that of control (8.36 and 8.95 kg/vine) in 2014 and 2015 seasons, respectively. Same treatments gave higher increase in the chemical characteristics of berries as SSC%, total sugars and total anthocyanin content in berry skin (20.17 & 21.00%), (18.43 & 19.20 %) and (78.98 & 79.82 mg/100g FW), while it gave the lowest decrease in acidity% (0.26 & 0.24 %) as compared with that of control (18.27 & 18.17 %), (13.83 & 14.20 %), (28.71 & 18.17 mg/100g FW) and (0.48 & 0.46 %), in 2014 and 2015 seasons, respectively.

INTRODUCTION

Grape (*Vitis vinifra* L) is one of the most commercially grown important fruit crops grown in the world it was among the first domesticated fruit species and remain the world's most economically important fruit crops. According to the Food and Agriculture Organization of The United Nations (FAO), grapevines were planted on almost 7 million hectars (16.67 million feddans) producing more than 67 million metric tons of grapes in 2012. More than 70% of them was used as wine, 27% was consumed as table grapes (fresh grapes), 2% was as raisins (dried fruits), and less than 1% was processed to grape juice, brandy, or transformed into vinegar. Additionally that, nutritional value of consuming fresh grapes, which containing natural sugars, potassium and iron, which make the grape one of the very hygienic and popular fruits for many people across the world (Keller, 2015). In Egypt, it ranks a second after citrus. The planted area reached 196993 fed. in 2015, producing about 1686706 tons (Ministry of Agriculture Statistics, 2015).

King Ruby grape cultivar is considered one of the most important commercial grape cultivars, the fruitful planted area reached about 3370 fed produced about 38263 ton (Ministry of Agriculture Statistics, 2011). This cultivar has a great importance either for the local or export markets. Therefore, the grape growers gave a great attention to all cultural practices related to this cultivar, especially fertilization program to provide the cultivated grapevines with their optimum nutrient requirements.

"Fulvic acid is the most significant component of organic and natyral substances in aquatic systems, it is highly beneficial to both plant and soil because: 1) it is important for increasing microbial activity. 2) it is considered as a plant growth bio-stimulant, it promotes nutrient uptake as chelating agent and enhances vegetative characteristics, nutritional status and leaf pigments. Fulvic acid is very effective due to:

1) its low molecular weight which range from approximately 1.000 to 10.000 compared with humic acid, It includes important and ability to effectively bond minerals and elements into its molecular structure leading them dissolve and grow to be mobilized fulvic complexes, fulvic acid typically bears 70 or more mineral and trace factors as a part of its molecular complexes (Aiken et al., 1985).
2) Fulvic acids have an oxygen content twice that of humic acids and they have many carboxyl and hydroxyl groups much than humic acid. So, they are much more chemically reactive. This make FAs exchange capacity is more than double that of humic acids" (Aiken et al., 1985).

Fulvic acids are key materials of excessive great foliar fertilizers. As they could assist the penetration to the plant parts, set off the uptake of elements from plant surfaces into plant tissues. As soon as applied to leaves, fulvic acids transport critical minerals directly to metabolic sites within plant cells. So, foliar spray applications at unique plant boom degrees, containing mineral chelated can be taken as a primary method for maximizing plant life efficient potential" (Chen et al., 2004).

Magnesium (Mg) is an important macronutrient with a number of physiological functions in the plant. The importance of magnesium in the plant is in many ways connected with photosynthesis. It is the central atom of chlorophyll and it activates enzymatic processes. Magnesium also favourably influences assimilation. Magnesium deficiency reduces the content of chlorophyll in the leaves and changes the chlorophyll a:b ratio in favour of chlorophyll b. Visually it is seen as chlorosis of leaves, especially older ones and causes premature abscission. Magnesium deficit results not only in reduce yields but also in increase risk of tendril atrophy. Foliar spraying with Mg containing fertilizers is a common practice to correct nutrient imbalances in grape but Mg doses beyond those required for maximum yield rarely induce further improvement of product quality (Gerendás and Führs 2013).

Potassium (K) is an essential element for plant nutrition among those mineral elements (N, P, and Mg) that continue to accumulate throughout berry growth (Rogiers *et al.,* 2006) and it is known that grapevine is one of the most potassium- friendly plants, and its ability to influence meristem growth, water status, photosynthesis and long distance transport of assimilates is well established (Mengel and Kirkby 2001). Owing to its fundamental roles in turgor generation, primary metabolism, and long-distance transport, K plays a prominent role in crop resistance to drought, salinity, high light, or cold as well as resistance to pest and pathogens. In K-deficient crops, the supply of sink organs with photosynthates is impaired and sugars accumulate in source leaves.

Therefore, the aim of the present investigation is to throw some light on the consequences of fulvic acid foliar utility either on my own or in aggregate with some macro- elements (Mg and K) fertilizers on vegetative increase, yield, and berries quality of King Ruby grapevine.

MATERIALS AND METHODS

The experiment was conducted on 16-year-old king Ruby grapevines growing in a clay soil as shown in Table (1) at a private vineyard Chycheny, located at Meniet Samanood village, near Mansoura city, Dakahlia Governorate, Egypt.

Vines cultivated at 2m within plants and 3m between-rows. The vines are grown in clay soil, under drip irrigation system with supporting by double (T) trellis system and during January of each experimental season, the tested vines were spur-pruned by leaving 5 spurs with 2 eyes buds on each cordon. The total load was 40 buds per vine. 72 vines were chosen for the present study, almost uniform in growth vigor, reputedly healthy, effective and they received the common cultural practices which had been carried out in that district, inclusive of irrigation and weeds, pests and diseases control. The experiment consists of 8 treatments organized in a complete randomized blocks layout, every treatment consist of three replicates of 3 vines, and borders have been left round and among replicates of treatments.

Table 1. Mechanical analysis and chemical constituents of experimental vineyard soil.

Sample depth (cm)	Mechanical analysis					Chemical analysis						
	Coarse sand	Fine sand	Silt	Clay	Texture class	pH 1:2.5	E.C 1:5 dS/m	$CaCO_3$ %	Organic matter %	Available (ppm) N	P	K
0-30	1.66	21.12	30.07	47.15	Clay	7.95	0.88	0.93	1.52	48.6	6.75	328
30-60	1.27	19.75	29.72	49.26		8.12	0.85	1.36	1.13	52.3	6.32	336
60-90	1.05	18.10	29.10	51.75		7.83	0.92	1.52	0.98	50.7	5.95	312

The treatments were applied as the following:-

T_1: Control (only water foliar spray).
T_2: Mg (1%) as magnesium sulphate.
T_3: K (2%) as potassium sulphate.
T_4: Mg 1% + K 2%.
T_5: Fulvic acid at 9 ml/liter/vine.
T_6: Fulvic acid (9 ml/liter/vine) + Mg 1%.
T_7: Fulvic acid (9 ml/liter/vine) + K 2%.
T_8: Fulvic acid (9 ml/liter/vine) + Mg 1% + K 2%.

All treatments were applied as foliar spray. All treatments solutions were calculated as weight per volume (w/v), while a surfactant agent with 0.05% was added to all these treatments solutions.

All previous treatments were sprayed at the following 3 stages:

1- A week before blooming (20 and 27 April in 2014 and 2015, respectively).
2- 7 days after fruit set stage (16 and 23 May in 2014 and 2015, respectively).
3- At véraison stage (10 and 27 July in 2014 and 2015, respectively).

Preparation of fulvic acid:

1-Compost (prepared from rice straw, farmyard manure, rock phosphate, bentonite and urea) were digested with 0.5N KOH for 48 h at r.t. with ratio of 1/10 (W\V).
2- Separation of the solute shape the undigested residues have been then finished by means of filtration via a hundred mesh screen.
3-The supernatant turned into acidified at pH 2 with concentrated H2SO4 and left for 24 h inside the dark so that you can permit humic acid flocculation.
4- Fulvic acid collected by filtration. (Vallini *et al.,* 1990).

Table 2. Chemical analysis of fulvic acid.

Trait	Values
pH (1 : 2.5)	2.8
EC (dS m-1)	8.68
Organic –C (%)	2.81
Available N (ppm)	210
Available P (ppm)	7.4
Total K (%)	2.26

Measurements:

bud behavior:

Bud burst%:

It was calculated as the following: recording the number of bursted buds then expressed as a percentage from the total number of buds left on the vine according to the following equation:

$$\text{Bud burst \%} = \frac{\text{Number of bursted buds/vine}}{\text{Total number of buds left/vine (40)}} \times 100$$

Bud fertility %:

It was calculated according to Omran (2000) as the following: recording the number of clusters then expressed as a percentage from the total number of buds left on vine according to the following equation :

$$\text{Bud fertility \%} = \frac{\text{Number of clusters/vine}}{\text{Total number of buds left/vine (40)}} \times 100$$

Vegetative growth

All vegetative growth parameters were carried out two weeks after the last spraying treatment.

Average shoot length (cm):

Shoot length was calculated by measuring the length of 4 shoot per vine (2 shoots from both side).

Average leaf surface area (cm^2/leaf):

At the equal shoot, samples of 8 absolutely mature leaves from the top of the growing shoot (sixth or 7th leaf) every examined vine that represented the distinctive vine sides had been used for leaf area measurements in step with the following equation according to Montero *et al.* (2000):

Leaf area (cm^2) = 0.587 (L × W)

Where, L= length of leaf blade. W= width of leaf blade.

Leaf chlorophyll content (mg/g fresh weight):

Overall chlorophylls content were measured in the leaves and envisioned by taken eight leaves from every vine, as a representative sample at the sixth to seventh leaf from the shoot tip at full bloom stage in the two seasons of study. Fresh leaf sample of 0.5 g was used, soaked in 20 ml CH_3OH for 24 hour in cool chamber and measured by spectrophotometer (Spekol). Chlorophylls A and B were determined according to the following equation, (Arnon, 1949).

$$Ch.A = 16.5\ OD_{665} - 8.3\ OD_{650}$$

$$Ch.B = 33.8\ OD_{650} - 12.5\ OD_{665}$$

$$Total = 25.5\ OD_{650} + 4.0\ OD_{665}$$

Where OD= Optical Density.

$$\text{Total chlorophyll (mg/g)} \quad \frac{\text{Total chl x Volume of solution}}{\text{Weight of sample x 1000}} \quad x\ 100$$

Yield (Kg/vine):

Whilst the clusters reached purple colour and the soluble solids content material percentage in berry juice reached about 18 %, yield of each vine was estimated in kg/vine in each seasons with the aid of multiplying the average cluster number consistent with every vine by the average cluster weight.

Berry chemical characteristics:

Soluble solids content percentage (SSC%)

It was measured as a percentage in juice of fresh berries represented each replicate within every treatment by using Carlzeiss hand refractometer.

Total acidity content (%):

It was measured by titrating 10 ml of clean juice against sodium hydroxide (0.1 N) after the addition of a some drops of phenolphthalein (ph.ph) as an indicator. The acidity was expressed as gram of tartaric acid in 100 ml juice consistent with the method described in AOAC (1990).

$$\text{Tartaric acid in g/100 ml juice} = \frac{\text{ml NaOH} \times}{0.1 \times 0.075} \times 100$$

Total sugars %

Total and reducing sugars were determined colormetrically according to phenol-sulphuric acid reaction method and sodium-arsinate method, respectively. A standard curve was prepared by using asending glucose concentration to determine the absorbance of reaction by Spectrophotometer on wave length 490 and 700 nm according to the method described by Nelson (1944).

Anthocyanin content in berries skin (mg / 100 g)

1/2 gram of fresh berries skin + 20 ml of acidify alcohol solution putted in dark place for forty eight hours at r.t., the extract was taking to measure at 535 nm using spectrophotometer in step with to Hsia *et al.* (1965).

Statistical analysis

Data reported under this study were assessed by analyses of variance (ANOVA) for the randomized blocks design, the new least significant difference (New L.S.D) method was used to determine the differences between treatment means at the probability $P < 0.05$ (Gomez and Gomez, 1984). All the analyses were conducted using computer software CoSTATE.

RESULTS AND DISCUSSION

Effect of fulvic acid and (K and Mg) on bud behavior:

Data present in Table 3 showed the effect of foliar application of fulvic acid, potassium and magnesium on bud burst and bud fertility % of King Ruby grapevines during 2014 and 2015 seasons. As shown in the same Table all applied treatments increased bud burst % in both seasons and bud fertility% in the 2nd season of the study as compared with control treatment. The combined application of (T8) (Fulvic acid + Mg + K) recorded the very best significant increase of bud burst and fertility% (86.75 & 87.50 %) and (65.83 & 69.17 %) during both seasons, respectively. The lowest values of bud burst and bud fertility % were observed with the control treatment (48.67 & 52.00 %) and (54.50 & 50.00 %) in 2014 and 2015, respectively. Data also revealed that potassium treatments were superior than magnesium treatments when added alone as for their effect on bud behavior. Similar results were attained by Omar (2005) on Thompson seedless grapevines and Ibrahim, Doaa (2013) on King Ruby grapevines, they discussed the effect of soil application of humic acid on bud fertility of grapevines. The end result showed that humic acid gave a big growth of bud fertility % in comparison with control. Also, Matter (2003) stated that both bud fertility and fruitfulness of Thompson seedless grapevines significantly increased by means of increasing the level of potassium fertilization. Omar and Abdelall (2005) provided that K fertilization considerably increased bud fertility of Crimson seedless grapevines. Furthermore, Abo Samra (2007) and El-Kady *et al.,* (2010) discussed the effect of potassium and magnesium as soil fertilization on Thompson seedless and Flame seedless grapevines. Data showed that, both potassium and magnesium fertilization increased bud burst and fertility % as compared with the control treatment.

This may be ascribed to the results of Srinivasan and Mullins, (1981). Dhillon *et al.,* (1999) and Ganeshamurthy *et al.*, (2011), they mentioned that adding K in sufficient quantities is important in the stage of differentiation of the buds and the formation of flower primordium. Also, they suggested that k fertilization causes an increase in the maximum average number of inflorescences. The positive effect of fulvic acid in this respect may be due to the relatively small size of fulvic acid molecules, which can easily enter plant roots and leaves. During their enter plant parts, they carry some mineral nutrients into plant tissues, which maximizing plant production capacity. Once applied to plant foliage, fulvic acid transport these mineral nutrients directly to metabolic sites in plant cells (Ghabbour and Davies, 2001).

Table 3. Effect of fulvic acid and (K and Mg) on bud burst and bud fertility (%) of King Ruby grapevines during 2014 and 2015 seasons.

Treatments		Bud burst (%)		Bud fertility (%)	
		2014	**2015**	**2014**	**2015**
Control	T1	48.67	52.00	54.50	50.00
Mg (1%)	T2	53.67	54.50	51.17	56.67
K (2%)	T3	60.25	63.33	51.67	59.17
Mg (1%)+K (2%)	T4	70.00	71.67	55.50	62.50
Fulvic acid (9ml/L/vine)	T5	73.67	76.17	58.67	62.50
Fulvic acid(9ml/L/vine)+Mg(1%)	T6	80.00	79.17	60.00	65.83
Fulvic acid (9ml/L/vine)+K(2%)	T7	84.33	84.50	63.33	67.50
Fulvic acid (9ml/L/vine)+Mg(1%)+K(2%)	T8	86.75	87.50	65.83	69.17
New LSD at 5%		4.85	4.59	Ns	6.68

Effect of fulvic acid and (K and Mg) on vegetative growth:

Shoot length:

Data illustrated in Table 4 showed shoot length, leaf area and total chlorophyll of King Ruby grapevines as affected by foliar application of fulvic acid and some nutrient elements K and Mg either alone or in combination during 2014 and 2015 seasons. Treated King Ruby grapevines with fulvic acid, potassium and magnesium significantly affected shoot length during both seasons of the experiment. With regard to the effect of all treatments, treatment 8 (Fulvic acid + Mg + K) gave the highest significant values (151.17 and 152.97 cm) for shoot length, (114.96 and 115.70 cm^2) for leaf area and (12.40 and 13.10 mg/g FW) for total chlorophyll in 2014 and 2015 seasons, respectively, followed by T7 (Fulvic acid + K). On the other hand, (T1) control treatment gave the lowest values (104.70 and 107.37 cm), (94.08 and 94.37 cm^2) and (7.088 and 7.207 mg/g FW) in 2014 and 2015 seasons, respectively. All other treatments gave values in between the previous treatments. Data also cleared that vines treated with Mg alone (T2) gave the second lowest values after control compared to other treatments. These result are in accordance with those obtained by Megawer (2009) on Superior grapevines, Fathy *et al.* (2010) on Canino apricot, Fayed (2010) on Roghiani olive, Ahmed *et al.* (2011) on Flame seedless and Ali *et al.* (2013) on Thompson seedless, they all studied the effect of Humic or Fulvic acids on vegetative growth. Result obtained indicated that spraying Humic substances led to a positive effect on shoot length and leaf area. Also, Zachariakis *et al.* (2001), Ferrara and Brunetti (2008), Ibrahim, Doaa (2013) and El-Boray *et al.* (2015a) on various grapevines cv., they all showed that application of Humic substances caused an increment on chlorophyll content of leaves.

Positive effect of fulvic acid on vegetative growth may be due to that, fulvic acid (FA) increases availability of antioxidants, hormones such as IAA, GA3 and Cytokines, many Vitamins such as Vitamin B) (Abd El-Hameed *et al.,* 2014). Also, uptake of humic substances improves processes in plant (Chen and Avid 1990). FA stimulates and balances cells, creating optimum growth and replication conditions and enhances cell division and elongation (Poapst and Schnitzer 1971). The positive effect of fulvic acid in chlorophyll content may be explained due to that fulvic acid increases both of the uptake of oxygen and the concentration of messenger ribonucleic acids (m RNA) in plants cells. Both are essential for many biochemical processes in plant cells as, synthesis of enzymes and protein causing an increase in chlorophyll synthesis (Dixon & Weed 1989 and Nardi *et al.*, 1996). Moreover, Matter (2003), Shoeib (2004), Rizk-Alla *et al.* (2006), Abo Samra (2007) on Thompson seedless grapevines and Mosa *et al.* (2015) on Anna apple trees resulted that using K or Mg fertilization significantly increased shoot length, cane thickness and leaf area in two seasons of study. A definite function of K in intensifying the synthesis of carbohydrates (Yagodin 1984). Also, K promotes protein metabolism and the accumulation of thiamin, riboflavin and more than 50 enzymes (Jones, 2012 and Marschner 2012), which, play an important role in encouraging cell division and elongation and building new tissues in the plants and development of meristematic tissues and formation of cellulose and lignin (Cooper *et al.,* 1967). So, K caused increasing in leaf area and shoot length and caused the canes to be thickened. Also, Potassium (K) plays an important role in accumulating structure of chloroplasts and mitochondria and promotes formation of energy rich ATP. So, it increases the processes of photosynthetic and oxidative phosphorylation (Yagodin 1984). Magnesium (Mg) has long been illustrious for essential role in chlorophyll formation and photosynthesis. Mg is critical for the biosynthesis of chlorophyll, which in turn creates a biological basis for absorption of sunlight energy, resulting in production of oxygen and carbohydrates (Barker 2015). Magnesium is the metallic constituent of chlorophyll and considered the central atom of chlorophyll and it activates enzymatic processes and regulates the uptake of other nutrients (Mia, 2015) that lead to increase in photosynthetic activity and improving all vegetative growth.

Table 4. Effect of fulvic acid and (K and Mg) on vegetative growth of King Ruby grapevines during 2014 and 2015 seasons.

Treatments		Shoot length (cm)		Leaf surface area/leaf (cm^2)		Total chlorophyll (mg/g FW)	
		2014	2015	2014	2015	2014	2015
Control	T1	104.70	107.37	94.08	94.37	7.088	7.207
Mg (1%)	T2	122.27	119.53	95.71	99.10	8.129	7.999
K (2%)	T3	129.57	131.30	101.43	102.48	8.895	8.926
Mg+K	T4	133.00	138.53	103.08	103.26	10.011	9.917
Fulvic acid (9ml/L/vine)	T5	133.93	140.70	104.16	104.38	10.897	11.048
Fulvic acid (9ml/L/vine)+Mg(1%)	T6	137.07	139.33	104.35	104.58	11.747	11.740
Fulvic acid (9ml/L/vine)+K(2%)	T7	143.20	144.67	109.49	109.73	11.860	12.484
Fulvic acid (9ml/L/vine)+Mg(1%)+K(2%)	T8	151.17	152.97	114.96	115.70	12.404	13.104
New LSD at 5%		7.30	6.93	4.56	3.60	0.390	0.286

Effect of fulvic acid and (Mg and K) on yield:

Data present in Table 5 explained the effect of foliar application of fulvic acid and a few nutrient elements such as potassium and magnesium on yield of King Ruby grapevines during 2014 and 2015 seasons. Data recorded in the same Table showed that treating vines with all treatments as fulvic acid, K or Mg either alone or in combination were significantly increased yield during both seasons of study. It can be noticed that the highest values of yield / vine (15.29 and 15.85 kg), were recorded when vines treated with T8 (Fulvic acid + K + Mg), compared to the untreated vines, which gained(8.36 and 8.95 kg) yield / vine, respectively, in both seasons of study. Data also, clearly indicated that control treatment recorded the lowest values for yield of studied grapevines, followed by vines treated with Mg (1%) alone which recorded (9.21 and 9.42 kg/vine) during 2014 and 2015 seasons of study. Data also indicated the superiority of combined treatments when compared with individual treatments. Also, Zhang *et al.* (2013), Suh *et al.* (2014) and El-Boray *et al.* (2015 a, b), they found a positive effect of humic acid or fulvic acid on yield per vines. Moreover, EL-Boray *et al.* (1997), Ahmed (2000), Matter (2003) and Shoeib (2004) on Thompson seedless grapevines, they recorded that application of potassium fertilization increased yield / vines. Also, Rizk-Alla *et al.* (2006), Abo Samra (2007), Bybordi and Shabanov (2010) and Zlámalová *et al.* (2015) mentioned that using foliar application of Mg gave the highest yield/vine.

Table 5. Effect of fulvic acid and (K and Mg) on yield of King Ruby grapevines during 2014 and 2015 seasons.

Treatments		Estimated yield (Kg/vine)	
		2014	2015
Control	T1	8.36	8.95
Mg (1%)	T2	9.21	9.42
K (2%)	T3	9.12	10.57
Mg+K	T4	10.05	11.08
Fulvic acid (9ml/L/vine)	T5	11.01	11.89
Fulvic acid (9ml/L/vine)+Mg(1%)	T6	12.65	13.95
Fulvic acid (9ml/L/vine)+K(2%)	T7	14.38	15.35
Fulvic acid (9ml/L/vine)+Mg(1%)+K(2%)	T8	15.29	15.85
New LSD at 5%		1.27	1.76

Effect of fulvic acid and (K and Mg) on berries chemical characteristics:

Soluble solids content (%) and acidity (%) in berry juice:

Data tabulated in Table 6 showed berries chemical characteristics (SSC% and acidity% in berry juice) of King Ruby grapevines as affected of fulvic acid, K and Mg either in separate or in combination form as foliar application during 2014 and 2015 seasons. Data also indicated a positive effect of all tested treatments as for soluble solids content (SSC%). In this respect, the untreated vines gave the lowest values, which recorded (18.27 and 18.17%) for soluble solids content during the two seasons of study. The very best values of these measurements had been corresponding with T8 (Fulvic acid + Mg + K), which treated vines recorded (20.17 and 21.00%) for SSC.

Table 6. Effect of fulvic acid and (K and Mg) on SSC, acidity and SSC/acidity ratio of King Ruby grapes during 2014 and 2015 seasons.

Treatments		SSC (%)		Acidity (%)	
		2014	2015	2014	2015
Control	T1	18.27	18.17	0.48	0.46
Mg (1%)	T2	18.53	18.77	0.32	0.31
K (2%)	T3	18.83	19.03	0.32	0.30
Mg+K	T4	18.90	19.10	0.31	0.30
Fulvic acid (9ml/L/vine)	T5	19.20	20.00	0.30	0.29
Fulvic acid (9ml/L/vine)+Mg(1%)	T6	19.50	20.07	0.29	0.28
Fulvic acid (9ml/L/vine)+K(2%)	T7	19.77	20.43	0.29	0.28
Fulvic acid (9ml/L/vine)+Mg(1%)+ K (2%)	T8	20.17	21.00	0.26	0.24
New LSD at 5%		0.60	0.59	0.02	0.03

As for acidity % in berry juice, data showed an opposite effect of the treated treatments, where control treatment gave the highest acidity% values, which recorded (0.48 and 0.46%) followed by T2 (Mg 1%), which treated vines recorded (0.32 and 0.31 %) during the two seasons of study. Also, the lowest values were corresponding with vines treated with T8 (Fulvic acid + Mg + K), which recorded (0.26 and 0.24 %) during the two seasons of study, respectively. As previously outlined by Elattar (2012), Akin (2011), Zhang *et al.* (2013) and Suh *et al.* (2014) they all mentioned that using Humic or Fulvic acids increased significantly SSC % and SSC/acidity ratio as well as decreased acidity %. Also, EL-Baz *et al.* (2003), Al-Moshileh and Al-Rayes

(2004) and Shoeib (2004) stated that potassium in different sources on Thompson seedless grapevines significantly increased SSC% and SSC/acid while, significantly decreased acidity%. As for the effect of Mg, Abo Samra (2007), Hassan *et al.* (2007), Takacs *et al.* (2007) on Thompson seedless grapevines stated that the use of Mg in a lot of sources significantly increased SSC%, SSC/acid ratio and decreased acidity%.

Total sugars (%) and total anthocyanin in berry skin:

The involved statistics in Table (7) indicated that all treatments gave an increase in total sugars in berries juice and total anthocyanin content in berries skin like compared with that of control in both seasons of study. The combination treatment T8 (Fulvic acid + Mg + K) gave the highest significant increase in percentage values (18.43 & 19.20 % for total sugars) and (78.98 & 79.82 mg/100g for anthocyanin content) during both seasons, respectively.

Table 7. Effect of fulvic acid and (K and Mg) on Total sugars, reducing sugars % and Total anthocyanin content in berry skin of King Ruby grapes during 2014 and 2015 seasons.

Treatments		Total sugars (%)		Total anthocyanin content (mg/100 g)	
		2014	2015	2014	2015
Control	T1	13.83	14.20	28.71	29.23
Mg (1%)	T2	14.50	14.87	41.24	47.51
K (2%)	T3	16.17	17.13	50.78	52.87
Mg+K	T4	16.67	17.77	51.29	55.29
Fulvic acid (9ml/L/vine)	T5	15.03	15.63	38.16	61.88
Fulvic acid (9ml/L/vine)+Mg (1%)	T6	15.87	16.27	56.20	67.10
Fulvic acid (9ml/L/vine)+K(2%)	T7	17.40	18.70	61.78	67.63
Fulvic acid (9ml/L/vine)+Mg (1%) +K (2%)	T8	18.43	19.20	78.98	79.82
New LSD at 5%		0.65	0.91	17.37	4.06

The other different treatments may be descending arranged as follows: T7, T4, T3, T6, T5 and T2 with a extensive variations amongst them during both seasons of study, except for total anthocyanin content in berry skin. Otherwise, the treatment of control had the lowest values (13.83 & 14.20 % for total sugars), and (28.71 & 29.23 mg/100g for anthocyanin content) in 2014 and 2015, respectively. Acquired statistics are in harmony with the ones mentioned by way of EL-Khawaga (2011) and Shaheen *et al.* (2012) on grapevines. They stated that Humic or Fulvic acids significantly increased total sugars (%). As for total anthocyanin content, Rizk-Alla and Tolba (2010), Paradian and Samavat (2012) and Ibrahim, Doaa (2013) stated that Humic or Fulvic acids significantly increased total anthocyanin content in berries skin. Also, those consequences are according with those received by means of Takacs *et al.* (2007) using Mg fertilization and Mosa *et al.* (2015) using K fertilization, they mentioned that the tested treatments significantly increased total sugars. Abdel-Mohsen (2003) and Omer and Abdel-All (2005) using K fertilization, and as for Mg fertilization, EL-Kady *et al.* (2010) and Farag and Nagy (2012) they all mentioned that K or Mg fertilization significantly increased total anthocyanin content in berry skin of grapes.

Referring to the previous stated results, it become clear the great role of fulvic acid in particular whine brought with some macro-elements such as Mg and K for King Ruby grapevines grown in clay soil because it essential for improvement of the nutritional status of the vines and production of maximum yield and quality of grapes. Also, minimizing the cost of production and in turn improved the income of vineyards. Therefore, it must be encouraged the superiority application of the combination treatment T8 (Fulvic acid + Mg + K) which gave the highest values of vegetative growth, yield and chemical characteristics of berries.

REFERENCES

Abd El- Hameed, M. M. W.; A. A. Gobara; E. A. Rizk and A. R.M. El-Wany (2014). Reducing mineral N fertilizer partially In Thompson seedless vineyards by using fulvic acid and effective microorganisms. World Rural Observations, 6(4): 36-42.

Abdel-Mohsen, M. A. (2003). The effect of rate of fertilization and timing on Flame seedless grapevines. Ph.D. Thesis, Fac. Agric. Cairo Univ., Egypt.

Abo Samra N. H. A. (2007). Studies on nutrition of Thompson seedless grapes under delta conditions. Ph.D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Ahmed, A. A.; M. A. Megawer; A. E. M. Mansour; N. E. Ashour and R. A. R. Eissa (2011). Impact of fulvic acid and *Spirulina platensis* algae as a bio-organic fertilizers for Flame seedless grapevines grown under sandy soil. Res. J. Agri. And Biol. Sci., 7(2): 287-293.

Ahmed, H. O. (2000). Potassium application to Thompson seedless grapevines in clay soil. Egypt. J. Agric. Sci. Mansoura Univ., 25(4): 2197-2204.

Aiken, G. R.; D. M. McKnight and P. MacCarthy (1985). Humic Substances of Soil, Sediment and Water. New York, Wildy- Interscience.

Akin, A. (2011). Effect of cluster reduction, herbagreen and humic acid applications on grape yield and quality of Horoz Karasi and Gok Uzum grape cultivars. African J. Biotechnology, 10(29): 5593-5600.

Al-Moshileh, A. and D. Al-Rayes (2004). Effect of potassium fertilization regimes on petiole nutrient contents, yield and fruit quality of table seedless grapes. IPI regional workshop on Potassium and Fertigation development in West Asia and North Africa; Rabat, Morocco, 24-28.

AOAC (1990). Association of Official Agricultural Analytical Chemists. Official Methods of Analysis. 15th Ed. Washington, DC., USA.

Arnon, D. J. (1949). Copper enzymes in isolated chloroplasts polyphenol oxidase in Beta vulgaris. Plant Physiol., 24: 1-15.

Barker, A. V. (2015). Handbook of Plant Nutrition. Books in Soil, Plants, and Environment. Taylor at Francis.

Bybordi, A. and J. A. Shabanov (2010). Effects of the foliar application of magnesium and zinc on the yield and quality of three grape cultivars grown in the calcareous soils of Iran. Not. Sci. Biol., 2(1): 81-86.

Chen, Y. and T. Avid (1990). Effect of humic substances on plant growth. In: Humic substances in soil and crop sciences: Selected reading, C.E.P. MacCarthy, R.L. Clapp, Malcolm and P. R. Bloom (Eds). Soil Science Society Am., Madison, Wi., pp: 161-187.

Chen, Y., C. E. Clapp and H. Magen (2004). Mechanisms of plant growth stimulation by humic substances: The role of organic-iron complexes. Soil Science and Plant Nutrition, 50: 1089-1095.

Cooper, R. B.; R. E. Blaser and R. H. Brown, (1967). Potassium nutrition effects on net photosynthesis and morphology of alfalfa. Soil. Sci. Amer. Proc., 31: 231-235.

Dhillon, W. S.; A. S. Bindra, and B. S. Brar (1999). Response of grapes to potassium fertilization in relation to fruit yield, quality and petiole nutrient status. J. Indian Society of Soil Sci., 47: 1.89-94.

Dixon, J. B. and S. B. Weed (1989). In Minerals in Soil Environments. Soi. Sci. Soci. Ameri., Madison, Wisconsin, Page 95.

El- Khawaga, A. S. (2011). Partial replacement of mineral N fertilizers by using humic acid and Spirulina platensis Algae biofertilizer in Floridaprince peach orchards. Middle East J. of Applied Sci., 1(1): 5-10.

Elattar, A. N. A. (2012). Effect of some organic compounds on date palm. MSc. Thesis, Fac. Agric., Mans. Univ., Egypt.

EL-Baz, El. El. T.; G. I. EL-Banna; E. F. EL-Dengawy and Amal N. M. Ramadan (2003). Yield and quality of Thompson seedless fresh grapes and raisins as influenced by potassium application. J. Agric. Sci. Mansoura Univ., Egypt, 28(1): 547-554.

El-Boray, M. S.; M. F. M. Mostafa; A. D. Shaltout and K. H. Hassan (2015a). Influence of fulvic plus some microelements and microorganisms on yield and quality characteristics of Superior seedless grapevines. J. Plant Production, Mansoura Univ., 6(3): 287-305.

El-Boray, M. S.; M. F. M. Mostafa; M. A. Iraqi and A. A. Lo'ay (1996). Effect of potassium soil and foliar fertilization on leaf potassium content, yield and berry qualities of Thompson seedless grape. J. Agric. Sci. Mansoura Univ., 21(3):1153-1162.

El-Boray, M. S.; M. F. M. Mostafa; M. M. Abd El-Galel and I. A. I. Somaa (2015b). Effect of humic and fulvic acids with some nutrients at different times of application on yield and fruits quality of Anna apple trees. J. Plant Production, Mansoura Univ., 6(3):307-321.

El-Kady, M. I.; N. R. E. Samra and A. S. S. EL-Shahat (2010). Studies on the effect of potassium and magnesium fertilization as well as vine load on Flame seedless grape productivity. J. Plant Prod. Mansoura Univ., 1(10): 1299-1311

Farag, K. M. and Neven, M. N. Nagy (2012). Effect of pre- and post- harvest calcium and magnesium compounds and their combination treatments on "Anna" apple fruit quality and shelf life. J. Hort. Sci. & Ornamental Plants, 4(2): 155-168.

Fathy, M. A.; M. A. Gaber and S. A. El-Shall (2010). Effect of humic acid treatments on "Canino" apricot growth, yield and fruit quality. New York Sci. J., 3(12): 109-115.

Fayed, T.A. (2010). Optimizing yield, fruit quality and nutrition status of Roghiani olives grown in Libya using some organic extracts. J. Horti. Sci. & Ornam. Plants, 2(2): 63-78.

Ferrara, G. and G. Brunetti (2008). Influence of foliar applications of humic acids on yield and fruit quality of table grape cv. Italia. J. Int. Sci. Vigne Vin, 42: 79-87.

Ganeshamurthy, A. N.; G. C. Satisha and P. Prakash (2011). Potassium nutrition on yield and quality of fruit crops with special emphasis on banana and grapes. Karnata J. Agric. Sci., 24: 1, 29-38.

Gerendás J. and H. Führs (2013). The significance of magnesium for crop quality. Plant and Soil, 368: 101–128.

Ghabbour, E. A. and Davies (2001). Humic substances Structures, Models and Functions. The Royal Society of Chemistry. Cambridge, CB4 OW, UK.

Gomez, K. N. and A. A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, 2nd Ed., 68p.

Hassan, A. H.; A. M. Mansour and N. H. Samra (2007). Studies concerning the effect of potassium and magnesium fertilization on bud behavior, yield and berry quality of Thompson seedless grapevines. J. Agric. Sci., Mansoura Univ., 32(4): 2747-2758.

Hsia, C.L.; B.S. Luh and C.O. Chichester (1965). Anthocyanin in freestone peaches. J. Food Sci., 30: 5-12.

Ibrahim, Doaa. M. H. (2013). Physiological studies on King Ruby grapevines. Ph.D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Jones, J. B. (2012). Plant Nutrition and Soil Fertility Manual. CRC Press.

Keller, M. (2015). The Science of Grapevines. Anatomy and Physiology. 2nd Edition. Academic Press. P ublished by Elsevier Inc.

Marschner, H. (2012). Mineral Nutrition of Higher Plants. New York: Academic press.

Matter, U. S. (2003). Studies on fertilization and summer pruning on grapes. Ph. D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Megawer, M. A. (2009). Reducing the amount of inorganic N fertilizers in Superior grape vineyard by using organic and bio-fertilizers and humic acid. Egypt. J. Agric. Res., 87(1): 317-344.

Mengel, K. and E. A. Kirkby (2001). Principles of Plant Nutrition. 5th Ed. London, Kluwer Academic Publishers.

Mia, M. A. (2015). Nutrition of crop Plants. Plant Science Research and Practices. Nova Science Publishers.

Ministry of Agriculture Statics (2011). Central Department of Horticulture Crops, General Management of Pomology.

Ministry of Agriculture Statistics, A R E (2015). Economic Agriculture, Department of Agriculture Economic and Statistics.

Montero, F. J.; J. A. De Juan; A. Cuesta and A. Brasa (2000). Non-destructive methods to estimate leaf area in Vitis vinifera L., HortScience,35:696-698.

Mosa, W. F. A. E.; N. A. Abd EL-Megeed and L. S. Paszt (2015). The effect of the foliar application of potassium, calcium, boron and humic acid on vegetative growth, fruit set, leaf mineral, yield and fruit quality of 'Anna' apple trees. American J. Exper. Agric., 8(4): 224-234.

Nardi, S.; G. Concher and G. Dell Agnola (1996). Biological activity of humus, In: Humic substances in Terrestrial Ecosystems (piccolo A., ed). Elsevier, NY, USA. Pp. 361-406.

Nelson, N. (1944). A photometric adaptation of the Somogyi method for the determination of glucose. J. Bio. Chem., 153 pp: 375-380.

Omar, A. H. (2005). Fertilization of Thompson seedless grapevines with mineral and organic sources of nitrogen. J. Agric. Sci., Mansoura Univ., 30 (12): 7855-7862.

Omar, A. H. and A. H. Abdelall (2005). Fertilization of Crimson seedless grapevines with nitrogen and potassium. J. Agric. Sci., Mansoura Univ., Egypt, 30(12): 7831-7842.

Omran, Y. A. M. (2000). Studies on histophysiological effect of dormex and yeast application on bud fertility, vegetative growth and yield of Romy red grapevines. Ph.D. Thesis, Fac. Agric., Assuit Univ.

Parandian, F. and S. Samavat (2012). Effect of fulvic and humic acid on anthocyanin, soluble sugar, amylase enzyme and some micronutrient elements in Lilium. International Res. J. Applied and Basic Sci., 3(5): 924-929.

Poapst, P. A. and M. Schnitzer (1971). Fulvic acid and adventitious root formation. Soil Biology and Biochemistry, 3: 215-219.

Rizk-Alla, M. S. and H. Tolba (2010). The role of some natural soil conditioner and AM fungi on growth, root density and distribution, yield and quality of Black Monukka grapevines grown on calcareous soil. J. Am. Sci., 6(12): 253- 263.

Rizk-Alla, S.; G. V. H. Mervat and A.A. Abd EL-Ghany (2006). Effect of foliar application of mineral or chelated calcium and magnesium on Thompson seedless grapevines grown in a sandy soil. J. Agric. Sci. Mansoura Univ.,Egypt,31(5):3067-3077.

Rogiers, S.; D. Greer; J. Hatfield; B. Orchard and M. Keller (2006). Solute transport into Shiraz berries during development and late-ripening shrinkage. Am. J. Enol. Vitic. 57:1.

Shaheen, M. A. G.; Sahar M. Abdel-Wahab; E. A. Hassan and A. M. R. A. Abdel Aziz (2012). Effect of some soil conditioners and organic fertilizers on vegetative growth and quality of Crimson seedless grapevines. J. Hort. Sci. & Ornamental Plants, 4(3): 260-266.

Shoeib, M. M. (2004). Effect of potassium sulphate and vine load on the growth and yield of Thompson seedless grapevines with a special reference to the occurrence of cluster tip desiccation problem. J. Agric. Sci. Mansoura Univ., Egypt, 29(8): 4711-4728.

Srinivasan, Ch. and M. G. Mullins (1981). Physiology of flowering in the grapevine. A review. Am. J. Enol. Vitic., 32: 47-63.

Suh, H. Y.; K. S. Yoo and S. G. Suh (2014). Effect of foliar application of fulvic acid on plant growth and fruit quality of Tomato (*Lycopersicon esculentum* L.). Hort. Environ. Biotechnol., 55(6): 455-461.

Takacs, M. ; Hajos, L. Szabo; I. Racz; A. Mathe and E. Szoke (2007). The effect of Mg-leaf fertilization on quality parameters of some horticultural species. Cereal Research Communications, 35: 1181–1184.

Vallini, G.; A. Pera; G. Sorace; C. Cecchi and P. Manetti (1990). Green composting. Bio Cycle, 31(6): 33-35.

Yagodin, B. A. (1984). "Agricultural Chemistry". Mir Publisher Moscow. English translation, p.p. 375.

Zachariakis, A.; E. Rzorakakis; I. Kritsotakis; C. I. Siminis and V. Manios (2001). Humic substances stimulate plant growth and nutrient accumulation in grapevine rootstocks. Acta Hort., 549: 141-136.

Zhang, L.; J. Zhou; Y. G. Zhao; Y. Zhai; K. Wang; A. Alva and S. Paramasivam (2013). Optimal combination of chemical compound fertilizer and humic acid to improve soil and leaf properties, yield and quality of apple (*Malus domestica*) in the loess plateau of China. Pak. J. Bot., 45(4): 1315-1320.

Zlámalová, T.; J. Elbl; M. Baroň; H. Bělíková; L. Lampíř; J. Hlušek and T. Lošák (2015). Using foliar applications of magnesium and potassium to improve yields and some qualitative parameters of vine grapes (*Vitis vinifera* L.). Plant Soil Environ., 61(10): 451–457.

تأثير حمض الفالفيك و بعض العناصر الغذائية على النمو, المحصول و الصفات الكيمائية لحبات العنب صنف الكنج روبى.

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أجريت هذه الدراسة خلال ثلاث مواسم متعاقبة من ٢٠١٣ حتى ٢٠١٥ على شجيرات العنب صنف الكنج روبى عمر ١٦ سنة و ذلك فى مزرعة خاصة (الشيشينى) تقع فى قرية منية سمنود بالقرب من مدينة المنصورة، محافظة الدقهلية.تهدف هذه الدراسة الى تقييم تأثير كفاءة رش حمض الفالفيك المحمل ببعض المغذيات الكبرى (الماغنسيوم و البوتاسيوم) على النمو الخضرى، المحصول والصفات الكيميائية لحبات العنب صنف الكنج روبى.سجلت معظم المعاملات تحت الدراسة بصورة عامة زيادة معنوية فى معظم القياسات. وكانت المعاملة الثامنة (حمض الفالفيك + الماغنسيوم + البوتاسيوم) هى التى أعطت أعلى زيادة معنوية فى تفتح وخصوبة البراعم(٨٦.٧٥ – ٨٧.٥٠ %) و (٦٥.٨٣ – ٦٩.١٧ %) بالمقارنة مع معاملة الكنترول (٤٨.٦٧ _ ٥٢.٠٠ %) و (٥٤.٥٠ – ٥٠.٠٠%) خلال الموسمين ٢٠١٤ و ٢٠١٥ على التوالي. بالإضافة لذلك، أعطت نفس المعاملة زيادة معنوية فى طول الفرع، المساحة الورقية و محتوى الأوراق من الكلوروفيل (١٥١.١٧- ١٥٢.٩٧ سم)، (١١٤.٩٦ – ١١٥.٧٠ سم٢) و (١٢.٤٠ – ١٣.١٠ مجم/جم) بالمقارنة مع معاملة الكنترول (١٠٤.٧٠ – ١٠٧.٣٧ سم)، (٩٤.٠٨ – ٩٤.٣٧ سم٢) و (٧.٠٨٨ – ٧.٢٠٧ مجم/جم) خلال موسمى الدراسة على التوالى.سجلت نفس المعاملة (حمض الفالفيك + الماغنسيوم + البوتاسيوم) زيادة ملحوظة فى المحصول (١٥.٢٩ – ١٥.٨٥ كجم/شجيرة) بالمقارنة مع الكنترول (٨.٣٦ – ٨.٩٥ كجم /شجيرة) خلال الموسمين ٢٠١٤ و ٢٠١٥ على التوالى.أعطت نفس هذه المعاملة زيادة معنوية فى محتوى عصير الحبات من المواد الصلبة الذائبة، السكريات الكلية، المحتوى الكلى من صبغة الأنثوسيانين فى قشرة الحبات (٢٠.١٧ – ٢١.٠٠ %)، (١٨.٤٣ – ١٩.٢٠ %) و (٧٨.٩٨ – ٧٩.٨٢ مجم/١٠٠ جم) بينما اعطت اقل نقص فى محتواها من الحموضة (٠.٢٦ – ٠.٢٤ %) بالمقارنة مع الكنترول (١٨.٢٧ – ١٨.١٧ %)، (١٣.٨٣ – ١٤.٢٠ %)، (٢٨.٧١ – ١٨.١٧ مجم /١٠٠ جم) و (٠.٤٨ – ٠.٤٦ %) فى موسمى الدراسة ٢٠١٤ و ٢٠١٥ على التوالى.