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EFFECT OF MORINGA LEAVES EXTRACTS AND LICORICE ROOTS ON SOME GROWTH CHARACTERISTICS AND YIELD OF GRAPE (*VITIS VINIFERA* L.) CV. HALAWANY

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Abstract

This study was conducted in a private grape vineyard during the year 2019, was located in Tapalw village, Lailan district, Kirkuk province, Iraq. The was to study the effect of spraying four levels of the moringa leaf extract (0, 15, 30 and 45) $g.L^{-1}$ and licorice root extract (0, 2.5, 5 and 7.5) $g.L^{-1}$ on some growth characteristics and yield of grape (*Vitis vinifera*) cv. Halawany. Spraying of the extracts were applied in three times: the first spraying was before flowering on 24/4/2019, the second, a week after berries set on 5/5/2019, and the third, two weeks after the second spray on 22/5/2019. The results showed that 15 $g.L^{-1}$ of the moringa leaf extract significantly superior on the control treatment in the leaf area, chlorophyll content of leaf, total yield, number of clusters per vine, an average of cluster weight, berries weight without a structure, structure weight without berries, and length and width of the cluster. However, spraying with the extracted moringa leaves at level 45 $g.L^{-1}$ superior significantly on the control treatment in the total soluble solids, total sugars and the anthocyanins content in berries peel. Spraying with the extracted of licorice root extract at level 2.5 $g.L^{-1}$ resulted in a significant increase in leaf area, chlorophyll content of leaf and total soluble solids. In addition, spraying at level 7.5 $g.L^{-1}$ of licorice root extract had a significant influence on increasing the total yield, number of clusters per vine, average of cluster weight, berries weight without structure, structure weight without berries, and cluster length and width, and anthocyanin content of berries peel.

Keywords **:** Moringa leaves, Licorice root, Grape, Halawany.

Introduction

Grapes are the most favored, high nutritional value and likeable fruit crops in the world (Shaheen *et al*., 2012). It has a delicious taste and a good source of sugar, acids, minerals, vitamins, tannins and possesses a sweet flavor (Isbat and Zeba, 2011). Grapes are adapted to a wide range of climates result in they distribute in tropics, subtropics and temperate regions. There are now 75 cultivars in Iraq. They are generally seeded cultivars, while some of them are seedless cultivars. Most of these cultivars are grown in Kurdistan Region of Iraq (Al-Rawi, 2005; Alsaidi, 2014). It is proved that addition of large quantities of chemical fertilizers can cause environmental pollution and human and animal health problems (Taiz and Zeiger, 2006). For this reason, it is necessary to find alternative materials that to avoid the mentioned problem (Wahba, 2002; Alla EL-Din, 2007). Foliar spraying of Moringa leaf extract increases the strength of growth, ability to resistant to adverse environmental conditions (Chang *et al*., 2007), delaying fruit aging, improves quality and quantity of yield (phiri and Mbewe, 2010; Nasira *et al*., 2016).

Recta and Bhatnager, (2011) also confirmed that licorice extract can decrease transpiration rate, maintaining cell fullness and reducing water loss due to transpiration. This behavior is because the licorice extract contains sugars and gum substances that increase the percentage of total soluble solid in plant cells and water retaining due to presence of iron and magnesium. Abou-Hussein *et al*. (2000) stated that licorice has a similar effectiveness. It increases the effectiveness of cellulose enzyme that is important in the lateral expansion of cells results in accelerating the plant growth.

Up to date there are no studies in Iraq which are conducted to determine the effect of Moringa leaf extract on vegetative growth, quality and quantity characteristics of fruit trees and also the effect of licorice root extract. Thus, the aim of this study was to determine the effect of spraying Moringa leaf extract and licorice roots on some of the vegetative growth and qualitative and quantitative characteristics of grape yield cv. Halawany.

Material and Methods

This study was conducted in a private grape vineyard located at Tapalw village, in Lailan district. It is approximately 30 km eastern of Kirkuk province. The study was done during the year 2019. The vines were pruned at the end of January and left 36 eyes per cane, distributed on 6 canes, with 4 regenerative canes which each of them contained two eyes. Agricultural service operations such as irrigation, and fertilization, were carried out equally for all treatments.

The trees were sprayed with four levels (0, 15, 30 and 45) $g.L^{-1}$ and (0, 2.5, 5 and 7.5) $g.L^{-1}$ of Moringa leaves and licorice root extracts on the vegetative part of vine, respectively, while, the controls were only sprayed with distilled water. The extracts were applied in three dates: the first spraying was before flowering on 24/4/2019, the second, a week after berries set on 5/5/2019, and the third, two weeks after the second spray on 22/5/2019 (AL-Dulaimy, 2015).

Preparation of the extracts

The young moringa leaves extract was prepared by merging a specific concentration (15, 30 and 45) g.L^{-1} with 225 ml of 80% ethanol (Makker and Becker, 1996), of the extracted mixture was then filtered by mutton cloth, and then the sediment was taken again. This process was repeated 3 times until the volume of the ethanol reached to 675 ml, and then rose to a liter. Whereas, the following concentrations of the licorice roots extraction (2.5, 5, and 7.5) g.L^{-1} were prepared by taken fine powder of the licorice roots after placing in distilled water. They were then incubated in a water bath at 50 °C for 24 hours in a dark place. The solution was finally filtered through a boring cloth.

Statistical analysis

Factorial randomized complete block design (RCBD) was followed with two factors (moringa leaves extract and licorice roots) with three replicates. The data were exposed to the analysis of variance (ANOVA) and the means were compared with Duncan multiple range test, at 0.05 using SAS program version 9.1 (SAS, 2002).

Vegetative growth characteristics

The leaf area (cm2) was calculated at harvesting time by taking 30 fully-grown leaves between the main fruiting shoot and different parts of the vine per each experimental unit (Shaheen, 1987). The area was measured using Image J software, while, the leaf chlorophyll content (SPAD) was estimated in the full-width of the leaves at harvesting time by the SPAD-502 meter device. From different directions of the vine, 40 leaves were taken to each experimental unit and finally making the rate.

Berries quality, total yield and Physical components of the cluster

The average number of berries per cluster (berry. cluster^{-1}) was calculated from five clusters. They were randomly taken from each experimental unit and calculated the rate. Number of the clusters per vine (cluster.vine^{-1}) was calculated in each experimental unit. Average cluster weight in (g): An average weight of five clusters was determined for each experimental unit. They were randomly selected at maturity and weighed with an electronic balance. Weight of 100 berries in (g): 100 mature berries were randomly taken from five clusters of each experimental unit and weighed with an electronic balance. Size of 100 berries (cm^3): The same 100 berries were used to calculate an average weight of 100 berries, and estimate the volume based on the volume of the displaced water. Average total yield per vine (kg.vine^{-1}): Total yield per vine was calculated by multiplying the average weight of five clusters x number of clusters per experimental unit.

Five clusters of each experimental unit were randomly taken to calculate the average of the following physical components of the cluster; Average cluster length and width (cm): The mean cluster length and width were calculated for five selected clusters, and the average length and width for each cluster were calculated. Average weight of berries without cluster structure (g) and cluster structure without berries (g): The berries from the cluster structure separated. The weight of the Structure and berries were then separately calculated, using an electronic balance and the mean was extracted (Al-bauty, 2015).

Chemical properties of berries:

Total soluble solids (TSS %) was calculated in fruit juice using a Hand Refractometer according to (A.O.A.C, 1986). Titratable acidity (TA%) was calculated by taking a specific volume of juice and titrated with the 0.1 N NaOH and using 2 to 3 drops of phenolphthalein as indicator, based on the tartaric acid presence in grape berries (Ranganna, 1977). Total sugar in juice (%) was estimated using 5% phenol and 97% sulfuric acid (Joslyn, 1970). Anthocyanin pigment in the berries skin (mg 100g^{-1}) and phenols in berries juice (mg 100ml^{-1}) were also estimated (Ranganna, 2011).

Results and Discussions

Vegetative growth characteristics

Results in (Table 1) Showed that spraying with Moringa leaf extract significantly increased the leaf area and leaf chlorophyll content compared with control. The highest leaf area and leaf chlorophyll of 89.033 cm2 and 28.132 were recorded respectively by spraying 15 g L^{-1} Moringa leaf extract.. While the lowest leaf area and leaf chlorophyll recorded in control treatment of 72.545 cm^2 and 24.3 respectively. Furthermore, spraying of licorice roots had a significant influence on the leaf area and the leaf chlorophyll content. As it recorded the highest value when spraying with concentration 2.5 g L^{-1} 90.209 cm^2 and 29.411 respectively. They were significantly superior on the control treatment.

The maximum values of the leaf area (128.339 cm^2), and for the maximum value of the leaf chlorophyll content, (128.339 cm^2) were observed on the vines that sprayed with Moringa leaf extract at level 15 g.L^{-1} plus licorice roots extract at level 2.5 g.L^{-1}. These were significantly superior on all interactions treatments except for the interaction that sprayed with 30 g.L^{-1} of moringa leaf extract and 5 g.L^{-1} of licorice roots extract.

Increasing in the vegetative growth characteristics of leaf area and the leaf chlorophyll content by spraying with Moringa leaf extract was under the effect of the extract because it contains beta-carotene, amino acids, some phenolic compounds, proteins and rich in zeatin, vitamins (A, B1, B2, B3, C, E), sugars, some minerals such as calcium, sodium, magnesium, phosphorus, potassium, and iron, and flavonoids (Makkar and Becker, 1996; Anwar *et al.*, 2005), In addition, the Moringa leaf extract significantly stimulate plant growth. This extract is normally used as a stimulant for the natural growth of plants and is considered a good source of natural antioxidants (Nagar *et al.*, 2006; Anwar *et al.*, 2007; Jacob and Shenbagaraman, 2011). Azra, (2011) also found that spraying different crops with 3.5% of Moringa leaf extract caused the increase in the all growth characteristics.

Increasing in the vegetative growth characteristics, such as leaf area and the leaf content of chlorophyll, by spraying with licorice roots extract may be due to its similar behavior to gibberellin. They contain the Mevalonic acid as it is

considered the vital part of gibberellin which leads to the expansion of the leaf cells. Moreover, the increase in the leaf area is due to the presence of salts and sugars in the extract which stimulated vegetative growth. Also, this extract contains nutritional elements such as N, Fe, Zn, Mg, and Cu. These minerals have a major effect in building chlorophyll as nitrogen contributes to the chlorophyll formation. For example, iron participates in the vital processes of chlorophyll formation, and increases the number of chloroplasts, enlarge chloroplasts size and increasing Karana (Marschner, 1995).

Berries quality, total yield and physical components of the cluster

Data are presented in (Tables 2 and 3) show that moringa leaves extract at 15 $g.L^{-1}$ and licorice roots extract at 7.5 $g.L^{-1}$ foliar spraying were significantly increased the Berries quality, total yield and physical components of the cluster parameters in terms of number of cluster per vine, average cluster weight, total yield, average cluster length and width, average weight of berries without cluster structure, and cluster structure without berries of Halawany vines.

Spraying 15 $g.L^{-1}$ of moringa leaves extract and 7.5 $g.L^{-1}$ of licorice roots extract were improved berries quality, total yield and physical components of the cluster parameters than combine extracted together compared to control treatment except in average weight of 100 berries parameter. While, the highest number of cluster per vine (11.33), average cluster weight (919.33 g), average size of 100 berries (450.00 cm^3), total yield (9.88 kg), and average weight of berries without cluster structure (914.73 g) were found on the vines that sprayed with moringa leaves extract at 15 $g.L^{-1}$ and licorice roots extract at 2.5 $g.L^{-1}$.

A moringa leaf contains more than 200 mg g^{-1} of zeatin. The zeatin has a main role in increasing yield and fruit characteristics (Fuglie, 2000), who found that fresh Moringa leaves contain high proportion of zeatin. Thus, the increase in the yield and fruit characteristics of current study might be due to the presence of zeatin. Although, zeatin plays important role in the division and elongation of cells it also works to encourage the growth of plants as well as anti-aging and antioxidant effects on plants (Siddhuraju and Becker, 2003 and Marcu, 2005, Nagar *et al*., 2006 and Anwar *et al*., 2007). Moreover, it causes an increase in the leaf area and the content of leaves chlorophyll (Table 1), which caused the increase in the photosynthesis products, providing the nutrients required for growth and development of flowery clusters, and also caused the preservation of the largest number of clusters, and the materials manufactured in the leaves moves to the different parts of the plant and from it to the clusters and berries, which leads to increase the total yield per vine.

Spraying of vines with licorice increased the fruit characteristics as shown in (Tables 2 and 3), a significant increase was found in most quantitative traits such as the number of berries per cluster, the number of clusters per vine, the average weight of the cluster, and the size of 100 berries were recorded. The reason may be due to the role of this extract in increasing the leaf area and the leaf chlorophyll content (Table 1). This is because it contains gibberellin and nutrients, cause increase the compounds that produced by leaves. And then, they improved in the nutritional status of the vine. Furthermore, gibberellin has a role in increasing the ratio of berries setting and the number of berries per cluster (Jiang, 1996; Magdalena, 2011). It also contains a high amount of carbohydrates and salts. They led to an increase in the shoot and root growth rate. Thus, leads to an increase in the amount of water and nutrients absorbed from the soil, which provided the flowery clusters with the nutrients. This is may also reduce the fall of flowers and berries. It strengthens the cell walls of the berries holder, which is gives more rigidity and reduces the fall of the berries (Al-Jabouri *et al*., 2006). This is contributed to improve the quantitative characteristics of the yield, including the number of berries per cluster and the number of clusters per vine. The decrease berries per cluster number when spraying with licorice extract at 7.5 g L^{-1} may be due to the role of this concentration in increasing the volume of 100 berries (Table 2), because of its a negative effect on berries per cluster number.

The average weight of the cluster was increased; it may be due to an increase in the cells division and their enlargement by increasing the availability of sufficient food. Which this caused a lack of competition between berries and clusters on foodstuffs and then positively increased in the total vines yield and improving the nutritional status of the tree through increasing photosynthesis process efficiency in leaves. Thus, this is caused an increase in the carbohydrates production and hormones in leaves and their transmission to the different parts of the plant. Including clusters and berries, and consequently distributes each cluster of these substances increased that stored in the berries and increased their weight. As it is known that licorice has a similar effect to the effect of gibberellin because it contains Mevalonic acid, the biological initiator of gibberellin, which is stimulate cell division and increase its size. This process increases the cells size due to increase in water and nutrients absorption (Cleland, 1986; Francisco and G'omez, 2000; Casanova *et al*., 2009) then improving the all quantitative traits.

Chemical properties of berries:

The chemical traits of berries are shown in Table 4. Moringa leaves extract at 45 $g.L^{-1}$ treatment attained the highest significant values of 12.308%, 24.413% and 31.46$mg.100g^{-1}$ for total soluble solids, total sugars and anthocyanin pigment, respectively. Concerning of the foliar spraying at 5$g.L^{-1}$ licorice roots extract significantly effects in increment of 0.42% titratable acidity, 24.62% total sugars, 29.81$mg.100g^{-1}$ anthocyanin pigment and 394.688 $mg.100\ ml^{-1}$ total phenols. In general, most interaction treatments between moringa leaves extract and licorice roots extract significantly improved all chemical traits of berries.

The positive effect of moringa leaves extract on the chemical properties TSS ratio, total acidity, total sugars ratio and anthocyanin tincture in the shell scales can be explained according to Iqbal, (2014), juice of the moringa leaves is rich in many growth hormones, especially zeatin, which has a role in increasing crop productivity to about 10-45%, and also contains sufficient quantities of the necessary nutrients with appropriate ratio which increase growth, yield components

and the productivity of many crops. In addition, calcium and potassium in Moringa leaves play essential roles in plant growth and development by regulating osmotic pressure, enzyme activation, and improving photosynthesis, and through other physiological processes (Hasegawa *et al*., 2000; Epstein and Bloom, 2005). This led to an increase in the percentage of TSS, total sugars and anthocyanin pigment (table 4). This data indicate that spraying with Moringa leaves extract with a concentration of 45g.L^{-1} was significantly superior on the other treatments.

As for its role in the decrease in the juice total phenols, it may be attributed to its role in accelerating the ripening process. This is supported by the reason that it increased the TSS ratio, total sugars and the anthocyanin pigment. Moreover, Abd El – Hamied and El-Amary, (2015) concluded that spraying with Moringa leaves extract at 4% improved the chemical properties of pear fruits. Thus it could be used as the natural plant extracts on various crops.

In regarding to the effect of licorice root extract on chemical properties, the reason for increasing the TSS ratio in the treated berries at 2.5 g L^{-1}, may be due to its role in the increasing the leaf area and the leaf chlorophyll content (Table 1). This is may be leads to an increase in the carbohydrates synthesis and nutrient absorption from the soil, thus, increasing in the total soluble solids. Spraying with licorice extract resulted in the low titratable acidity. It may be due to the consumption of these acids in physiological processes such as respiration. Abd El – Hamied and El-Amary, (2015) found that spraying with this extract caused a decrease in the total acidity in the pear fruits. They also, found that this extract increased ascorbic acid in fruits. This vitamin has a key role in the respiration process, while reduced the grain juice acidity. Regarding the increase in the titratable acidity when spraying at 5g.L^{-1} may be attributed to the fact that part of the sugars can be oxidized and transformed into organic acids in the leaves. And then it is transferred to other parts of the tree including the fruits. This caused an increase in the acidity of berries juice. The reason for spraying licorice root extract at 5g.L-1 is the significant increase in total sugars and anthocyanin pigment that may be due to its role in increasing the number of berries per cluster (Table 2). Thus, the number of seeds and their hormone content increase, which in turn helps to attract nutrients to the berries. Thereby, increased of totals sugars in the berries (Table 4), Salisbury and Ross (1968) reported that the formation of anthocyanin requires large amount of soluble sugars.

Table 1 : Effect of spraying with extracts of Moringa leaves and licorice roots and their interactions on the vegetative growth of grape vine cv. Halawany.

Treatments			Leaf area (cm^2)	leaf chlorophyll content (SPAD)
Moringa g.L^{-1}		0	72.55 c	24.30 c
		15	89.03 a	28.13 a
		30	85.11 b	27.98 a
		45	74.09 c	25.96 b
licorice roots g.L^{-1}		0	78.41 b	26.33 c
		2.5	90.21 a	2941 a
		5	74.66 c	27.17 b
		7.5	77.51 c	23.46 d
Moringa 0	licorice roots	0	75.86 def	27.01 cd
		2.5	62.13 h	22.66 fgh
		5	76.66 def	23.38 fgh
		7.5	75.54 def	24.17 f
Moringa 15	licorice roots	0	79.40 cde	27.20 cd
		2.5	128.34 a	36.71 a
		5	66.37 gh	22.63 fgh
		7.5	82.02 cd	25.98 de
Moringa 30	licorice roots	0	92.61 b	28.13 c
		2.5	85.58 c	23.76 fg
		5	81.14 cd	38.35 a
		7.5	81.12 cd	21.69 h
Moringa 45	licorice roots	0	65.77 gh	22.98 fgh
		2.5	84.78 c	34.51 b
		5	74.45 ef	24.34 ef
		7.5	71.37 fg	22.02 gh

The same letter indicates non-significant difference between treatments and their interactions according to the Duncan multiple test at the 0.05 level.

Table 2 : Effect of spraying with extracts of Moringa leaves, licorice roots, and their interactions on the berries quality of grape vine cv. Halawany.

Treatments			No. of berries / cluster	No. of cluster / vine	Average cluster weight (g)	Size of 100 berries (g)	Weight of 100 berries(g)
Moringa g.L^{-1}		0	117.95 a	6.58 c	753.92 b	414.16 b	451.25 a
		15	119.08 a	10.67 a	831.00 a	419.16 ab	453.75 a
		30	119.68 a	8.25 b	775.38 b	432.50 a	449.58 a
		45	117.17 a	7.92 b	678.40 c	403.33 b	423.75 a
licorice roots g.L^{-1}		0	117.53 bc	7.83 c	733.85 b	415.00 ab	459.17 a
		2.5	118.73 b	8.17 bc	759.33 ab	430.00 a	430.00 a
		5	122.47 a	8.33 b	759.00 ab	405.83 b	449.58 a
		7.5	115.15 c	9.08 a	786.52 a	418.33 ab	439.58 a
Moringa 0	licorice roots	0	120.27 bcd	6.00 e	783.73 bcde	380.00 e	448.33 a
		2.5	117.67 bcde	6.33 e	707.67 efg	443.33 ab	465.00 a
		5	119.67 bcd	6.67 de	760.67 cdef	403.33 bcde	435.00 ab
		7.5	114.20 defg	7.33 d	763.60 cdef	430.00 abc	456.67 a
Moringa 15	licorice roots	0	118.47 bcde	11.00 ab	813.33 bcd	436.67 abc	475.00 a
		2.5	123.67 abc	11.33 a	919.33 a	450.00 a	443.33 ab
		5	117.00 cdef	9.00 c	766.00 cdef	376.67 e	455.00 a
		7.5	117.20 cde	11.33 a	825.33 bc	413.33 acde	441.67 ab
Moringa 30	licorice roots	0	122.20 abc	8.33 c	722.67 def	423.33 abcd	460.00 a
		2.5	112.00 efg	8.33 c	681.67 fg	436.67 abc	438.33 ab
		5	125.20 ab	9.00 c	827.33 bc	440.00 abc	475.00 a
		7.5	119.33 bcde	7.33 d	869.87 ab	430.00 abc	425.00 ab
Moringa 45	licorice roots	0	109.20 g	6.00 e	615.67 g	420.00 abcd	453.33 a
		2.5	121.60 abcd	6.67 de	728.67 def	390.00 de	373.33 b
		5	128.00 a	8.67 c	682.00 fg	403.33 bcde	433.33 ab
		7.5	109.87 fg	10.33 b	687.27 efg	400.00 cde	435.00 ab

The same letter indicates non-significant difference between treatments and their interactions according to the Duncan multiple test at the 0.05 level.

Table 3 : Effect of spraying with extracts of Moringa leaves, licorice roots, and their interactions on the total yield and physical components of the cluster of grape vine cv. Halawany.

Treatments			Total yield (kg)	Average cluster length (cm)	Average cluster width (cm)	Average weight of berries without cluster structure (g)	Average weight of cluster structure without berries (g)
Moringa g.L^{-1}		0	5.04 d	18.93 c	11.70 b	749.17 b	3.17 b
		15	8.73 a	21.70 a	12.48 a	818.05 a	3.90 a
		30	6.44 b	20.42 b	12.75 a	762.55 b	3.42 b
		45	5.60 c	19.17 c	11.72 b	674.75 c	3.17 b
licorice roots g.L^{-1}		0	5.95 c	18.87 d	11.72 b	729.30 b	3.25 b
		2.5	6.37 b	19.97 c	12.05 b	746.65 ab	3.32 b
		5	6.22 bc	20.47 b	12.10 b	746.05 ab	3.25 b
		7.5	7.28 a	20.92 a	12.78 a	782.52 a	3.83 a
Moringa 0	licorice roots	0	4.87 d	16.07 h	11.80 def	779.27 bcde	3.33 bc
		2.5	4.73 d	21.13 cd	12.20 bcde	702.33 defg	3.00 cd
		5	4.79 d	19.20 f	11.73 def	754.67 cde	3.33 bc
		7.5	5.77 c	19.33 f	11.07 fg	760.40 bcde	3.00 cd
Moringa 15	licorice roots	0	9.15 a	22.47 b	11.73 def	806.60 bcd	4.00 ab
		2.5	9.88 a	20.33 de	12.40 bcde	914.73 a	3.27 bc
		5	6.55 c	20.33 de	12.67 bcd	728.53 cdef	3.67 bc
		7.5	9.36 a	23.67 a	13.13 b	822.33 abc	4.67 a
Moringa 30	licorice roots	0	6.01 c	18.20 g	11.60 ef	718.67 cdef	3.33 bc
		2.5	5.97 c	21.53 c	13.00 bc	645.00 fg	3.33 bc
		5	7.34 b	20.80 cd	11.53 ef	822.33 abc	3.00 cd
		7.5	6.45 c	21.13 cd	14.87 a	864.20 ab	4.00 ab
Moringa 45	licorice roots	0	3.76 e	18.73 fg	11.73 def	612.67 g	2.33 d
		2.5	4.90 d	16.87 h	10.60 g	724.53 cdef	3.67 bc
		5	6.20 c	21.53 c	12.47 bcde	678.67 efg	3.00 cd
		7.5	7.54 b	19.53 ef	12.07 cdef	683.13 efg	3.67 bc

The same letter indicates non-significant difference between treatments and their interactions according to the Duncan multiple test at the 0.05 level.

Table 4 : Effect of spraying with extracts of Moringa leaves, licorice roots, and their interactions on the chemical properties of berries of the cluster of grape vine cv. Halawany.

Treatments			Total Soluble Solids (%)	Titratable Acidity (%)	Total Sugars (%)	Anthocyanin pigment (mg.100g^{-1})	Total Phenols (mg.100ml^{-1})
Moringa g.L^{-1}		0	11,92 c	0.40 a	21.37 b	27.10 b	393.42 a
		15	12.24 ab	0.41 a	24.44 a	28.78 b	376.48 a
		30	11.99 bc	0.38 a	19.66 c	28.84 b	293.12 b
		45	12.31 a	0.38 a	24.41 a	31.46 a	361.41 a
licorice roots g.L^{-1}		0	11.93 b	0.39 b	22.71 b	29.69 a	339.78 b
		2.5	13.07 a	0.39 b	22.15 c	26.68 b	384.31 a
		5	11.57 c	0.42 a	24.62 a	29.84 a	394.69 a
		7.5	11.89 b	0.37 b	20.39 d	29.97 a	305.64 b
Moringa 0	licorice roots	0	11.83 c	0.40 abc	19.70 g	21.38 fg	376.71 bcd
		2.5	13.60 b	0.37 bc	22.52 de	35.78 bc	468.36 a
		5	10.37 d	0.44 a	23.80 c	24.02 ef	428.31 abc
		7.5	11.87 c	0.36 c	19.45 g	27.22 e	300.27 def
Moringa 15	licorice roots	0	13.40 b	0.41 abc	23.47 cd	41.07 a	344.54 cde
		2.5	11.83 c	0.41 abc	24.60 c	21.92 fg	358.25 bcde
		5	10.30 d	0.43 ab	29.66 a	20.16 fg	427.22 abc
		7.5	13.43 b	0.37 bc	20.03 fg	31.97 cd	375.90 bcd
Moringa 30	licorice roots	0	12.20 c	0.36 c	20.59 fg	39.03 ab	356.76 bcde
		2.5	11.80 c	0.40 abc	19.37 g	20.56 fg	222.86 f
		5	12.07 c	0.39 abc	21.00 f	33.72 c	285.68 ef
		7.5	11.90 c	0.39 abc	17.67 h	22.06 fg	307.20 def
Moringa 45	licorice roots	0	10.30 d	0.39 abc	27.09 b	17.30 g	281.13 ef
		2.5	15.03 a	0.37 bc	22.11 e	28.44 de	487.78 a
		5	13.53 b	0.43 ab	24.04 c	41.47 a	437.54 ab
		7.5	10.37 d	0.35 c	24.41 c	38.62 ab	239.17 f

The same letter indicates non-significant difference between treatments and their interactions according to the Duncan multiple test at the 0.05 level.

Conclusions

This study showed that spraying with moringa leaves extract at 15g.L^{-1} significantly outperformed than the another treatments in all vegetative growth characteristics, most of the quantitative yield characteristics, the physical components of clusters, and spraying at 45g.L^{-1} moringa leaves extract enhancing the most chemical properties. Spraying with licorice root extract at 7.5g.L^{-1} had a significant effect on the increasing the overall yield and physical components of the clusters, the number of clusters per vine, and the average weight of the cluster. In addition, the interaction treatment between spraying at 15 g.L^{-1} Moringa leave extract and 2.5 g.L^{-1} licorice roots significantly improved all vegetative growth characteristics, most of the quantitative yield characteristics and the physical components of the clusters.

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