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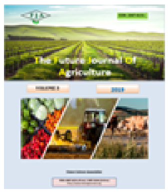

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EFFECT OF BRASSINOSTEROID AND METHIONINE ON VEGETATIVE GROWTH, YIELD AND FRUIT QUALITY OF KING RUBY GRAPEVINE

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ABSTRACT: This research was executed during two consecutive years (2019 and 2020) in a specific vine at El-Deer hamlet, Aga Center, Dakahlia region, Egypt. King Ruby grapevines aged 6 years were used in the experiment. The vines were trained to a quadrilateral cordon using a double-T support system and were cultivated in a clay soil with surface irrigation. Brassinosteroid at rate (2, 4, and 6 ppm) and methionine at rate (200, 400, and 600 ppm) were applied to the vine three times: at the commencement of growth, after flowering stage, and at veraison stage. The results showed that spraying brassinosteroid and methionine improved vegetative growth and total free amino acids in the leaves, as well as percentages of nitrogen, phosphor and potassium in leaf petioles, yield per vine, cluster weight, cluster length, number of berries in a cluster, hundred berry weight, berry firmness, chemical properties of berries and total phenols in berries. The best data in terms to vegetative growth, yield per vine, and berry standard of the King Ruby grapevine cultivar were acquired when vines were foliar with brassinosteroid at a rate of 6 ppm.

Key words: Grapevines, King Ruby, brassinosteroid, methionine, physical and chemical properties.

INTRODUCTION

Grapevine (*Vitis vinifera L.)* is one of the important productive fruit crops in the world - wide. Grapes, as fresh or dried fruits, they are also utilised in nutrition and winemaking **(Gerrath *et al.*, 2004),** as well as for medical treatments **(Cui *et al.*, 2018),** the creation of fragrances **(Gashkova, 2009),** and other applications **(Ping *et al.*, 2018; Zhang *et al.*, 2018).**

King Ruby Seedless cultivar produce dark red, crisp berry that is sweet and juicy, eat it fresh or dry it to raisin. Ripens mid-late season. medium-large bunch of conical-pyramidal shape. It was not released until 1968 because of its susceptibility to powdery mildew and bunch rot. In both domestic and international markets, the Ruby Seedless cultivar has emerged as one of the most significant table grapes. The primary issues with this cultivar are small berry size and poor colour, which can result in a significant loss in output and quality. **(Belal *et al.*, 2016)**

Brassinosteroids are said to benefit human health. Brassinosteroids are therefore seen as substances with the potential to be employed safely in agriculture. **Zehra *et al.*, (2020)**. Moreover, first derived as for flower of the mustard-related plant Brassica napus, A group of steroidal plant hormones known as brassinosteroids are substantial for typical plant vigor and development. (**Clouse and Sasse, 1998**). Brassinosteroid hormones control the expression of particular plant genes as well as intricate physiological processes such as cell development and division, nutrient intake, antioxidant systems, and fruit quality, **Asghari and Zahedipour (2016)** Recently, a more thorough analysis of the role of brassinosteroids were found to be more impact in enhancing fruit coloration on downstream genes of anthocyanin biosynthesis than on upstream genes during the control of ethylene biosynthesis during the ripening of fruit. **(Luan *et al.*, 2013).**

Methionine is an essential amino acid, methionine is employed in cellular metabolism on a variety of levels, including S-adenosylmethionine functions as a regulatory molecule, a protein building block, and to initiate mRNA translation in mitochondria cells. **(Hesse *et al.*, 2004).** Also, Methionine is a presage for metabolic impacts in an ecosystem that aid vine in adapting to a variety of environmental situations, and it also helps plants grow, **(Alfosea-Simón *et al.*, 2020**). In addition to promoting tolerance to abiotic stressors via the S-adenosyl methionine (SAM) route, methionine also controls the assimilation of polyamines, secondary metabolites, and ethylene **(Capaldi *et al.*, 2015).** Moreover**,** Methionine is a presage for the hormone ethylene synthesis through the data of S-adenosyl-methionine, which is then converted to 1-aminocyclopropane-1-carboxylate and then ethylene synthesis, as well as for the cellular energy glucosinolates, cell wall biosynthesis, polyamines, chlorophyll biosynthesis, and many other minor metabolites **(Goyer *et al.*, 2007).** The purpose of this research is to examine the influence of brassinosteroid and methionine on the vegetative development, yield, and berry standard of King Ruby cultivar grapevine.

MATERIAL AND METHODS

This research was executed during two consecutive years (2019 and 2020) in a specific vine vine at El-Deer hamlet, Aga Center, Dakahlia region, Egypt. King Ruby grapevines aged 6 years were used in the trial. The vines were trained to a quadrilateral cordon using a double-T support system and were cultivated in a clay soil with surface irrigation. The grapevines are cultivated at a spacing of 2 meters between rows and 2.5 meters among rows. The vines are grown in a clay soil with surface irrigation system and a quadrilateral cardoon trained with a double-T support system. Pruning was done on the tested vines in the second week of February, in order to spur-prune them, 6 spurs with 2 buds were left on each cardoon. The total load was 48 nodes. Crop load was adjusted to 24 bunches per vine in two years for all treatments at fruit set. For this study, Sixty-three vines that were as uniform in vigor as feasible were chosen, and all of the vines got the same cultural care suggested by the Ministry of Agriculture. The trial consisted of seven treatments arranged in a complete randomize blocks design, each treatment included three replicates, each used of three vines.

Brassinosteroid (Blank ®, Spanish) at a rate of 2,4 and 6 ppm, and methionine, at rate 200, 400, and 600 ppm) were used as foliar applications on the vine three times: at the commencement of growth (when the branch length was between 20 and 35 cm), after flowering stage, and at veraison (after 30-day berry set) stage.

Treatments used as follow:

- Control
- Foliar with brassinosteroids at 2 ppm
- Foliar with brassinosteroids at 4 ppm
- Foliar with brassinosteroids at 6 ppm
- Foliar with methionine at 200 ppm
- Foliar with methionine at 400 ppm
- Foliar with methionine at 600 ppm

The following characteristics were measured:

1- Vegetative growth measurements

After one week from the last dosage, non-bearing shoots were used to collect the following vegetative growth measurements:

- Average shoots length (cm).

-Shoot length was determined by measuring the rate length of 6 shoots per vine.

- Total leaf area/vine (m^2) was calculated by multiplying average leaf surface area by the average number of leaves per shoot by the number of shoots per vine.

- Total Chlorophyll content in the leaves

After one week following the last dosage, the sixth and fifth leaves from the growing shoots' tips were utilized to measure the amount of total chlorophyll in the leaves using the techniques outlined by **Mackinny (1941).** And it determined as mg/g fresh weight.

- Nitrogen, phosphor and potassium and total amino acids content in the leaves

Following the completion of the last dosage, samples of 16 leaf petioles per replicate from leaves on the obverse side of the cluster were collected and utilised to measure the amounts of nitrogen, phosphor and potassium by **Cottenie *et al.*, (1982).**

According to **(Selim *et al.*, 1978),** the total free amino acids were measured as (g /100g dry weight) in the leaf blades. Total free amino acids in the leaves were measured according to **Jayarman (1981)** including a few changes **(Chen *et al.*, 2009).**

According to **(Selim *et al.*, 1978),** the total free amino acids were determined as (g /100g dry weight) in the leaf blades.

2- Yield and Physical parameters in cluster and berries

Six clusters per vine were weighed at harvest, when the SSC percentage of the berries reached around 16% in the control, and the average cluster weight was multiplied by the number of clusters per vine to calculate the average yield per vine.

- Average cluster weight was multiplied by the number of clusters per vine to calculate the average yield per vine.

- The average cluster weight (g), length (cm), and width (cm), average of hundred berry weight (g), and number of clusters were also determined, shot berries (%) were measured as the percentage by dividing the number of shot berries/cluster by the total number of berries/ cluster and the cluster compactness was measured by according to **(Fawzi *et al.*, 2019),** the firmness of the berries was assessed using a Push/Pull and the results were evident in (g/cm^2).

3- Chemical properties of berries

- Soluble solids content, a hand refractometer type Master T was used to measurement the percentage of soluble solids in the sample (ATAGO Co., Ltd., Japan).

- Titratable acidity percentage was measured the mode substantive by **A.O.A.C. (2006).**

- Total sugars (%) were measured outlined by **Sadasivam and Manickam (1996)**

- Total anthocyanins of berry skins (mg/100 g fresh weight) were determined outlined by **Husia *et al.* (1965).**

-Total phenols (mg/g berries as gallic acid eouivalent) was based on Folin-Ciocalteau reagent (**zieslin and ben zaken (1993**).

Statistical analysis

For the experiment, the randomised complete blocks design was used. Data from the study were statistically analysed recommendations in accordance with **Snedecor and Chocran (1980)**. Treatments means were detached and compared made the New LSD value at 5%. The Co-Stat software, version 6.303, was applied to analyse the formation (789 lighthouse Ave PMB 320, Monterey, CA, 93940, USA).

RESULTS AND DISCUSSION

Shoot length, leaf area per vine and total chlorophyll in the leaves

From the information in Table1 that treating King Ruby cultivar three times with brassinosteroid and methionine significantly improvement shoots length, leaf area/vine and total chlorophyll in the leaves when compared to the control. It is obvious from Table 1 that the shoot length, leaf area/vine, and total chlorophyll in the leaves were improved by increasing the concentrations on brassinosteroid and methionine. Furthermore, there were no significant differences in shoot length among brassinosteroid at 6 and at 4 ppm in two years of the study. The greatest values in this regard were registered when the vines were foliar with brassinosteroid at 6 ppm, which recorded (167.66 and 175 cm) for shoot length, (13.04 and 13.68 m^2) for leaf area per vine, and (13.33 and 13.63 mg/g F.W.) for total chlorophyll, respectively, as compared to other treatments in 2019 and 2020. While, the untreated achieved the smallest values for shoot length (140.66 and 145.0 cm), leaf area per vine (10.5 and 10.98 m^2), and total chlorophyll levels (10.23 and 11.03 mg/g), in 2019 and 2020, respectively.

The rise in vegetative characteristics could be explained by brassinosteroid which it catalyzes cell division, flower bud differentiation, and elongation, and carbohydrate stimulation, subsequently enhancing the physiological status of plants and increasing vegetative growth (**Asghari and Rezaei-Rad, 2018; Senthilkumar *et al.*, 2018).**

Brassinosteroid hormones impact a number of different processes of vegetative growth and gene expression and influence complicated systems' activity metabolic passageway **(Bartwal *et al.*, 2013)**. **Kamiab (2018) and Hassan Zadeh (2013)** demonstrated that cantaloupe's chlorophyll content was boosted by the application of brassinosteroid. Furthermore, methionine, an amino acid, is important for plant metabolism because it regulates the levels of numerous important metabolites, including polyamines and biotin, through its metabolite, S-adenosyl methionine. Moreover, SAM functions as a major supplier of methyl groups to a variety of plant activities, including the creation of cell walls and chlorophyll. **Rachel and Hacahm (1998). Belal *et al.*, (2016)** found that methionine, improved growth parameters when compared to control. **Mekawy (2019)** reported that foliar application of methionine at 100 mg/L enhanced growth parameters.

Table 1. Effect of brassinosteroid and methionine on shoot length, leaf area per vine and total chlorophyll of King Ruby seedless grapevine during 2019 and 2020 years.

	Treatments	Shoot length (cm)		leaf area/vine (m^2)		Total chlorophyll (mg/g F.W)	
		2019	2020	2019	2020	2019	2020
1	Control	140.6	145.0	10.50	10.98	10.23	11.03
2	Brassinosteroid at 2 ppm	161.3	165.0	12.02	12.34	11.10	12.33
3	Brassinosteroid at 4 ppm	167.6	172.3	12.37	13.20	13.13	13.06
4	Brassinosteroid at 6 ppm	167.6	175.0	13.04	13.68	13.33	13.63
5	Methionine at 200 ppm	145.6	151.0	10.77	11.38	12.03	12.36
6	Methionine at 400 ppm	150.6	157.3	11.65	11.57	11.26	12.36
7	Methionine at 600 ppm	155.6	165.3	11.46	12.82	11.96	12.73
	New L.S.D at 5%	3.6	5.2	0.62	0.33	0.57	0.49

N, P, K and total amino acids content in leaf petioles

From the information Table 2 mentioned that foliar Ruby seedless grapevine with brassinosteroid and methionine improved the nutrient content of nitrogen, phosphor and potassium in leaf petioles as compared with the control. Brassinosteroid are superior to methionine in nitrogen, phosphor and potassium in leaf petioles. As data of potassium in leaf petioles throughout both research seasons, the results also showed that the differences among the levels of brassinosteroids concentration at 6 and 4 ppm were not significant of study. The data also demonstrated that brassinosteroid at 6 ppm resulted in pronounced significant values for the content of nitrogen, phosphor and potassium in leaf petioles. While the control recorded the smallest values in this regard for nitrogen, phosphor and potassium in leaf petioles during both seasons.

These data were in agree with by **Miao *et al.*, (2007)** demonstrated that root nodulation capability and nitrogenase activity were boosted by the use of brassinosteroids, increasing the percentage of nitrogen in plant tissues. Brassinosteroids are recognised as hormones with pleiotropic actions that affect a variety of activities, including pollen tube growth, nutrient status, photosynthesis, cell elongation, senescence, and xylem differentiation, growth, and stem elongation. (**Clouse and Sasse, 1998; Steber and McCourt, 2001; Krishna, 2003; Yu *et al.*, 2004; Vert *et al.*, 2005). Belal (2019)** found that spraying brassinosteroid at two rates (1 and 2 mg L-1) improved nitrogen, phosphor and potassium content in leaf petioles compared to the control. Methionine increased nitrogen, phosphor and potassium content t in leaf petioles due to its function as a regulatory molecule, as a component of the protein S-adenosyl methionine, and as a factor in the start of mRNA translation in plant cells **(Hesse *et al*. 2004).** In addition, **Belal *et al.*, (2016)** reported that methionine improved nitrogen, phosphor and potassium in leaf petioles when compared to control, and **Mekawy (2019)** found that foliar application of methionine at 100 mg/L improved nitrogen, phosphor and potassium in leaf petioles when compared to the control (spraying with tap water) in two years.

As regard to total amino acids, the total amino acids in the leaves in King Ruby seedless grapevine leaves as impact with different concentration of brassinosteroid and methionine are shown in the same Table 2. Spraying King Ruby seedless three times with brassinosteroid and methionine significantly improved total free amino acids in the leaves as compared with untreated during two years. Using methionine at 600 ppm gave the raise values in total amino acids in the leaves, followed by methionine at 400 ppm while the control (spraying with tap water) gave the smallest value of total amino acids in the leaves in the 2019 and 2020 years, **Mekawy, (2019)** reported that foliar application of methionine at 100 mg/L that increased total amino acids in the leaves of Superior.

Table 2. Effect of brassinosteroid and methionine on percentages of N, P, K and total amino acids content in leaves of King Ruby seedless grapevine during 2019 and 2020 years.

	Treatments	Leaf N (%)		Leaf P (%)		Leaf K (%)		Total amino acids in the leaves (g /100g D.W	
		2019	2020	2019	2020	2019	2020	2019	2020
1	Control	1.80	1.90	0.20	0.23	1.19	1.30	1.55	1.75
2	Brassinosteroid at 2 ppm	2.10	2.19	0.33	0.37	1.61	1.74	1.71	1.91
3	Brassinosteroid at 4 ppm	2.34	2.51	0.39	0.45	1.69	1.86	1.81	2.11
4	Brassinosteroid at 6 ppm	2.54	2.68	0.47	0.49	1.72	1.87	1.98	2.35
5	Methionine at 200 ppm	1.90	2.00	0.25	0.28	1.3	1.42	1.91	2.15
6	Methionine at 400 ppm	1.92	2.15	0.28	0.31	1.45	1.50	2.17	2.49
7	Methionine at 600 ppm	2.01	2.25	0.39	0.42	1.6	1.73	2.65	2.83
	New L.S.D at 5%	0.07	0.06	0.05	0.03	0.03	0.05	0.07	0.09

Yield and Physical parameters in cluster and berries

The data from Table 3 show that, in two years, three treatments with brassinosteroid and methionine on King Ruby seedless considerably enhanced yield per vine, cluster weight, and hundred berry weight compared to untreated. It is obvious that the yield per vine, cluster weight, and hundred berry weights are enhanced by increasing the concentrations of brassinosteroid and methionine. Also, the application of brassinosteroid at 6 ppm recorded the greatest values of yield / vine (16.7 and 17.2 kg/vine), cluster weight (699.0 and 719.6 g), and hundred berry weight (399.0 and 420.6 g), followed by in descending order brassinosteroid at 4 ppm, as compared with the other application during two years. While the control provided the lowest values for vine yield (13.28 and 13.928 kg/vine), cluster weight (553.33 and 580.3 g), and hundred berry weight (302.66 and 320.33 g) in the 2019 and 2020 seasons, respectively.

The positive influence of brassinosteroid on improving yield may be refer, to their important role in promoting photosynthesis, carbohydrate assimilation, and cell division and elongation **(Sasse, 2003)**. Improved vegetative growth, physiological status which consequently improved bunch weight, weight of berries, and yield **(Zhou-Yushu *et al.*, 2003). Harindra champa *et al.*, (2015)** observed that using of brassinosteroid improved in bunch weight when vines were treated at 1.0 mgl-1. **Ghorbani *et al.*, (2017**) found that application of brassinosteroids enhances yield per fadden, bunch weight and hundred berry weight of 'Thompson grape'**. Belal, (2019**) demonstrated that the berries' weight, size, and diameter increased significantly under the influence of brassinosteroids. There are a variety of factors that can explain how methionine affects the quality of grapevine berries, including its part in maintaining the build, of proteins necessary for cell division, cell differentiation, and development as well as the fact that it supplies plants with enough sulphur and nitrogen. **(Khan *et al.*, 2019). Also**, **Belal *et al.* (2016)** reported that during two years of Flame Seedless grapevines, amino acids, particularly methionine, significantly enhanced yield per vine, bunch weight, and hundred berry weight compared to untreated and **Mekawy, (2019)** reported that foliar application of methionine at 100 mg/L increased yield/vine, bunch weight, and hundred berry weight of Superior cultivar grapes.

Table 3. Effect of brassinosteroid and methionine on yield pervine, cluster weight and hundred berry weight of King Ruby seedless grapevine during 2019 and 2020 years.

	Treatments	Cluster weight (g)		Yield/vine (Kg)		Hundred berry weight (g)	
		2019	**2020**	**2019**	**2020**	**2019**	**2020**
1	**Control**	553.3	580.3	13.28	13.92	302.6	320.3
2	**Brassinosteroid at 2 ppm**	611.0	619.6	14.66	14.87	350.3	370.0
3	**Brassinosteroid at 4 ppm**	682.0	701.0	16.36	16.82	375.0	410.3
4	**Brassinosteroid at 6 ppm**	699.0	719.6	16.77	17.27	399.0	420.6
5	**Methionine at 200 ppm**	569.6	589.6	13.67	14.15	319.3	327.0
6	**Methionine at 400 ppm**	590.6	610.0	14.17	14.64	340.0	350.6
7	**Methionine at 600 ppm**	650.6	674.66	15.61	16.19	370.3	392.3
	New L.S.D at 5%	12.8	8. 8	0.57	0.38	16.9	10.3

As for physical properties of cluster

Information in Table 4 clearly the results demonstrated that there were no significant differences among the application brassinosteroid concentration at 6 and 4 ppm in cluster length. In the second season, spraying brassinosteroid at 6 ppm significantly increased cluster length as compared to the other treatments. Non-significant differences between using brassinosteroids at 6, and 4 ppm and methionine at 600 ppm cluster width in the two seasons of study. Spraying brassinosteroid at 6 ppm significantly increased cluster width as compared with the other treatments. While the control reported the reduced in this regard for cluster length and width across two years study. Also, spraying brassinosteroids reduced cluster compactness as compared to methionine during the two study years of study. The best treatment with regard to reduce cluster compactness was obtained by spraying brassinosteroid at 6 ppm, followed by 4 ppm.

These findings concur with those that have been reported by **Harindra Champa *et al.*, (2015),** who found that bunch length and breadth, and berry size were prominently higher when clusters of Flame seedless were treated with 0.5 and 1.0 ppm brassinosteroid which improved vegetative growth, physiological status consequently, this reflected on improving therapy properties of bunch or fruit **(Zhou-Yushu *et al.*, 2003). Ghorbani *et al.*, (2017)** demonstrated that application of brassinosteroid to Thompson seedless grapevines after bloom and véraison stage enhanced cluster length and cluster width. **Belal, (2019)** found that using brassinolide at 1.0 and 2.0 ppm, increased bunch length and reduced compactness of bunch. Methionine plays a function in preserving the build, of proteins necessary for cell division, cell differentiation, and vigor, and it also supplies enough sulphur and nitrogen to meet plant needs, all of which improve the fruit quality of grapes. **(Khan *et al.*, 2019).** Furthermore**, Mekawy, (2019)** reported that foliar application of 100 mg/L methionine increased the cluster parameters of Superior Seedless grapevines.

Number berries/cluster, shot berries% and berry firmness

Data in the Table 5 showed that spraying brassinosteroid and methionine significantly reduced the percentage of shot berries and number berries per cluster of King Ruby seedless grapevines compared to control during both seasons data in the same table indicated that berry firmness was improved by increasing the concentrations of brassinosteroid and methionine as compared to the control. Brassinosteroid concentrations at 6 ppm gave the highest values of berry firmness followed by spraying methionine at 600 ppm, in both seasons. The control had the lowest results for berry firmness in the 2019 and 2020 in both years.

The beneficial impact of brassinosteroid and methionine applications enhancement the firmness of berries may be due to increased Ca^{2+}, protopectin, and pectin in cell walls in litchi **(Peng *et al.*, 2004).** and **Zhu *et al.*, (2010**) in jujube tree. **Harindra champa *et al.*, (2015)** found that bunches foliar with brassinosteroids maintained berry firmness was higher than it was when untreated. These results are in lines with those obtained by **Mekawy (2019)** who found that a foliar application of methionine at 100 mg/L increased the fruit parameters of Superior Seedless grapevines.

Table 4. Effect of brassinosteroid and methionine on cluster length, cluster width and Cluster compactness of King Ruby seedless grapevine during 2019 and 2020 years

	Treatments	cluster length (cm)		cluster width (cm)		Cluster Compactness	
		2019	2020	2019	2020	2019	2020
1	Control	25.0	26.0	13.1	13.5	6.1	5.8
2	Brassinosteroid at 2 ppm	26.8	27.3	13.9	14.1	5.3	5.0
3	Brassinosteroid at 4 ppm	28.2	28.8	14.6	14.8	5.3	4.8
4	Brassinosteroid at 6 ppm	29.0	30.6	15.0	15.6	5.0	4.6
5	Methionine at 200 ppm	25.4	26.5	13.5	13.6	5.8	5.6
6	Methionine at 400 ppm	26.0	27.3	13.9	14.3	5.5	5.2
7	Methionine at 600 ppm	27.0	28.6	14.7	15.1	5.3	4.9
	New L.S.D at 5%	0.8	0.8	0.5	0.5	0.6	0.1

Table 5. Effect of brassinosteroid and methionine on number berries of cluster, shot berries and berry firmness of King Ruby seedless grapevine during 2019 and 2020 years

	Treatments	Number berries/cluster		Shot berries %		Berry firmness (g/cm^2)	
		2019	2020	2019	2020	2019	2020
1	Control	153.4	151.1	7.0	6.0	131.0	14.0
2	Brassinosteroid at 2 ppm	144.4	137.4	4.5	3.6	146.3	160.0
3	Brassinosteroid at 4 ppm	151.8	140.8	4.0	3.4	169.6	176.6
4	Brassinosteroid at 6 ppm	145.2	141.1	3.4	2.5	190.0	223.6
5	Methionine at 200 ppm	148.4	146.3	4.5	3.9	159.0	189.3
6	Methionine at 400 ppm	143.8	144.1	4.1	3.9	173.0	198.0
7	Methionine at 600 ppm	145.7	141.9	3.8	3.0	179.6	210.0
	New L.S.D at 5%	8.5	4.75	0.8	1.0	5.3	9.6

Chemical properties of berries

1- SSC%, acidity and total sugars

It is clear from the information provided in Table 6 that all using brassinosteroid and methionine resulted in both years in the lowest titratable acidity values and the most significant increases in SSC% and total sugars as compared to the control. Spraying brassinosteroid at 6 ppm and methionine at 600 ppm resulted in the greatest significant increases in SSC% and total sugars when compared to other treatments. The control (spraying with tap water) produced the minimum values of SSC% and total sugars during both seasons.

Our findings agreed with the research done by **Symons *et al.*, (2006)** who showed that the using of exogenous brassinosteroid significantly proved TSS and ripening of fruits**.** **Jegadeeswari *et al.*, (2010)** reported that the vines, which were received with brassinosteroid improved the chemical parameters such as TSS, and total sugars of grape cv. Muscat**.** **(Ghorbani *et al.*, 2017**) Brassinosteroid applications improvement the SSC and reduce the titratable acids content. Moreover, Methionine is a presage for the manufacture of the hormone ripening ethylene, which is play a significant part in the ripening of fruits. Methionine may also be responsible for increasing SSC percentage and decreasing total acidity percentage in grape berries. **(Khan *et al.*, 2019)**. These results are in lines with those obtained by **Mekawy, (2019)** who found that foliar methionine applications at 100 mg/L, increased SSC% and total sugars in Superior Seedless grapevines. In addition, **Belal, (2019)** found that spraying the vines with brassinosteroid significantly improved the chemical parameters of fruit, such as SSC.and total sugars, while lowest total acidity percent when compared with the untreated.

Table 6. Effect of brassinosteroid and methionine on soluble solids content (SSC), acidity and total sugars of King Ruby seedless grapevine during 2019 and 2020 years

Treatments		SSC (%)		Titratable acidity (%)		Total sugars (%)	
		2019	2020	2019	2020	2019	2020
1	**Control**	17.0	17.3	0.64	0.61	12.7	13.0
2	**Brassinosteroid at 2 ppm**	17.5	17.8	0.55	0.51	13.1	13.3
3	**Brassinosteroid at 4 ppm**	18.0	18.0	0.50	0.46	13.5	13.5
4	**Brassinosteroid at 6 ppm**	18.6	19.0	0.39	0.33	13.9	14.2
5	**Methionine at 200 ppm**	17.4	18.0	0.59	0.53	13.0	13.5
6	**Methionine at 400 ppm**	17.7	18.4	0.55	0.48	13.3	13.8
7	**Methionine at 600 ppm**	18.2	18.7	0.45	0.40	13.7	14.0
New L.S.D at 5%		0.3	0.4	0.03	0.03	0.28	0.29

2- Total anthocyanin and total phenols in berries

Results in Table 7 reported that all applications of brassinosteroid and methionine improved total anthocyanin and total phenols in berries as compared to the control. The foliar of brassinosteroid concentration at 6 ppm provided the greatest values of total anthocyanin in berry skin and total phenols in berries, followed by the spraying of methionine concentration at 600 ppm, in both years. While, the control provided the smallest values in total anthocyanin and total phenols in berries in the 2019 and 2020 years, respectively,

The positive effect of brassinosteroid on enhancing the chemical characteristics, of fruit may be contributions to their imporatant roles in photosynthesis, carbohydrate assimilation, increasing anthocyanin biosynthesis, nucleic acid, and ATP activity, which, subsequently, improves phonological status and directs cell to a start ripening as well as enhancement berry standard **(Vardhini and Rao, 2002).** Also, more research was done on the role of brassinosteroids in the control of anthocyanins biosynthesis during the ripening of berries, and the authors came to the conclusion that these steroids had a more potent effect on the genes involved in anthocyanin biosynthesis, which improved fruit coloration. **(Luan *et al.*, 2013).** The same results were obtained by **Asghari and Rezaei-Rad (2018) and Senthilkumar *et al.*, (2018).** In addition, **Belal (2019)**, who revealed that spraying the vines with brassinosteroid significantly raised T.S.S, total sugars and total phenols. Fruit's significant contributions to photosynthesis can be linked to their chemical characteristics.

Table 7. Effect of brassinosteroid and methionine on total anthocyanin and total phenols of King Ruby seedless grapevine during 2019 and 2020 years

	Treatments	Total anthocyanin (mg/100g F.W)		Total phenols (mg/100g D.W)	
		2019	2020	2019	2020
1	Control	35.0	36.5	249.6	259.9
2	Brassinosteroid at 2 ppm	37.1	39.3	270.6	274.5
3	Brassinosteroid at 4 ppm	38.6	40.3	291.0	300.0
4	Brassinosteroid at 6 ppm	41.1	42.1	368.4	372.0
5	Methionine at 200 ppm	36.6	38.3	316.1	320.1
6	Methionine at 400 ppm	36.6	39.0	330.0	338.6
7	Methionine at 600 ppm	39.4	41.0	339.4	349.9
	New L.S.D at 5%	1.04	1.42	7.3	11.8

Conclusion

From the above findings, it may be recommend that foliar King Ruby grapevine cultivar with a brassinosteroid at a rate of 6 ppm resulted in the highest values of vegetative growth measurements and total amino acids in the leaves, Furthermore, the amounts of nitrogen, phosphor and potassium content in leaves, yield per vine, cluster weight, cluster length, number of berries in a cluster, berry weight, firmness, and chemical properties of berries.

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RESEARCH ARTICLE

Effect of Brassinosteroid and Methionine on Vegetative Growth, Yield and Fruit Quality of King Ruby Grapevine

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