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EFFECT OF FOLIAR SPRAYING OF SOME ANTIOXIDANTS ON GROWTH AND PRODUCTIVITY OF GRAPEVINES (*VITIS VINIFERA* L. VC. "BARANY") UNDER SEMIARID REGION

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Abstract

Grapevines (*Vitis vinifera* L.) "Barrany" variety are considered one of the most important fruit crops for local consumption and production in Matrouh Governmental of Egypt, the longtime of drought during the vegetative period which has a severe impact on the crop. A field experiment was conducted in a public farm of Faculty of Agriculture Desert and Environmental in "Ras El Hekma" region, under a rainfed condition during the two seasons of 2018 and 2019. The study aims to investigate the influence of foliar spraying of salicylic Acid (SA; 0, 1.5 and 3 Mm) and Ascorbic Acid (AA; 0, 2 and 6 mg L^{-1}) on some growth parameters and productivity of Grapevines vc. "Barrany" under semiarid region. The results indicated that the foliar spraying of SA and AA up concentrations increased most of the studied characteristics *i.e.*, leaf area, shoot length, chlorophyll content, bunches and berry characteristics, yield (kg/vine), proline. Foliar application with SA and AA significantly ($p < 0.05$) enhanced all measured quality attributes. In the semi-arid environment of the Matrouh region, these results suggest that foliar applications of salicylic and ascorbic acid could be used as a management practice for improving water stress tolerance of grapevines trees under suboptimal water regimes.

Key words: Grapevines, Drought stress, Ascorbic and salicylic Acid.

Introduction

Grapevines (*Vitis vinifera* L.) are considered one of the most important fruit cops in Egypt, the total area of grapes reached (193,695) feddans (FAO, 2018). Barrany" is the local grape varieties cultivated in North Coast region of Egypt, this plant is growing in a traditional way. Water availability for irrigation is among the most critical factors that affect fruit tree growing in arid and semiarid area.

The important limiting factor for crop production is drought, whoever, it is becoming an increasingly severe problem in arid and semiarid of the world (Passioura, 2007). The plants cultivated in dry condition change their metabolism to overcome the changed environmental condition. The effect of drought stress is negatively on leaf water content and reduced fruit yield and quality (Hallac Turk and Aksoy, 2011). The impact of water stress in plants resulting oxidative stress (Manivannan *et al.,* 2008). The response of the plant under drought stress could be justified it is produced proteins to reaction biotic and a biotic stress that were induced by salicylic acid and Ascorbic acid, these material can decrease the effect of drought in plants under stress condition (Davis, 2005).

Salicylic acid is a growth stimulant regulating in plants, where phenols play an important role in renewing the physiological process in plants such as photosynthesis and other metabolic processes (Sakhabutinova *et al.,* 2003). The result of the use of plant growth regulators has been significant progress in many fruit crops in terms of growth and production as well as quality. Also, is a conservative compound of some biological stresses and it being important molecular signal for adjustment plants reaction to environmental stresses (Syeed *et al.,* 2011; Khan *et al.,* 2012).

The efficacy of ascorbic acid is resisted plant to stresses by reduction oxygenic free radicals constituted stress duration the drought stress and decrease starch metabolism in cotyledons and transformation sucrose. (Inze and Montago, 2000). A mechanism exists in plants to overcome the effects of water stress as the accumulation of compatible osmosis, such as proline, is increased. The impact of ascorbic acid is regulation of

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photosynthesis processes and antioxidant defense and growth, also, increased and total nitrogen percent and carbohydrates (Tarraf *et al.,* 1999). Other studies detected that the antioxidants give positive effects on growth, yield and fruit quality of fruit trees (Ahmed and Abdelaal, 2007; Mohamed and El Berry, 2019). Nevertheless, the efliects of exogenous applications of As a in fruit tree species under water stress have been scarcely researched in olive trees (Ibrahim, 2013), (Penella *et al.,* 2017) on peach tree and grapevines (Zonouri *et al.,* 2014).

The objective of this investigation was to enhance plant growth, yield and chemical constituents as well as proline production of grapevines "Barrany" affected by foliar application of ascorbic acid and salicylic acid, under arid region area.

Material and Methods

This investigation work was conducted during two seasons of 2018 and 2019 on 4-year-old, own-rooted plants of *Vitis vinifera* L. "Barrany" grown in a Farm of Faculty of Agriculture Desert and Environmental is located at Ras El-Hekma district, Matrouh governorate, Egypt. The climate is Mediterranean condition, with mild, relatively rainy winters and hot, sunny summers the average annual temperature is 19.6:21.5°C and the Rainfall is scarce, since it amounts to about 100, 150 millimeters form seasons 2018, 2019 respectively, however, that is, it occurs from September to April.

The selected trees were planted in calcareous soil under rainfed agriculture conditions and planted at 3 x 5 m apart. The experimental trees were selected to be healthy and nearly similar in growth vigor and uniform, all plants it received the normal cultural practices. Twenty-seven trees were divided into nine treatments including the control. Each treatment was executed on three trees (Replicates). The treatment categories were as follows:

Treatments

1 S1+A1 3Mm Salicylic acid (+ 6 mg L^{-1} Ascorbic acid

2 S1+A2 3Mm Salicylic acid (+ 2 mg L^{-1} Ascorbic acid

3 S1+0 3Mm Salicylic acid (+ 0

4 S2+A1 1.5Mm Salicylic acid (+ 6 mg L^{-1} Ascorbic acid

5 S2+A2 1.5Mm Salicylic acid (+ 2 mg L^{-1} Ascorbic acid

6 S2+0 1.5Mm Salicylic acid (+ 070+A1 0 + 6 mg L^{-1} Ascorbic acid

8 0+A2 0 + 2 mg L^{-1} Ascorbic acid

9 CO control (potable water)

The foliar treatment of trees were sprayed with salicylic acid and ascorbic acid (Merck, KGaA, Germany) at (0, 6 and 2 mg L^{-1} SA) and (0, 3 and 1.5 mg L^{-1} AA) and the combinations of these treatments at two different times (25^{st} Abril and 25^{st} May at the two seasons, respectively) and each vine was sprayed with 4 L of these solutions. The control grapevines were sprayed with water during each application.

The following parameters Measured traits including shoot length, fruit yield, the number of, bunch weight, bunch length, bunch number, berry length, berry weight and the berry number. In order to measuring leaf area, of each sapling, three leaves; small, medium, big were chosen and the leaf area was measured by vine leaves were fresh weighed and scanned every year using an image analysis software (APS Assess, Winipeg, Canada).

In order the total leaf chlorophyll content was determined in the fresh leaf samples composed of 3 leaves selected from each plant at the end of both experimental seasons. Total leaf chlorophyll was determined according to the method described by (Yadava, 1986), using a Minolta SPAD 502 plus chlorophyll-meter model. The results were expressed as SPAD units. Free proline content was determined from standard curve according to (Bates *et al.,* 1973). The data of proline was expressed as mg/g dry weight of leaf tissues.

Fruit Chemical Characters: At harvest day a sample of three clusters was randomly collected from each replicate in both seasons. In additional the measured Titratable Acidity (TA), were measured by a digital refractometer (REF121; Atago, Guangzhou, China) in the juice as tartaric acid was determined by titration with 0.1 N NaOH and expressed as %, fruit total sugars content determined according to (AOAC, 1990). In order the percentage of total soluble solids (TSS) in the juice was measured a hand refractometer (A.S.T., Japan) and maturity index was defined as the TSS/acidity ratio was estimated in fresh weight. Firmness, were determined in the both seasons of the study by the equatorial region of fruit, using a texture analyzer (FT-011, with 7 mm probe, Effegi, Italy) and expressed as kg.cm^{-2}. Determination of proline: Proline concentration was determined calorimetrically as an organic osmolyte at 520 nm using the method described by (Bates *et al.,* 1973).

Statistical analysis

This experiment was carried out in a randomized complete block design RCBD in three replications. Data were subjected to analyses of variance. Data in this study were statistically analyzed using Statistix 8.0 statistical package (Analytical Software, Tallahassee, FL, USA) Steel and Torrie, 1980.

Result and discussion

Pants need water to grow and produce yields. Drought escape' is the ability of a plant species to complete its life cycle before the onset of drought. Grape fields are exposed to water deficit and lack of rain in the study area, the average precipitation is 80, 150 mm for tow season respectably. The results obtained in this research to reduce the impact of drought on grape trees using antioxidant. In general, the statistical analysis of the data obtained was detected a significant difference between for all treatments compared to the control in both seasons.

Vegetative growth measurements: (Shoot Vine length (cm), Total chlorophyll and Leaf area)

Table 1: The soils of the studied plots are homogenous in their soil textures we can see the properties in the table.

Soil physical properties			Soil chemical properties		
Depth cm	**0-30**	**30-60**	**Depth cm**	**0-30**	**30-60**
Sand %	63.40	55.90	pH	7.63	7.62
Silt %	10.00	15.00	EC (dS/m)	0.33	0.28
Clay %	26.60	29.10	SAR %	1.78	2.23
FC %	22.37	25.85	CEC %	16.07	16.07
WP %	10.32	11.95	CaCO3 %	48.35	66.00
Texture	sandy		OM %	0.73	0.4
class	clay loam				

Table 2: Effect of foliar application of salicylic acid and ascorbic acid on Shoot length and Chlorophyll of grapevine during two growing seasons.

Treat-ments	Leaf area (dm2 per plant)		Chlor-ophyll		Shoot length (cm)	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**
S1+A1	206.0 ab	139.8 a	31.1 a	29.7 ab	53.6 a	70.9 a
S1+A2	195.8 abcd	131.7 ab	31.6 a	30.9 a	54.4 a	84.8 a
S1+ 0	217.0 a	116.7 ab	32.2 a	30 ab	55.3 a	52.9 d
S2+A1	175.3 cde	144.4 a	27.6 bc	28 b	47.5 bc	64.9 bc
S2+A2	189.1 bcd	134.3 ab	29.9 ab	28.2 b	51.5 ab	59.2 cd
S2+0	154.2 e	118.4 ab	27.8 bc	29 ab	47.8 bc	58.6 cd
0+A1	203.0 ab	127.9 ab	27.7 bc	29.9 ab	47.4 bc	51.8 d
0+A2	197.0 abc	109.0 ab	26.1 c	30.6 a	44.9 c	52.9 d
CO	173.8 de	94.4 b	26.5 c	27.9 ab	45.6 c	34.0 e
Signif-icance	*	*	**	*	**	**

The same letter in each column are *P≤0.05; **P≤0.01; N.S., non-significant; different letters indicate signiflicant differences at P≤0.05.

The applications of AA and SA generally increased the length of shoots in table 2 the studied maximum vine length (70.9cm and 55.3 cm) was recorded with the treatment S1+A1 and S1+0 respectively. Data in table 2 indicated that all treatments had positive effects on the total chlorophyll compared with the control treatment in both seasons. There was an insignificant difference between the values of all treatments while, S1+0 and S1+A2 gave the highest value (32.2, 30.9) compared with the other treatments including the CO treatment which gave the lowest effect (26.5, 27.9) in the two successive seasons, respectively.

Table 2 indicated that, all the treatments of SA and AA significantly increased leaf area compared with the control in 2019. The highest values (217, 144.4 dm^2) were obtained with sprayed S1+0, S2+A1comparing with other treatments used in the two growing seasons. The lowest values (154.2, 94.4 dm^2) were recorded in the S2+0 and CO treatment in both seasons respectively.

These results were agreement by detected of (Fayed, 2010; Abbaspour and Babaee, 2017), these increases in the above parameters by using ascorbic acid may be due to the fact that Ascorbic acid as an antioxidant has an effect as plant growth regulators (Johnson *et al.,* 1999). That the spraying transplants wit ascorbic and salicylic acid significantly increased the leaf area and total chlorophyll.

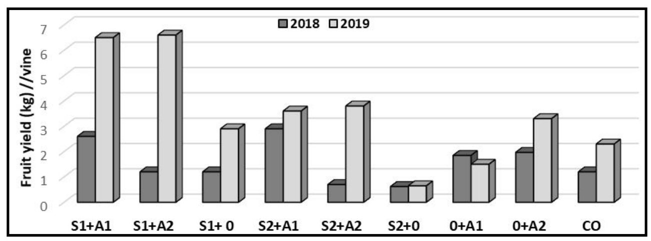

Fig. 1: Effect of different foliar application SA and AA on yield kg/tree of grape during two seasons Different letters are express for significant differences while the same are non-significant at L.S.D.

Table 3 shows the effect of spraying with SA and AA on grapevines for the characteristics of the length, number and weight of bunch. The results of the statistical analysis showed significant differences between the treatments in compared to the control. But there were no significant differences between control vine and those treated by SA and AA in terms of bunch number during 2018. The effect of SA and AA treatments on the number of bunches was significant at 5% level for year 2019 table 3. Bunch weight was statistically affected by SA and AA treatments at 5% level. Mean comparison showed that the highest bunch weight (average 343.3, 230.2 g)

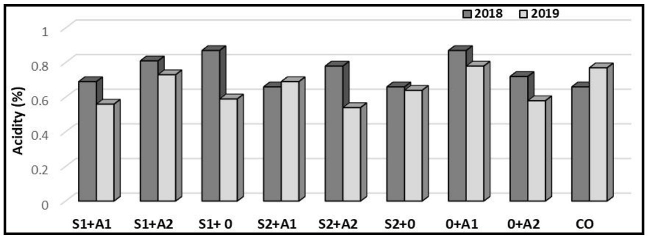

Fig. 2: Effect of different foliar application AA and SA on Acidity (%) content in grapefruit during two seasons Different letters are express for significant differences while the same are non-significant at L.S.D. p>0.05.

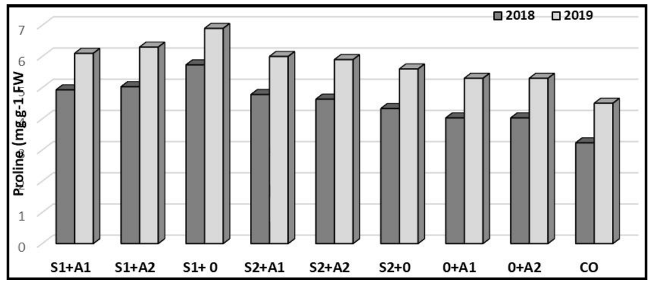

Fig. 3: Effect of different foliar application AA and SA on proline content in grape leaves during two seasons Different letters are express for significant differences while the same are non-significant at L.S.D. p>0.05.

Table 3: Effect of foliar application of salicylic acid and ascorbic acid on bunch number, bunch weight and bunch length of grapevine during two growing seasons.

Treat-ments	Bunch Numbers		Bunch weight (g)		Bunch Length (cm)	
	2018	2019	2018	2019	2018	2019
S1+A1	12.0	28.3 ab	206.8 cd	230.2 a	16.3 cd	20.1 ab
S1+A2	5.3	31.0 a	226.1 bc	215.5 ab	20.8 abc	20.3 ab
S1+0	12.3	20.3 abcd	106.3 d	136.7 bc	23.3 a	16.6 cd
S2+A1	11.0	21.6 abcd	327.7 ab	167.1 abc	15.3 d	21.6 a
S2+A2	5.0	24.6 abc	148.6 cd	158.5 abc	18.0 bcd	19.4 ab
S2+0	4.6	6.3 e	143.1 cd	103.2 c	20.6 abc	15.2 d
0+A1	9.3	12.3 cde	210.4 cd	121.9 bc	20 abcd	18.3 bc
0+A2	6.3	17.3 bcde	343.3 a	155.3 abc	22.0 ab	19.5 ab
CO	7.3	9.0 de	163.3 cd	145.5 abc	18.1 bcd	14.3 d
Signif-icance	N.S.	**	*	**	**	**

The same letter in each column are $*P \leq 0.05$; $**P \leq 0.01$; N.S., non-significant; different letters indicate signiflicant differences at $P \leq 0.05$.

Table 4: Effect of foliar application of salicylic acid and ascorbic acid on berry number berry length and average weight berry of grapevine during two growing seasons.

Treat-ments	Berry Number		Berry Length (mm)		Average weight berry (GR)	
	2018	2019	2018	2019	2018	2019
S1+A1	38 ab	63.4 a	2.26	1.75 ab	3.79 b	5.2 a
S1+A2	54 a	56.3 ab	2.2	1.6 abc	5.0 a	4.2 b
S1+0	26.3 b	45.6 bc	1.8	1.58 abc	3.8 b	4.5 b
S2+A1	30.6 b	58.8 a	1.53	1.73 abc	4.8 ab	4.8 ab
S2+A2	30.6 b	53.1 ab	1.56	1.78 a	4.6 ab	4.5 ab
S2+0	26.3 b	44.2 bc	2.0	1.5 bc	4.7 ab	4.2 b
0+A1	37.3 ab	52.3 abc	2.0	1.8 a	5.4 a	5.0 ab
0+A2	26.3 b	59 a	2.0	1.5 bc	3.9 b	4.7 ab
CO	29.6 b	39.7 c	1.9	1.17 c	3.6 b	4.3 b
Signif-icance	*	**	N.S.	**	*	*

The same letter in each column are $*P \leq 0.05$; $**P \leq 0.01$; N.S., non-significant; different letters indicate signiflicant differences at $P \leq 0.05$.

were recorded in vines that treated with 0+A2, S1+A1. But the lowest bunch weight (103.3, 103.1 g) was produced in vines those treated with S1CO and S2+0 in both seasons respectively. Analysis of variance showed that SA and AA treatments had significant effects on bunch length table 3. The highest value (23.3, 21.6 cm) with vines treated by S1+0, S2+A1 in both seasons respectively and lowest (15.3, 14.3 cm) bunch width were recorded in vines that treated with S2+A1 and CO, respectively table 3. These results are in harmony with those of (Roustakhiz and Saboki, 2017) on Ruby grapevine, (Ahmed and Abdelaal, 2007) on Anna apple trees, (Khiamy, 2003; Wassel *et al.,* 2007 and Fayed 2010) on grapevines and El (Badway *et al.,* 2017) on Washington navel orange trees.

The impact of the different treatments on berry physical characteristics is showed in table 4 this result revealed that the significant effect of SA and AA in both seasons by all spraying treatments as compared with the control. A significant increase in berry number, length and average width the was obtained by spraying. The mean comparison of treatments showed that the average berry number per bunch was influenced by treatments and the lowest berry number was observed in 0+A2 (26.3) and CO (39.7) and the highest berry number was treatment S1+A2 (54) S1+A1 (63.4) in both seasons respectively. The increase of resistance to stress conditions under ascorbic acid application seems related to accumulation of abscisic acid in root, which is cause an adaptation to stress. Data demonstrated that, all treatments had significantly different values of average weight berry compared with the control treatment in both seasons, the maximum values in the first season, observed with 0+A1 and S1+A1 reached to of (5.4, 5.2), respectively, compared with the other treatments, while control value (3.6, 4.3) whereas, in both seasons.

In respect a berry length there were no significant differences between treatments and the control in the first season, whereas, in the second season recorded the lowest value (1.17), CO and the highest berry length was treatment 0+A1 (1.8 mm). The above results go online with those obtained by (EL-Rizk- *et al.,* 2013; Ibrahim and Abo-ELwafa, 2018) on Thompson Seedless.

Sugars (Total, reducing and Non-reducing sugars)

No significant differences for total sugars and reducing except nonreducing sugars were noticed table 5 showed significantly during the season 2018 for treatments, however during season 2019 the data declared that spraying the plants with SA and AA caused a significant increase between treatments. The maximum value in non-reducing sugars (7.4%) whereas, minimum value (5.6%) was recorded in S1+A2 and S2+A2 respectively. in case of Total sugar 0+A1 showed maximum (7.3 %) whereas minimum value (4.1 %) was noticed in 0+A2. The maximum reducing sugars (1.56 %) was observed in S1+A1 whereas minimum reducing was recorded (1.15 %) CO. Similar results have also reported by (Abbas Khan *et al.,* 2018).

Table 5: Effect of foliar application of salicylic acid and ascorbic acid on some chemical aspects, (total sugars percentage, Non-reducing sugars and Reducing sugars%) of grapevine during two growing seasons.

Treat-ments	Non-reducing sugars %		total sugar %		Reducing sugars %	
	2018	2019	2018	2019	2018	2019
S1+A1	4.8 abc	6.6 ab	5.59	6.2 abc	2.1	1.56 a
S1+A2	4.9 ab	5.6 b	12.24	6.1 abc	2.75	1.39 abc
S1+0	5.5 ab	5.7 ab	11.24	6.7 ab	1.94	1.36 bc
S2+A1	3.4 cd	5.7 b	12.93	4.6 de	2.43	1.35 bc
S2+A2	4.3 bc	7.4 a	6.09	5.5 bcd	2.86	1.29 cd
S2+0	6.2 a	7.1 ab	7.95	7.2 a	2.54	1.3 bc
0+A1	6.1 a	7.2 ab	4.4	7.3 a	2.53	1.48 ab
0+A2	2.8 d	6.4 ab	12.18	4.1 e	2.6	1.29 cd
CO	4.1 bcd	6.7 ab	7.86	4.6 de	1.77	1.15 d
Signif-icance	*	*	N.S.	**	N.S.	*

The same letter in each column are *P≤0.05; **P≤0.01; N.S., non-significant; different letters indicate signiflicant differences at P≤0.05.

Table 6: Effect of foliar application of salicylic acid and ascorbic acid on some physical and chemical aspects, (T.S.S%, juice pH and Firmness (g/cm) of grapevine during two growing seasons.

Treat-ments	T.S.S%		Juice pH		Firmness (g/cm)	
	2018	2019	2018	2019	2018	2019
S1+A1	19.8 cd	18.9 d	0.69	0.56 bc	-	6.1 Abc
S1+A2	20.7 a	20.5 bcd	0.81	0.73 ab	-	6.3 ab
S1+0	20.7 a	20.8 bc	0.86	0.59 abc	-	6.9 a
S2+A1	20 abc	20 bcd	0.66	0.69 abc	-	6.0 bcd
S2+A2	20.5 ab	21.3 ab	0.78	0.54 c	-	5.9 bcd
S2+0	19.3 d	22.9 a	0.66	0.64 abc	-	5.6 bcd
0+A1	19.5 cd	20.5 bcd	0.87	0.78 a	-	5.3 cd
0+A2	20.7 a	19.8 bcd	0.72	0.58 bc	-	5.3 de
CO	20 abc	19.4 cd	0.66	0.77 a		4.5 e
Signif-icance	*	**	N.S.	**		*

The same letter in each column are *P≤0.05; **P≤0.01; N.S., non-significant; different letters indicate signiflicant differences at P≤0.05.

Increase in TSS was generally noticed during tow season of study in all treated and untreated plants, However, 0+A2 had the highest TSS (22.9); where as S1+A1 showed minimum T.S.S (18.9) respectively table 6. The result showed that SA and AA had significant effect on the TSS of grapefruit. Our results regarding TSS are in agree with findings of (Abbas Khan *et al.,* 2018) that AA and SA application had significantly maintained the TSS of pear fruit. The recorded results of ascorbic acids on enhancing fruit quality are in harmony with earlier studies of (Ali, 2000); Ahmed *et al.,* 2002 and Abd El-Aziz, 2001) on Anna apples, (Hasaballa, 2002; Fayed 2010) on Manfalouty pomegranates and (Mansour *et al.,* 2010) on four mango cultivars, (Mohamed and Elbeery, 2019) on Fig tree the foliar application of ascorbic and citric acids could be used as management practices for improving water stress tolerance.

The results proved that, the best value of acidity% was found the control while the other treatments had insignificant differences between them and with the control in the two successive seasons Fig. 2.

As shown in table 6, although there were no significant differences between treatments with respect to their effect on juice pH, in the 1st season. However, the increase in the 2 st season with the high pH (0.78%) whereas 0+A1.

Data showed in table 6, cleared that, berry firmness was significantly affected with the application of SA and AA as well as compared to control in both seasons. The vines received the combination (S1+0) treatment showed the highest significant values as compared to other treatments at picking date in season 2019. (Sebastian *et al.,* 2019) detected the fruits treated with salicylic acid were positive affected to berry firmness compared to control.

The analysis of variance showed that foliar application of SA and AA significantly affected yield and acidity fruit of vine trees compared to untreated trees Fig. 1. However, maximum yield (2.6 and 6.6 kg/tree) was recorded with the treatments S1A1 and S2+A1 application in both seasons respectively. The minimum yield was recorded with the treatment application of control. This result is agreed with detected by (Mandal *et al.,* 2015). Suggested that the developing fruits need auxin in higher quantity and fruit drop and SA plays on important role in regulating number of physiological process including synthesis of auxin and/or cytokinin.

Proline content of the leaves. The plants treated with SA and AA had higher amount of proline as compared to the controls in both seasons. The increase of SA caused the increase in proline content Fig. 3. This data is harmony with detected by (Roustakhiz and Saboki, 2017), the application of SA with 2 mM concentration would increase antioxidant enzymes activities and therefore reduce the detrimental effects of drought stress.

Conclusion

We can conclude that exogenous spray of SA and AA could improve tree physiological responses to suboptimal water conditions and upon rewatering. Nevertheless, the parameters measured on vine trees revealed that the cultivar had a different response mechanism of the trees to the SA and AA foliar application resulted in improving the drought tolerance and recovery. The main conclusion that can be drawn is that the exogenous application of antioxidant improved the yield and quality under the water limited conditions of Matrouh region. Finally, the foliar spray of SA and AA with (3Mm and 6 mg L^{-1} respectively) during grapevines growth season can apply as a safe and environmentally friendly agrotechnical tool to improve growth and yield under semiarid region.

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