Studies on Advancing Berries Maturation and Promoting Grapes Quality of Some Grapevine Cultivars Grown Under Minia Region Conditions

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Abstract: Maturation date, yield / vine, berries colouration % berries, shattering %, cluster weight, total anthocyanins and both physical and chemical characteristics of grapevine cv., Flame seedless, Red Globe and Crimson seedless grown under Minia region conditions in response to treating the clusters with protone (10% ABA) at 250 to 1000 ppm, ethrel at 250 ppm and amino acids at 1 % either applied alone or in different combinations were investigated during 2017 and 2018 seasons. Single and combined applications of protone at 250 to 1000 ppm, ethrel at 250 ppm and amino acids at 1% once to veraison stage when approximately 10% of the berries on 50% of the clusters had softened resulted in measurable advancement in maturation date and promotion on berries colouration and berries quality compared to the control. In ascending order the best materials in this respect were amino acids, protone and Ethrel. Combined application were favourable than using each material alone in hastening fruit maturation and improving berries quality. Yield as well as weights of cluster and berries were unaffected by the present treatments. The most early in maturation date grape cvs could be arranged as follows in descending order Flame Red Globe and Crimson. The best results with regard to berries quality parameters were recorded on grapevine cvs crimson seedless, Flame seedless and Red Globe, in descending order. For solving the problem of uneven colouration of the berries in the clusters of Flame seedless, Red Globe and Crimson seedless grapevines grown under Upper Egypt region conditions, it is suggested to subject the clusters once at veraison stage when approximately 10% of the berries on 50% of the clusters on each vine had softened with a mixture of ethrel at 250 ppm, protone at 500 ppm and amino acids at 1%.

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1. Introduction

Many efforst were done for solving the problems of irregular colouraiton of coloured grapevine cvs Flame seedless, Red Globe and Crimson seedless under hot climates Nowadays, several trials were conducted to use amino acids as replacement of Ethrel and protone for advancing maturation date and promoting berries colouration grapevine cvs (**Davies, 1980**). The occurrence of this problem had negative effects on marketing of the fruits to local and foreign markets (**Orth *et al.,* 1993; Taiz and Zeiger, 2002. Zhang *et al.,* 2009 and Dal *et al.,* 2010**).

Previous studies showed that using amino acids (**Ahmed *et al.,* 2012; Abdelaal, 2012; Abdelaal *et al.,* 2013; El- Khawaga, 2014; Mohamed, 2014; Abdel aziz et al., 2017 and Mohamed, 2017);** ethrel (**Liu *et al.,* 2002, Omar and Girgis, 2005, El- Halaby, 2006; El- Sayed, 2007; Kassem, *et al.,* 2011; Aly, 2017 and Ibrahiem, 2018)** and ABA **(Geny et al., 2005; Koyama, 2010; Giribadi *et al.,* 2010; Strydom, 2014, Ferrara *et al.,* 2015, Yamamoto *et al.,* 2015 Lichter *et al.,* 2015, Casterllarin *et al.,* 2016, Aly, 2017 and Ibrahiem, 2018**) were very effective in advancing maturation date, berries colouration and grapes quality in different grape cvs.

The merit of this study was examining the effect of single and combined applications of amino acids, ethrel and protone as a source of ABA on maturation date, berries colouration and quality of berries in grapevines cvs Flame seedless, Red Globe and Crimson seedless grown under Minia region conditions.

2. Material and Methods

This study was carried out during the two consecutive seasons of 2017 and 2018 on ninety uniform in vigour own rooted 11 years old of grapevine cvs Flame seedless, Red Globe and Crimson seedless and grown in a private vineyard, namely El Karam, Talla village, Minia district, Minia

Governorate where the texture of the soil is clay.

The selected vines are planted at 1.5 x 3 meters apart. The chosen vines were trained by spur pruning system leaving 72 eyes/ vine (12 fruiting spurs x 5 eyes plus six replacement spurs x two eyes) using Gable supporting method. Winter pruning was conducted on the first week of Jan. during both seasons. Surface irrigation system was followed using Nile water containing 50 ppm salinity.

The selected vines (90 vines) received the same horticultural practiced that were already applied in the vineyard except application of Ethrel, proton and amino acid. These practices including the application of 10 tons FYM, (0.3% N), 240 kg ammonium nitrate, 150 kg calcium superphosphate (15.5 % P_2O_5) and 200 kg potassium sulphate (48 % K_2O) per one fedddan annually. F.Y.M was added once at the middle of Jan. Nitrogen fertilizer was added at three unequal batches as 37.5 % just after growth start, 37.5 % just after berry setting and 25% just after harvesting. Phosphate fertilizer was added once at the middle of Jan. Potassium fertilizers was applied twice at growth start (middle of Feb.) and again just after berry settin^g (middle of April) during both seasons. Another horticultural practices such as twice hoeings, irrigation, pinching and pest management were carried out as usual.

Table (1): Mechanical, physical and chemical analysis of the tested orchard soil:

Parameters	**Values**
Particle size distribution	
Sand %	10.0
Silt %	15.0
Clay %	75.0
Texture garde	Clay
pH (1: 2.5 extract)	7.59
E.C. (1: 2.5 extract) (mmhos/ 1cm 25°C)	0.81
O.M. %	2.11
$CaCO_3$%	2.4
Macronutrients values	
Total N %	0.09
P (Olsen method, ppm)	4.11
K (ammonium acetate, ppm)	419
Mg (ppm)	6.12
S (ppm)	2.20
EDTA extractable micronutrients (ppm):	
Zn	0.79
Fe	1.11
Mn	1.9
Cu	0.72

Soil is classified as clay in texture with water table depth not less than two meters deep. The results of orchard soil analysis according to **Wilde *et al.*, (1985)** are given in **Table (1).**

This experiment included thirty treatments from two factors (A & B). The first factor (A) comprised from three grapevine cvs namely a_1) Flame seedless, a_2) Red Globe and a_3) Crimson seedless. The second factor (B) contained the following ten treatments from single and combined applications of Ehrel at 250 ppm, proton at 250 to 1000 ppm and amino acids at 1%:

b_1- Control.
b_2- Spraying protone at 250 ppm (2.5 ml / L)
b_3- Spraying protone at 500 ppm (5.0 ml/L)
b_4- Spraying protone at 1000 ppm (10 ml/L)
b_5- Spraying ethrel at 250 ppm (0.52 ml/L)
b_6- Spraying amino acids at 1% ppm (10 ml/L)
b_7- Spraying protone at 500 ppm+ ethrel at 250
b_8- Spraying protone at 500 ppm + amino acids
b_9- Spraying ethrel at 250 ppm + amino acids
b_{10}- Spraying ethrel at 250 ppm + protone at 500 ppm + amino acids at 1%

Each treatment was replicated three times, one vine per each. Ethrel (48%) and Proton (10% ABA) were sprayed once at veraison stage when approximately 10% of the berries per cluster on 50% of the number of vine clusters had softened.

Triton B as a wetting agent was added at 0.05%. Spraying was done till clusters runoff.

Randomized complete block design (RCBD) was followed where the three grapevine cvs and the ten ethrel, protone and amino acid treatments occupied the whole and suplot, respectively. Each treatment was replicated three times, one vine per each.

For realizing the objectives of this study, the following parameters were recorded in response to application of Ethrel, Proton and amino acid.

1-Maturation time

It was calculated when T.S.S./acid reached 25:1

2-Yield per vine

The yield of each vine was recorded in terms of weight (in kg.), then the average weight of cluster (g.) was recorded. Five clusters per each vine were taken at random for determinations of the following physical and chemical characteristics of the berries:

1- Percentage of berries colouration by dividing number of red coloured berries by total number of berries per cluster and multiplying the product by 100.

2- Percentage of berries shattering by counting the number of dropped berries by the total number of berries per cluster and multiple the product by 100.

3- Average berry weight (g.) and dimensions (longitudinal and equatorial, cm).

4- Percentage of total soluble solids in the juice by using handy refractometer.

5- Percentage of total acidity (as gram tartaric acid / 100 ml juice) by titration against 0.1 N NaOH using phenolphthalein as indicator (**A.O.A.C**, **2000).**

6- The ratio between T.S.S. and acid.

7- Percentage of reducing sugars in the juice by using **Lane and Eynon (1965)** volumetric method as described in **A.O.A.C. (2000).**

8- Total phenols (**A.O.A.C., 2000**) and total anthocyanins in the berries by using ethyl alcohol and HCL method (mg /100 g F.W.) **(Fulcki and Francis, 1968).**

The proper statistical analysis was done. Treatment means were compared using new L.S.D. test at 5% (according to **Mead *et al.*, 1993.**

3. Results and Discussion

1- Maturation time

Data in Table (2) show the effect of single and combined application of protone, ethrel and amino acids on maturation date of grapevine cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Table (2): Effect of single and combined applications of protone, Ethrel and amino acids on maturation time and yield / vine of grapevines cvs Flame seedless Red Globe and C0rimson seedless during 2017 and 2018 seasons.

Protone, ethrel and amino acid treatments (B)	Maturation time								Yield/ vine (kg.)							
	2017				2018				2017				2018			
	a_1 Flame	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**
b_1 control	30/6	25/7	26/8		2/7	30/7	31/8		10	16	12	12.7	9.5	17.1	12.9	13.2
b_2 Proton at 250 ppm	22/6	17/7	18/8		24/6	22/7	23/8		10	16	12	12.7	9.4	17.0	12.9	13.1
b_3 Protone at 500 ppm	19/6	14/7	15/8		21/6	19/7	20/8		9.9	16	12	12.7	9.4	17.0	12.8	13.1
b_4 Protone 1000 ppm	16/6	11/7	12/8		18/6	16/7	16/8		9.8	16	12	12.7	9.4	17.0	12.8	13.1
b_5 Ethrel at 250 ppm	9/6	4/7	5/8		11/6	9/7	21/8		9.8	16	11.9	12.6	9.4	17.0	12.8	13.1
b_6 Amino acids at 1%	27/6	20/7	23/8		30/6	27/7	27/8		10.0	16	11.9	12.7	9.5	16.9	12.8	13.0
b_7 Protone at 500 ppm + Ethrel	2/6	27/6	28/7		4/6	2/7	3/8		9.7	16	11.9	12.5	9.4	16.9	12.8	13.0
b_8 Protone at 500 ppm + amino acid	7/6	2/7	3/8		9/6	7/7	8/8		9.8	15.8	11.8	12.5	9.4	16.9	12.8	13.0
b_9 Ethrel + amino acids	5/6	30/6	1/8		7/6	6/7	5/8		9.8	15.8	11.8	12.5	9.5	16.9	12.8	13.0
B10 Ethrel + 500 ppm proton + amino\	29/5	25/6	25/7		31/5	28/6	1/8		9.8	15.8	11.8	12.5	9.5	16.9	12.8	13.0
Mean (A)	8/6	26/6	-						9.9	15.9	11.9		9.4	17.0	12.8	13.0
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
									2.1	Ns	Ns		2.3	NS	NS	

It is clear from the obtained data that maturation time was greatly varied among the three grapevine cvs Flame seedless, Red Globe and Crimson seedless. It was advanced in grapevine cvs Flame seedless, Red Globe and Crimson seedless in descending order. The early in maturation time grapevine was Flame seedless and the late one was Crimson seedless. Grapevine cvs Red Glove was in between. These results were true during both seasons.

Maturation time was materially hastened with using protone at 250 to 1000 ppm, ethrel at 250 ppm and amino acid at 1% either applied alone or in combination compared to the control treatment. Maturation date was measurably advanced gradually with increasing concentrations of protone from 250 to 1000 ppm. Using amino acids at 1%, protone at 250 to 1000 ppm and ethrel at 250 ppm, in ascending maturation date. Combined applications of protone, ethrel and amino acids was materially advanced maturation time than using each material alone. Combined application using two materials together gave an outstanding promotion on maturation time than using each material alone. The best double application treatment was the application of protone at 500 ppm plus ethrel at 250 ppm. Using protone at 500 ppm, ethrel at 250 ppm and amino acid at 1% gave a great advancement on maturation date. These results were true during both seasons.

Maturation date was highly affected by the interaction between protone, ethrel, amino acids and different grapevine cvs. The great advancement on maturation date was recorded on grapevine cv Flame seedless treated with protone at 500 ppm, ethrel at 250 ppm and amino acid at 1% together. Under such promised treatment, maturation date was 29 and 31 May during both seasons, respectively. The untreated Crimson seedless grapevines matured on 26 and 31 August during both seasons, respectively. Similar trend was noticed during both seasons.

2- The yield / vine

Data in Table (2) show the effect of single and combined applications of protone, ethrel and amino acids on the yield/ vine of grapevine cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Yield/ vine was significantly affected among the three grapevine cvs. It was significantly maximized in grapevine cvs Flame seedless, Crimson seedless and Red Globe, in ascending order. The grapevine cv Red Globe recorded the higher yield relative to the other grapevine cvs Flame seedless and Crimson seedless. The grapevine cv Crimson seedless ranked the second position in this respect. The grapevine cv. Flame seedless occupied the last position in this connection. Similar trend was noticed during both seasons.

Single and combined applications of protone at 250 to 1000 ppm, ethrel at 250 ppm amino acids at 1% caused unsignificant promotion on the yield / vine relative to the control treatment. These results were true during both seasons.

The interaction between proline, ethrel and amino acids from one side and the grapevine cvs from the other side had significant effect on the yield. The maximum yield (16.0 & 17.0 kg) was recorded on the untreated vine cv. Red Globe during 2017 and 2018 seasons, respectively. These results were true during both seasons.

3- The percentage of berries colouration

Data in Table (3) show the effect of single and combined application of protone, ethrel and amino acids on berries colouraiton % of grapevine cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Table (3): Effect of single and combined applications of protone, Ethrel and amino acids on the percentage of berries colouration and shattering of grapevines cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Protone, ethrel and amino acid treatments (B)	Berries colouration %								Berries shattering %							
	2017				2018				2017				2018			
	a_1 Flame	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**
b_1 control	70.5	50.5	40.5	53.8	71.2	51.2	41.4	54.6	6.5	2.9	8.9	5.8	7.0	3.1	9.2	6.4
b_2 Proton at 250 ppm	75.0	54.9	45.0	58.3	75.8	55.9	45.9	59.2	6.7	3.1	9.1	6.3	7.3	3.3	9.4	6.7
b_3 Protone at 500 ppm	77.1	57.0	47.0	60.4	78.0	58.0	47.8	61.3	6.8	3.1	9.2	6.4	7.4	3.3	9.5	6.7
b_4 Protone 1000 ppm	80.0	59.0	55.1	64.7	80.9	60.0	55.9	65.6	6.9	3.2	9.3	6.5	7.5	3.4	9.6	6.8
b_5 Ethrel at 250 ppm	82.9	61.6	51.6	65.4	84.0	62.6	52.5	66.4	7.0	3.3	9.4	6.6	7.5	3.4	9.6	6.8
b_6 Amino acids at 1%	72.6	52.6	42.9	56.0	73.6	53.7	44.0	57.1	6.6	3.0	9.0	6.2	7.2	3.2	9.3	6.6
b_7 Protone at 500 ppm + Ethrel	90.0	70.0	64.5	74.8	90.9	70.9	65.9	75.9	7.3	3.6	9.0	6.6	7.7	3.5	9.7	7.0
b_8 Protone at 500 ppm + amino acid	85.0	64.0	55.0	68.0	86.0	65.0	56.0	69.0	7.1	3.4	9.5	6.7	7.6	3.5	9.6	6.9
b_9 Ethrel + amino acids	87.0	66.0	57.0	70.0	87.9	67.0	57.8	70.9	7.2	3.5	9.5	6.7	7.7	3.5	9.7	7.0
B10 Ethrel + 500 ppm proton + amino\	92.1	71.9	66.0	76.7	93.0	74.9	69.9	78.3	7.4	3.4	9.5	6.8	7.7	3.6	9.7	7.0
Mean (A)	81.2	60.4	51.9		82.1	62.4	53.7		7.0	3.3	9.2		7.5	3.4	9.5	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	1.1	1.7	2.9		1.5	1.9	3.3		1.9	NS	NS		2.1	NS	NS	

Percentage of berries colouration was significantly varied among the three grapevine cvs namely Flame seedless, Red Globe and Crimson seedless. Grapevine cv Flame seedless recorded the highest values of berries colouration % among the other grapevines. The lowest values were recorded on the grapevine cv. Crimson seedless. These results were true during both seasons.

Single and combined applications of protone at 250 to 1000 ppm, ethrel at 250 ppm and amino acids at 1% significantly was followed by enhancing berries colouration compared to the check treatment. Increasing concentrations of protone from 250 to 1000 ppm significantly caused a gradual promotion on berries colouration % in the three grapevine cvs. Treating the clusters of the three grapevine cvs with ethrel, protone and amino acids, in descending was significantly responsible for advancing berries colouration %. Combined applications of the previous three materials were significantly favourable in enhancing berries colouration than application of each material alone. Using the three materials namely ethrel at 250 ppm, protone at 500 ppm and amino acids at 1% gave the maximum values of berries colouration %. The untreated vines produced the lowest values. These results were true during both seasons.

Percentage of berries colouration was significantly enhanced due to the investigated interaction. The maximum values of berries colourations (92.1 & 93.0%) were recorded on the grapevine cv. Flame seedless treated with ethrel at 250 ppm + protone at 500 ppm + amino acids at 1% during both seasons, respectively. The untreated Crimson seedless grapevine recorded the lowest values (40.5 & 41.4%) during 2017 and 2018 seasons, respectively. Similar trend was noticed during both seasons.

4- The percentage of berries shattering

Data in Table (4) show the effect of single and combined application of protone, ethrel and amino acids on the percentage of berries shattering of grapevine cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Berries shattering % was significantly varied among the three grapevine cvs. It was maximized in grapevine cv Crimson seedless grapevines and minimized in grapevine cv Red Globe. These results were true during both seasons.

Varying ethrel, protone and amino acid treatments had no significant effect on the percentage of berry shattering. These results were true during both seasons.

The investigated interaction had significant effect on the percentage of berries shattering during both seasons. The maximum values of berries shattering % were observed in grapevine cv Crimson seedless regardless the application of ethrel, proton and amino acid treatment. The lowest values were recorded on grapevines cv. Red Globe regardless the application of the studied materials. These results was nearly the same during both seasons.

5- The average cluster weight

Data in Table (5) show the effect of single and combined application of protone, ethrel and amino acids on the average cluster weight of grapevine cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Varying grapevine cvs had significant effect on the average cluster weight. The maximum values were recorded on grapevine cv. Red Globe grapevine cv. Flame seedless grape cv gave the minimum values. These results were true during both seasons.

Average cluster weight was significantly unaffected by varying ethrel, protone and amino acid treatment during both seasons.

The studied interaction had significant effect on the average cluster weight. Using any treatments with Red Globe grapevine cvs gave he maximum values. The grapevine cv Flame seedless grapevines treated with any treatment gave the lowest values. Similar trend was noticed during both seasons.

6- Physical and chemical characteristics of the berries

Data in Tables (5 & 6) show the effect of single and combined application of protone, ethrel and amino acids on the TSS, reducing sugars %, T.S.S/ acid Titratable acidity %, Total phenols, Total anthocyanins in the juice and cluster of berry weight and dimensions of grapevine cvs Flame, Red Globe and Crimson during 2017 and 2018 seasons.

6-1 Berry weight and dimensions

Averages berries weight and dimensions (equatorial and longitudinal) were significantly varied among the three grapevines cvs. The maximum values were recorded on grapevine cv Red Globe. Similar trend was noticed during both seasons.

Average berry weight and dimensions were significantly unaffected by ethrel, protone and amino acid treatments during both seasons.

Significant effect on berry weight and dimensions was attributed to the investigated interaction. The maximum values were recorded on grapevine cv Red Globe regardless the application of ethrel, protone and amino acid treatments. The grapevine cvs Flame seedless sand Crimson seedless regardless the studied treatment recorded the lowest values. These results were true during both seasons.

6-2 Total soluble solids, reducing sugars % and T.S.S/ acid

Varying grapevine cvs had significant effect on T.S.S. %, reducing sugars % and T.S.S. /acid in the grapes. The maximum values were recorded on grapevine cv. Crimson seedless, Grapevine cv Red Globe achieved the lowest values. Grapevine cv. Flame seedless occupied the second position in this respect. These results were true during both seasons.

Single and combined applications of ethrel at 250 ppm, protone at 250 to 1000 ppm and amino acids at 1% significantly enhanced T.S.S. %, reducing sugars and T.S.S./ acid relative to control. The promotion on these chemical traits was significantly in proportional to the increase in protone concentrations from 250 to 1000 ppm. Using ethrel, protone and amino acids, in descending order was significantly very effective in enhancing these chemical characteristics. These results were true during both seasons.

Total soluble solids %, reducing sugars % and T.S.S./ acid were significantly affected by the interaction between grapevines, cvs and material treatments. The maximum values were recorded on the grapevine cv. Crimson seedless subjected to ethrel at 250 ppm, protone at 500 ppm and amino acids at 1%. The lowest values were recorded on untreated grapevine cv Red Globe. These results were true during both seasons.

6-3 Titratable acidity %

Tritratable acidity was significantly varied among the three grapevine cvs. It was maximized in grapevine cv Red Globe and minimized in grapevine cv. Flame seedless in the first season and Crimson seedless in the second one. Similar trend was noticed during both seasons.

It was significantly reduced with single and combined applications of ethrel at 250 ppm, protone at 250 to 1000 ppm and amino acids at 1% relative to the control. There was a gradual reduction on such chemical characteristic with increasing protone concentrations from 250 to 1000 ppm. Using ethrel at 250 ppm was significantly favourable than the other two material in reducing titratable acidity protone significantly ranked the second position and amino acids occupied the last position in this respect. Combined application were significantly favourable than using each material alone in this connection. The lowest values were recorded on the vines treated with ethrel at 250 ppm, proton at 500 ppm and amino acids at 1%.

It is worth to mention that the lowest values of titratable acidity were recorded on grapevine cv. Flame seedless treated with ethrel at 250 ppm, protone at 500 ppm and amino acids at 1%. The highest values were recorded on untreated Red Globe grapevines. These results were true during both seasons.

6-3 Total phenols

Total phenols in the juice was significantly varied among the three grapevine cvs. It was maximized in grapevine cv Red Globe and minimized in grapevine cv Crimson seedless. These results were true during both seasons.

Total phenols was significant declined with using ethrel at 250 ppm, protone at 250 to 1000 ppm and amino acids at % either application alone or in combination. Using ethrel was significantly favourable than application of protone or amino acids in reducing total phenols. The lowest values were recorded on the vine that received ethrel at 250 ppm, potone at 500 ppm and amino acids at 1%. The untreated vines produced the maximum values.

The studied combination had signfiicant effect on the juice total phenols. The lowest values of total phenols were recorded on grapevine cv Crimson seedless treated with ethrel at 250 ppm, protone at 500 ppm and amino acids at 1%. The untreated Red Globe grapevines produced the highest values. Similar trend were detected during both seasons.

6-4 Total anthocyanins in the juice

Varying grapevine cvs had significant effect on total anthocyanins in the juice. The highest content was observed in grapevine cv. Flame seedless. Grapevine cv. Crimson seedless gave the lowest values. In between effect was appeared in grapevine cv. Red Globe grape cv. Similar trend was noticed during both seasons.

It is evident from the obtained data that subjecting the vines of the tree grapevine cvs once with ethrel at 250 ppm, prone at 250 to 1000 ppm and amino acids at 1% either singly or in combinations significantly was very effective in enhancing the total anthocyanins relative to the control. The promotion was significantly associated with using amino acids, protone and ethrel, in ascending order. Combined applications were preferable than using each material alone in enhancing total anthocyanins,. The maximum values were detected on the vines that treated with ethrel at 250 ppm, protone at 500 ppm and amino acids at 1%. The untreated vines produced the lowest values.

The highest values of total anthocyanins were recorded on grapevine cv. Flame seedless treated with ethrel at 250 ppm, protone at 500 ppm and amino acids at 1%. The untreated Crimson seedless grapevine gave the lowest values. Similar trend was noticed during both seasons.

Table (4): Effect of single and combined applications of protone, Ethrel and amino acids on average cluster weight and berry weight of grapevines cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Protone, ethrel and amino acid treatments (B)	Average cluster weight								Average berry weight							
	2017				2018				2017				2018			
	a_1 Flame	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**	**a_1 Flame**	**a_2 Red**	**a_3 Crimson**	**Mean (B)**
b_1 control	450.0	994.0	600.0	681.3	471.0	998.0	611.3	693.3	5.91	11.21	4.22	7.11	5.94	11.31	4.50	7.25
b_2 Proton at 250 ppm	450.0	994.0	600.0	681.3	471.0	998	611.3	693.4	5.91	11.21	4.22	7.11	5.93	11.30	4.45	7.24
b_3 Protone at 500 ppm	449.0	993.0	599.0	680.3	470.0	997	611.3	692.8	5.90	11.20	4.21	7.10	5.93	11.30	4.48	7.24
b_4 Protone 1000 ppm	449.0	993.0	599.0	680.3	470.0	997	611.0	692.7	5.89	11.19	4.20	7.09	5.92	11.29	4.47	7.23
b_5 Ethrel at 250 ppm	449.0	993.0	598.0	680.3	469.0	996	610.0	691.7	5.89	11.19	4.20	7.09	5.92	11.29	4.47	7.23
b_6 Amino acids at 1%	450	994	600	681.3	471	998	611.3	693.4	5.91	11.21	4.22	7.11	5.94	11.31	4.50	7.25
b_7 Protone at 500 ppm + Ethrel	448.0	992.0	597.0	679.0	467.0	994	608	689.7	5.87	11.17	4.17	7.07	5.90	11.27	4.45	7.21
b_8 Protone at 500 ppm + amino acid	448.0	992.0	597.0	679.0	468.0	995	609	690.7	5.88	11.18	4.19	7.08	5.91	11.28	4.46	7.22
b_9 Ethrel + amino acids	448.0	992.0	597.0	679.0	468.0	995	609	690.7	5.88	11.18	4.18	7.09	5.91	11.28	4.46	7.22
B10 Ethrel + 500 ppm proton + amino\	446.0	990.0	546.0	677.3	465	993	608	688.7	5.85	11.16	4.15	7.05	5.88	11.25	4.43	7.19
Mean (A)	449.7	992.7	598.3		469.0	996.1	610.0		5.89	11.19	4.20		5.92	11.92	4.47	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	9.1	NS	13.1		8.9	NS	12.8		1.11	NS	1.81		1.01	NS	1.41	

Table (5): Effect of single and combined applications of protone, Ethrel and amino acids on average longitudinal and equatorial of berry of grapevines cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Protone, ethrel and amino acid treatments (B)	Average berry longitudinal (cm)								Average berry equatorial (cm)							
	2017				2018				2017				2018			
	A_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)
b_1 control	2.11	2.51	2.1	2.24	2.11	2.49	2.13	2.24	1.79	2.49	1.71	2.00	1.81	2.51	1.72	2.01
b_2 Proton at 250 ppm	2.10	2.50	2.10	2.23	2.10	2.49	2.13	2.24	1.79	2.49	1.72	2.00	1.82	2.52	1.73	2.02
b_3 Protone at 500 ppm	2.10	2.50	2.10	2.23	2.10	2.49	2.13	2.24	1.79	2.48	1.71	1.99	1.81	2.51	1.72	2.01
b_4 Protone 1000 ppm	2.09	2.49	2.09	2.22	2.10	2.44	2.13	2.22	1.79	2.48	1.71	1.99	1.81	2.31	1.72	1.95
b_5 Ethrel at 250 ppm	2.09	2.49	2.09	2.22	2.09	2.43	2.12	2.21	1.78	2.47	1.70	1.98	1.80	2.30	1.71	1.94
b_6 Amino acids at 1%	2.11	2.51	2.11	2.24	2.11	2.50	2.14	2.25	1.80	2.50	1.72	2.01	1.82	2.52	1.73	2.02
b_7 Protone at 500 ppm + Ethrel	2.07	2.47	2.06	2.20	2.09	2.42	2.11	2.21	1.77	2.46	1.65	1.97	1.79	2.29	1.69	1.92
b_8 Protone at 500 ppm + amino acid	2.08	2.48	2.08	2.21	2.09	2.42	2.11	2.21	1.78	2.47	1.70	1.98	1.79	2.29	1.70	1.93
b_9 Ethrel + amino acids	2.10	2.50	2.07	2.22	2.09	2.42	2.11	2.21	1.77	2.47	1.69	1.98	1.79	2.29	1.70	1.93
B10 Ethrel + 500 ppm proton + amino\	2.06	2.46	2.09	2.19	2.07	2.40	2.10	2.19	1.77	2.46	1.68	1.97	1.78	2.28	1.68	1.91
Mean (A)	2.09	2.49	2.09		2.10	2.45	2.12		1.78	2.48	1.70		1.80	2.38	1.71	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	0.27	NS	0.31		0.22	NS	0.25		0.41	NS	0.61		0.30	NS	0.59	

Table (6): Effect of single and combined applications of protone, Ethrel and amino acids on the percentage of total soluble solids and reducing sugars in the grapes of grapevines cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Protone, ethrel and amino acid treatments (B)	T.S.S. %								Reducing sugars %							
	2017				2018				2017				2018			
	A_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)
b_1 control	16.0	14.1	19.1	16.4	16.3	14.5	19.5	16.8	14.4	12.7	17.2	14.8	14.7	13.1	17.6	15.1
b_2 Proton at 250 ppm	16.8	14.9	19.9	17.2	17.1	15.3	20.3	17.6	15.1	13.4	17.9	15.5	15.4	13.8	18.3	15.8
b_3 Protone at 500 ppm	17.2	15.3	20.3	17.6	17.5	15.7	20.7	18.0	15.5	13.8	18.3	15.9	15.8	14.1	18.6	16.2
b_4 Protone 1000 ppm	17.5	15.6	20.6	17.9	17.9	16.1	21.1	18.4	15.8	14.0	18.5	16.1	16.1	14.5	19.0	16.5
b_5 Ethrel at 250 ppm	18.0	16.1	21.1	18.4	18.3	16.5	21.5	18.8	16.2	14.5	19.0	16.6	16.5	14.9	19.4	16.9
b_6 Amino acids at 1%	16.3	14.4	19.4	16.7	16.6	14.8	19.8	17.1	14.7	13.0	17.5	15.1	14.9	13.3	17.8	15.3
b_7 Protone at 500 ppm + Ethrel	19.1	17.2	22.2	19.5	19.4	17.6	22.6	19.9	17.2	15.5	20.0	17.6	17.5	15.8	20.3	17.9
b_8 Protone at 500 ppm + amino acid	18.5	16.6	21.6	18.9	18.8	17.0	22.0	19.3	16.7	14.9	19.4	17.0	16.9	15.3	19.8	17.3
b_9 Ethrel + amino acids	18.8	16.9	21.9	19.2	19.1	17.3	22.3	19.6	16.9	15.2	19.7	17.3	17.2	15.6	20.1	17.6
B10 Ethrel + 500 ppm proton + amino\	19.5	17.6	22.6	19.9	19.8	18.0	23.0	20.3	17.6	15.8	20.6	18.0	17.8	16.2	20.7	18.2
Mean (A)	17.9	15.9	20.3		18.1	16.3	21.3		16.0	14.3	18.8		16.3	14.7	19.2	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	

Table (7): Effect of single and combined applications of protone, Ethrel and amino acids on titratable acidity % and T.S.S. /acid of in the grapes of grapevines cvs Flame seedless, Red Globe and Crimson seedless during 2017 and 2018 seasons.

Protone, ethrel and amino acid treatments (B)	Maturity time								Yield/ vine (kg.)							
	2017				2018				2017				2018			
	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)
b_1 control	0.640	0.738	0.569	0.649	0.657	0.755	0.589	0.667	25.0	19.1	33.6	25.9	24.8	19.2	33.1	25.7
b_2 Proton at 250 ppm	0.600	0.698	0.529	0.609	0.620	0.718	0.564	0.634	28.0	21.4	37.6	29.1	27.6	21.3	27.7	28.9
b_3 Protone at 500 ppm	0.580	0.678	0.509	0.589	0.600	0.698	0.544	0.614	29.7	22.6	39.9	30.7	39.2	22.5	38.1	32.2
b_4 Protone 1000 ppm	0.561	0.659	0.489	0.570	0.580	0.678	0.524	0.598	31.2	23.7	42.1	32.3	30.9	23.8	40.3	31.7
b_5 Ethrel at 250 ppm	0.541	0.639	0.469	0.550	0.560	0.658	0.504	0.574	33.3	25.2	45.0	34.5	32.7	25.1	42.7	33.4
b_6 Amino acids at 1%	0.620	0.700	0.549	0.623	0.640	0.738	0.584	0.654	30.8	20.6	35.3	28.9	36.0	20.1	34.0	26.7
b_7 Protone at 500 ppm + Ethrel	0.471	0.651	0.499	0.540	0.500	0.600	0.444	0.515	40.6	26.4	44.5	37.2	38.8	29.3	51.0	39.7
b_8 Protone at 500 ppm + amino acid	0.510	0.691	0.532	0.578	0.540	0.638	0.484	0.554	36.3	24.0	40.6	26.3	36.2	26.7	45.5	36.1
b_9 Ethrel + amino acids	0.490	0.671	0.512	0.558	0.520	0.618	0.464	0.534	35.4	25.2	42.8	35.5	36.7	28.0	48.1	37.6
B10 Ethrel + 500 ppm proton + amino\	0.451	0.630	0.472	0.518	0.480	0.582	0.424	0.495	43.2	27.9	47.0	39.4	41.3	31.0	54.3	42.2
Mean (A)	0.546	0.697	0.562		0.570	0.668	0.513		33.3	23.6	40.8		36.4	27.4	41.5	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	0.041	0.018	0.031		0.039	0.017	0.030		1.9	1.2	2.1		2.0	1.0	1.7	

Table (8): Effect of single and combined applications of protone, Ethrel and amino acids on total phenols and total anthocyanins in the juice of grapevines cvs Flame seedless, red Globe and Crimson seedless during 2017 and 2018 seasons.

Protone, ethrel and amino acid treatments (B)	Total phenols (mg/ g F.W.)							
	2017				2018			
	A_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)
b_1 control	4.71	5.11	4.11	4.64	4.60	5.00	3.99	4.53
b_2 Proton at 250 ppm	4.20	4.60	3.60	4.14	4.18	4.58	3.57	4.11
b_3 Protone at 500 ppm	4.00	4.40	3.40	5.93	4.00	4.40	3.39	3.93
b_4 Protone 1000 ppm	3.00	4.20	3.20	3.73	3.71	4.11	3.10	3.64
b_5 Ethrel at 250 ppm	3.51	3.91	2.91	3.44	3.41	3.81	2.80	3.34
b_6 Amino acids at 1%	4.50	4.90	3.90	4.43	4.41	4.81	3.80	3.34
b_7 Protone at 500 ppm + Ethrel	2.88	3.28	2.28	2.81	2.71	3.11	2.10	2.64
b_8 Protone at 500 ppm + amino acid	3.30	3.70	2.70	3.23	3.20	3.60	2.59	3.13
b_9 Ethrel + amino acids	3.10	3.50	2.50	3.03	3.00	3.40	2.39	2.93
B10 Ethrel + 500 ppm proton + amino\	2.11	2.51	1.51	2.04	3.09	2.49	1.48	2.02
Mean (A)	3.61	4.01	3.01		3.53	3.93	2.92	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	0.14	0.16	0.28		0.18	0.14	0.24	

Protone, ethrel and amino acid treatments (B)	Total anthocyanins (mg / g F.W.)							
	2017				2018			
	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)	a_1 Flame	a_2 Red	a_3 Crimson	Mean (B)
b_1 control	15.29	12.11	9.22	12.21	16.00	12.81	10.09	12.97
b_2 Proton at 250 ppm	18.50	15.32	12.43	15.42	20.10	16.91	14.19	17.07
b_3 Protone at 500 ppm	19.80	16.62	13.73	16.72	22.11	18.92	16.20	19.08
b_4 Protone 1000 ppm	21.81	17.91	15.02	18.01	25.00	21.81	19.09	22.00
b_5 Ethrel at 250 ppm	22.99	19.81	16.92	19.91	28.11	24.92	22.28	25.08
b_6 Amino acids at 1%	17.0	13.82	10.93	13.92	18.09	14.90	12.18	15.06
b_7 Protone at 500 ppm + Ethrel	28.31	25.1	22.21	25.21	35.1	31.91	29.14	32.07
b_8 Protone at 500 ppm + amino acid	25.00	21.82	18.93	21.92	29.96	26.77	24.05	26.84
b_9 Ethrel + amino acids	26.22	23.0	20.11	23.11	32.11	28.92	16.2	29.08
B10 Ethrel + 500 ppm proton + amino\	31.96	28.78	25.89	28.88	26.28	33.11	30.39	33.27
Mean (A)	22.61	19.43	16.54			23.10	20.38	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	0.22	1.00	1.73		1.33	1.11	1.92	

4. Discussion

1- Effect of protone and Ethrel:

The acceleration on maturation of Flame seedless, Red Globe and Crimson seedless grapes due to application of Ehrel could be attributed to the break down of Ethrel to ethylene which results in activation the hydrolytic and oxidative enzymes involved in maturation, increasing the degradation of chlorophylls and promoting the biosynthesis of plant pigments namely anthocyanins and carotenoids and hastening the compartmentation. In addition, ethrel is effective in increasing mitochondrial oxidation of malic acid (**Dal *et al.,* 2010**).

The effect of ABA in enhancing maturation of the berries might be attributed to its effect as main signal triggering the onset of the secondary metabolism in grape skine as well as enhancing the enzymes especially UPP- Glucose – Flavonic 3-O Glucose –T (**Zhang *et al.,* 2009**). The beneficial effects of ABA in reaching the plant tissues to senescence could give another explanation (**Taiz and Zeiger, 2002**).

These results regarding the effect of ethrel are in concordance with **Liu *et al.,* (2002),** on Cabernet Sauvignon grapes; **Strydom (2014),** on Flame seedless grapes, **Ibrahiem (2018)** on Crimson seedless grapes. **The results of Ferrara *et al.,* (2015)** on Crimson seedless grapes**, Lichter *et al.,* (2015)** on Flame seedless grapes and **Castellarin *et al.,* (20156)** on Thompson seedless grapes supported the present results.

2- Effect of amino acids:

Amino acids as organic nitrogenous compounds are the building blocks in the synthesis of proteins, which are formed by as process in which ribosomes catalyze the polymerization of amino acids (**Davies, 1982**). Several hypothesis have been proposed the explain for the role of amino acids in plant. Available evidence suggests several alternative routes of IAA and ethylene synthesis in plants, starting from amino acid (**Davies, 1982**). In this respect, (**Taiz and Zeiger, 2002**) suggested that the regulatory effect of certain amino acids like phenylalanine and ornithine in plant development appeared through their influence on the biosynthesis of gibberellins, tryptophane and methionine in building of IAA and ethtlene respectively.

The results regarding the promoting effect of amino acids on maturation date, berries colouration, total athocyanins and fruit quality are in agreement with those obtained by **Ahmed *et al.,* (2012); Abdelaal (2012), Abdelaal *et al.,* (2013)** on Thompson seedless grapes, **El- Khawaga (2014) and Mohamed (2014)** on Superior grapes and **Abdel- Aziz *et al.,* (2017) and Mohamed (2017)** on Flame seedless grapes.

Conclusion

For overcoming irregular colouration of clusters, advancing berries maturation and improving berries quality of the three grapevine cvs Flame seedless, Red Globe and Crimson seedless grown under Minia region conditions, it is preferable for treating clusters with ethrel at 250 ppm, protone at 500 ppm and amino acids (tryptophane + methionene + cysteine) at 1% when approximately 10% of the berries on 50% of the clusters had softened (Veraison stage).

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