Attempts for Reducing Alternate Bearing in Balady Mandarin Trees by Spraying Some Amino Acids and Vitamins

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Abstract : During 2012 and 2013 seasons, Balady mandarin trees on two fruiting states namely off and on years received there sprays of vitamins K, E, D, A and B complex (B_1+B_2+B_6+ B_{12}) each at 50 ppm and amino acids namely methionene, tyrptophan and cystene at 0.05 %. The target was finding out the relation between fruiting state and using these antioxidants. Single and combined applications of all vitamins and amino acids was favourable in enhancing growth, vine nutritional status, yield as well as physical and chemical characteristics of the fruits rather than non- application. A great reduction on alternate bearing was observed with using all vitamins and amino acids together three times. Using amino acids was superior than using vitamins in this respect. Using all vitamins and amino acids was superior than using each alone in this respect. Treating Balady mandarin trees on off year fruiting state three times with a mixture of vitamins K, E, D, A and B (B_1+B_2+B_6+ B_{12}) and amino acids (methionene, tyrptophan and cystene) at 0.05 % was very effective in controlling alternate bearing and at the same time improving yield and fruit quality.

[Faissal F.A.; Moawad, A.M., Yousef, A.H. and Hassan, S.H.E. **Attempts for Reducing Alternate Bearing in Balady Mandarin Trees by Spraying Some Amino Acids and Vitamins.** *World Rural Observ* 2014;6(2):48-57]. ISSN: 1944-6543 (Print); ISSN: 1944-6551 (Online). http://www.sciencepub.net/rural. 8

Keywords: Balady mandarin trees, vitamins, amino acids, alternate bearing, yield and fruit quality.

1. Introduction

Unbalancing bearing from year to year or alternate bearing character in Balady mandarin trees is considered genetic phenomenon. It is negatively affect the yield especially in off years. For alleviating the reduction on yield partially in off years many trials were conducted to know nutritional status of the trees in such years and the balance occurred between different organic and mineral nutrients.

An antioxidant as a molecule capable of inhibiting the oxidation of other molecules oxidation is a chemical reaction that transfers electron from a substance to an oxidizing agent. Oxidation reactions can produce free radicals. In turn, these radicals can start chain reaction that may damage cells. Antioxidants terminate this chain reaction by removing free radical intermediates and inhibit other oxidation reactions. So, antioxidants are considered as reducing agents such as amino acids and different vitamins. Antioxidant system superoxide dismutase, catalase, ascorbate peroxidade, dehydro ascorbare reductase and glutathione reductase may participate in delaying membrance lipid peroxidation (**Sies, 1997; Sandermann *et al*, 1998; Klesiig *et al.* 2000 and Ren-Hua- Huang, *et al.*, 2008**).

Vitamins with their antioxidative properties play an important role in plant defense against oxidative stresses induced by unfavourable conditions. Application of vitamins is accompanied with enhancing alpha keto glutaric acid biosynthesis which is unite with ammonia to form amino acids and proteins. They are favourable in protecting the plant cells from senescence and death, preventing the free radicals from oxidation of lipids the components of plasma membrane which is accompanied with the loss of permeability, and controlling the incidence of disorders. They are responsible for stimulating the biosynthesis of proteins, natural hormones like cytokinines and GA_3, cell division, organic foods, enzymes and amino acids. These positive actions surely reflected on producing healthy trees (**Oretili, 1987; Prusky, 1988; Samiullah *et al,* 1988; Vianello and Marci, 1991 and Elade, 1992**).

Amino acids as organic nitrogenous compounds are the building blocks in the synthesis of proteins, which are formed by a process in which ribosomes catalyze the polymerization of amino acids (**Davies, 1982**). Several hypothesis have been proposed to explain the role of amino acids in plant growth. Available evidence suggests several alternative routes of IAA and ethylene synthesis in plants, starting from amino acids (**Hashimoto and Yamada, 1994**). In this respect, **Waller and Nowaki (1978)** suggested that the regulatory effect of certain amino acids like phenylalanine and ornithine on plant development is through their influence on gibberellins biosynthesis.

Using vitamins and amino acids in different evergreen fruit crops was accompanied with enhancing fruiting (**Hamad- Mona, 2011, Hegab and Hegab, 2011; Merwad, 2011, Saied, 2011; Roshdy *et al.,***

2011; Masoud and El- Sehrawy, 2012 Abd El-Rahman and El- Masry, 2012; Ahmed *et al.*, 2013, Rizk, 2013, Ibrahiem *et al,* 2013; El- Badawy and Abd El-aal, 2013; Fathalla, 2013 and Al- Wasfy, 2013)

The target of this study is elucidating the relation between fruiting state from one hand and growth, nutritional status, yield and fruit quality from the other hand in Balady mandarin trees treated with some vitamins and amino acids. Suggesting the best treatment that was responsible for solving particularly the decline on the yield in the off years bearing state is considered another goal.

2. Material and Methods

This study was conducted during 2012 and 2013 seasons on thirty– six uniform in vigour 16- years old Balady mandarin trees (*Citrus reticulata*) budded on sour orange rootstock in a private orchard situated at Rayramon village, Mallawy district, Minia Governorate where the soil is clay and well drained and with a water table not less than two meters deep. Tree spacing is 5 × 5 meters apart. Surface irrigation system was followed.

This investigation included twelve treatments from two factors namely A & B. The first factor (A) contained two fruiting stats namely a_1) off year fruiting state and a_2) On year fruiting state. The second factor (B) comprised from the following six treatments from application of some vitamins and amino acids:

b_1) Control (sprayed with water trees).

b_2) Spraying vitamins K, E, D and A each at 50 ppm.

b_3) Spraying vitamins B (B_1+ B_2 + B_6 + B_{12}) at 50 ppm.

b_4) Spraying all vitamins together (vitamins K, E, D, A and B complex) at the named concentrations.

b_5) Spraying the three amino acids namely methionene, tryptophan and cystene at 0.05%.

b_6) Spraying all vitamins and amino acids at the named concentrations.

Therefore, this experiment included twelve treatments (2 x 6). Each treatment was replicated three times, one tree per each (36 trees). All vitamins and amino acids were sprayed three times at growth start (1^{st} week of March), after fruit setting (2^{nd} week of April) and at one month later (2^{nd} week of May). All vitamins and amino acids were applied at fixed concentrations (according to **Mostafa, 2004 and Hegab and Hegab, 2011**). Triton B as a wetting agent was added to all vitamins and amino acid solutions at 0.05 %. All the trees were sprayed till runoff (20 I/ tree).

Randomized complete block design in split plot arrangement was followed. The two fruiting states (On or Off) and the six vitamins and amino acids treatments occupied the main and subplots, respectively.

Sixteen new shoots from Spring growth cycle were chosen on four labeled branches (four shoots on the four each directions) for measuring the shoot length in the spring growth flush (1^{st} week of Sept.). To determine the leaf area in spring growth cycle according to **Ahmed and Morsy (1999),** twenty mature leaves were taken (1^{st} week of Sept.). Leaf area (cm^2) was measured according to the following equation: LA = 0.49 (L × W) + 19.09 where L = Leaf length (cm) W = Leaf width (cm.) and LA = leaf area (cm^2).

Samples of five mature and fresh leaves from Spring growth cycle/ tree were taken. The leaves were cut at small pieces, homogenated and extracted by 25 % acetone in the presence of a little amount of Na_2CO_3 and silica quartz then filtered through central glass funnel G_4. The optical density of the filtrate was determined using spectrophotometer at the wave length of 662, 644 and 440 nm to determine chlorophylls a & b and carotenoids, respectively. Content of each pigment was calculated by using the following equations (according to **Wettstein, 1957 and Hiscox and Isralstam, 1979).**

Chl. A = (9.784 × E 662) – (0.99 × E 644) mg/ L^{-1}

Chl. B = (21.426 × E 644) – (4.65 × E 622) mg/ L^{-1}

Total carotenoids = (4.965 × E 440 – 0.268 (Chl. A + Chl. B).

where E = Optical density at a given wave length

Chlorophylls a and b as well as total carotenoids were calculated as mg/100 g F.W of leaves. Also, total chlorophylls was estimated by summation of chlorophyll a plus chlorophyll b (mg/ 100 g F.W).

To determine the percentages of N, P, K & Mg in the leaves, fifty mature leaves seven months age from non- fruiting shoots in the Spring growth cycle (1^{st} week of Sept.) were taken (according to **Summer, 1985**). The leaves were dried at 70°C and digested using H_2SO_4 and H_2O_2 **(**according to **Wilde *et al.*, 1985)**. In the digested solutions nutrients namely N, P, K & Mg on dry weight basis were determined according to the following procedures.

(a) Total nitrogen was determined by using the micro-kjeldahl method as described by **(Piper, 1950).**

(b) Phosphorus was determined by using the method of **Peach and Chapman and Pratt (1961).**

(c) Potassium was determined by using Flame photometer, according to the method of **Evenhuis and Dewaard (1980).**

(d) Magnesium was determined by using EDTA method according to the procedure of **Wilde *et al.*, (1985).**

Total carbohydrates % was determined colometrically by using phenol- sulfuric acid method

(according to **A.O.A.C., 1995**). Values of C/N in the leaves were recorded by dividing total carbohydrates % by total N %.

Number of flowers on the labeled shoots were counted periodically at five days interval starting at the second week of March in the two seasons till all flowers were setted (1st week of April), then the number of fruitlettes was recorded. Fruit retention percentage was estimated by dividing the number of fruits just before harvesting time by total number of flowers and multiplying the product × 100.

Harvesting was achieved during the regular harvesting time prevailing under Minia region conditions (mid of Dec.) during the two seasons when T.S.S/ acid reached nearly 8: 1 (according to **El-Nabawy *et al.* 1967 and Chandler, 1987)**. Yield per tree expressed in weight (kg.) and number of fruits per tree was recorded.

To determine the following physical and chemical characters of the fruits, ten fruits per tree at picking date were taken at random from constant height and from all directions of each tree:

1- Fruit weight (g.) and dimensions (height and diameter in cm.).

2- Percentage of fruit peel weight.

3- Fruit peel thickness (cm.).

4- Percentage of total soluble solids by handy refractometer.

5- Percentage of total acidity (as g citric acid/ 100 ml juice) by titration against 0.1 N sodium hydroxide using phenolphthalein as an indicator **(A.O.A.C., 1995).**

6- Percentages of total and reducing sugars according to **Lane and Eynon (1965)** volumetric method **(A.O.A.C, 1995).**

7- L- ascorbic acid content (as mg/ 100 ml juice) by using 2, 6 dichlorophenol indophenol dye **(A.O.A.C, 1995).**

All the obtained data during the course of this study in the two successive seasons, 2012 and 2013 were tabulated and statistically analyzed. The differences between various treatment means were compared using new L.S.D. parameter at 5 % (according to **Mead *et al*., (1993)**

3. Results and Discussion

1-Shoot length and leaf area in the Spring growth cycle:

It is clear from the data in Table (1) that varying fruiting state of the trees had not effect on the shoot length during both seasons and caused an obvious effect on the leaf area in the first season of the study. The trees on off year fruiting state had lower leaf area in relative to those on on year fruiting state. In the second season, leaf area had the same values on both fruiting states (on or off years).

Single and combined application of vitamins K, E, D, A and B complex as well as amino acids (tryptophan, cystene and methionene) were very effective in promoting such two growth characters. As a general, using amino acids was superior than using these vitamins in this respect. Using all vitamins and amino acids together gave the highest values.

Using all vitamins and amino aids together regardless fruiting state gave the highest values. The control trees produced the minimum values.

2- Leaf chemical composition:

It is clear from the data in Tables (2 to 6) that leaves in trees on off year fruiting state had lower content of N, P, K, Mg, total carbohydrates, C/N, chlorophylls a & b, total chlorophylls and total carotenoids in the leaves in relative to those trees in on year in 2012 season and were the same in both on and off year fruiting states in 2013 season.

A considerable promotion on these leaf components was observed in response to application of vitamins K, E, P, A and B complex as well as the three amino acid either alone or in combinations rather than non application. The promotion was associated with using amino acids rather than using these vitamins. Using all vitamins and amino acids together resulted in maximizing these leaf contents. The little values were observed in untreated trees.

A remarkable stimulation on these components in the leaves was detected with using all vitamins and amino acids together to the trees either on off or on year fruiting states comparing with non-application of these antioxidants to the trees.

3-Fruit retention %, number of fruits and yield/ tree:

It is clear from the data in Tables (7 & 8) that percentage of fruit retention as well as yield expressed in number of fruits and weight (kg.) per tree were greatly declined in the trees under off year fruiting state in the first season. However, in the second season they were similar in both on and off year fruiting states.

Treating the trees with all vitamins and/ or amino acids was very effective in improving fruit retention %, number of fruits / tree and yield in relative to the check treatment. Using amino acids was favourable in improving fruit retention% and yield than using vitamins. Using all vitamins and amino acids together gave the best results.

Treating on or off year fruiting state trees with all vitamins and amino acids was accompanied with enhancing fruit retention %, number of fruits/ tree and yield rather than untreating with these antioxidants. In most instances, spraying on year fruiting state trees with these antioxidants gave the greatest values.

4- Fruit quality:

It is clear from the data in Tables (8 to 13) that occurring the trees on off year fruiting state materially

improved fruit quality in terms of increasing fruit weight and dimensions, T.S.S.%, total and reducing sugars% and vitamin C content and decreasing fruit peel weight and thickness and total acidity % rather than those on the trees under on year fruiting state.

Single or combined application of vitamins and amino acids was very effective in improving fruit quality in terms of increasing fruit weight and dimensions, T.S.S.%, total and reducing sugars % and vitamin C content and decreasing fruit peel weight and thickness and total acidity in relative to the control treatment. Using amino acids surpassed the application of these vitamins in improving fruit quality. The great promotion on fruit quality was associated with using all vitamins and amino acids together.

Supplying Balady mandarin trees on fruiting states namely off or on year with all vitamins and amino acids gave the best results with regard to fruit quality comparing with leaving of these trees without antioxidant treatments.

Table (1): Effect of fruiting state as well as some vitamins and amino acids on the shoot length (cm) and leaf area (cm) of the spring growth cycle of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Shoot length (cm)						Leaf area $(cm)^2$					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	38.7	39.0	**38.9**	39.9	40.0	**40.0**	7.9	8.4	**8.2**	8.6	8.6	**8.6**
b_2 Vitamins KEDA at 50 ppm	39.9	40.0	**40.0**	41.1	41.1	**41.1**	8.5	8.9	**8.7**	9.2	9.3	**9.3**
b_3 Vitamins B complex at 50 ppm	41.0	41.1	**41.1**	42.3	42.4	**42.4**	9.0	9.5	**9.3**	9.6	9.7	**9.7**
b_4 All vitamins	41.9	42.0	**42.0**	43.5	43.6	**43.6**	9.5	10.0	**9.8**	10.2	10.3	**10.3**
b_5 Amino acids at 0.05%	43.0	43.1	**43.1**	44.7	44.8	**44.8**	10.0	10.6	**10.3**	11.0	11.0	**11.0**
b_6 All vitamins + Amino acids	44.5	44.6	**44.6**	46.3	46.4	**46.4**	10.6	11.2	**10.9**	11.6	11.6	**11.6**
Mean (A)	**41.5**	**41.6**		**43.0**	**43.1**		**9.3**	**9.8**		**10.0**	**10.1**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	NS	0.9	1.3	NS	1.0	1.4	0.4	0.5	0.7	NS	0.5	0.7

Table (2): Effect of fruiting state as well as some vitamins and amino acids on the percentages of N and P in the leaves of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Leaf N %						Leaf P %					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	1.51	1.58	**1.55**	1.64	1.66	**1.65**	0.11	0.14	**0.13**	0.12	0.13	**0.13**
b_2 Vitamins KEDA at 50 ppm	1.60	1.66	**1.63**	1.73	1.73	**1.73**	0.14	0.17	**0.16**	0.16	0.16	**0.16**
b_3 Vitamins B complex at 50 ppm	1.66	1.73	**1.70**	1.79	1.80	**1.80**	0.17	0.20	**0.19**	0.20	0.20	**0.20**
b_4 All vitamins	1.72	1.79	**1.76**	1.88	1.88	**1.88**	0.20	0.24	**0.22**	0.23	0.23	**0.23**
b_5 Amino acids at 0.05%	1.80	1.87	**1.84**	1.95	1.94	**1.95**	0.23	0.27	**0.25**	0.25	0.26	**0.26**
b_6 All vitamins + Amino acids	1.88	1.95	**1.92**	1.99	1.99	**1.99**	0.26	0.30	**0.28**	0.29	0.30	**0.30**
Mean (A)	**1.70**	**1.76**		**1.83**	**1.83**		**0.19**	**0.22**		**0.21**	**0.21**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.05	0.06	0.08	NS	0.05	0.07	0.02	0.03	0.04	NS	0.03	0.04

Table (3): Effect of fruiting state as well as some vitamins and amino acids on the percentages of K and Mg in the leaves of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Leaf K %						Leaf Mg %					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	1.22	1.30	**1.26**	1.34	1.35	**1.35**	0.33	0.37	**0.35**	0.44	0.44	**0.44**
b_2 Vitamins KEDA at 50 ppm	1.28	1.36	**1.32**	1.42	1.42	**1.42**	0.38	0.43	**0.41**	0.50	0.50	**0.50**
b_3 Vitamins B complex at 50 ppm	1.34	1.42	**1.38**	1.48	1.49	**1.49**	0.44	0.50	**0.47**	0.56	0.57	**0.57**
b_4 All vitamins	1.41	1.48	**1.45**	1.55	1.55	**1.55**	0.55	0.60	**0.58**	0.63	0.64	**0.64**
b_5 Amino acids at 0.05%	1.46	1.54	**1.50**	1.61	1.62	**1.62**	0.61	0.66	**0.64**	0.70	0.70	**0.70**
b_6 All vitamins + Amino acids	1.53	1.63	**1.58**	1.72	1.72	**1.72**	0.71	0.82	**0.77**	0.84	0.84	**0.84**
Mean (A)	**1.37**	**1.46**		**1.52**	**1.53**		**0.50**	**0.56**		**0.61**	**0.62**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.04	0.05	0.07	NS	0.05	0.07	0.03	0.04	0.06	NS	0.04	0.06

Table (4): Effect of fruiting state as well as some vitamins and amino acids on the percentage of total carbohydrates and C/N in the leaves of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Leaf Total carbohydrate %						C /N					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	14.0	15.5	**14.8**	15.5	15.6	**15.6**	9.27	9.81	**9.54**	9.45	9.40	**9.43**
b_2 Vitamins KEDA at 50 ppm	15.1	16.7	**15.9**	16.8	16.8	**16.8**	9.44	10.06	**9.75**	9.71	9.71	**9.71**
b_3 Vitamins B complex at 50 ppm	16.2	17.9	**17.1**	18.1	18.2	**18.2**	9.76	10.35	**10.06**	10.11	10.11	**10.11**
b_4 All vitamins	17.3	19.1	**18.2**	19.5	19.6	**19.6**	10.06	10.67	**10.37**	10.37	10.42	**10.40**
b_5 Amino acids at 0.05%	18.5	20.2	**19.4**	21.0	21.0	**21.0**	10.28	10.80	**10.54**	10.77	10.82	**10.80**
b_6 All vitamins + Amino acids	19.6	21.5	**20.6**	22.4	22.5	**22.6**	10.43	11.03	**10.73**	11.26	11.31	**11.29**
Mean (A)	**16.8**	**18.5**		**18.9**	**19.0**		**9.87**	**10.45**		**10.28**	**10.30**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	1.0	1.1	1.5	NS	1.3	1.8	0.37	0.41	0.57	NS	0.31	0.43

Table (5): Effect of fruiting state as well as some vitamins and amino acids on chlorophylls a and b in the fresh leaves of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Chlorophyll a (mg/100gF.W)						Chlorophyll b (mg/100gF.W)					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	13.3	14.5	**13.9**	15.1	15.3	**15.2**	6.6	7.6	**7.1**	8.0	8.1	**8.1**
b_2 Vitamins KEDA at 50 ppm	14.5	15.6	**15.1**	16.2	16.4	**16.3**	7.6	8.6	**8.1**	9.0	9.1	**9.1**
b_3 Vitamins B complex at 50 ppm	15.7	16.9	**16.3**	17.5	17.7	**17.6**	8.5	9.7	**9.1**	10.1	10.2	**10.2**
b_4 All vitamins	17.0	18.0	**17.5**	18.9	19.0	**19.0**	9.6	10.8	**10.2**	11.1	11.2	**11.2**
b_5 Amino acids at 0.05%	18.1	19.3	**18.7**	20.0	20.2	**20.1**	10.7	12.0	**11.4**	12.2	12.3	**12.3**
b_6 All vitamins + Amino acids	19.3	21.0	**20.2**	21.1	21.2	**21.2**	12.0	13.5	**12.8**	13.5	13.6	**13.6**
Mean (A)	**16.3**	**17.6**		**18.1**	**18.3**		**9.2**	**10.4**		**10.7**	**10.8**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.9	1.1	1.5	NS	1.0	1.4	0.7	0.8	1.1	NS	0.7	1.0

Table (6): Effect of fruiting state as well as some vitamins and amino acids on total chlorophylls and total carotenoids in the fresh leaves mg(100gF.W) of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Total chlorophylls (mg/100gF.W)						Total carotenoids(mg/100gF.W)					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	19.9	22.1	**21.0**	23.1	23.4	**23.3**	5.1	6.2	**5.7**	6.0	6.0	**6.0**
7.1b_2 Vitamins KEDA at 50 ppm	22.1	23.7	**22.9**	25.2	25.4	**25.3**	6.1	7.2	**6.7**	7.0	7.0	**7.1**
b_3 Vitamins B complex at 50 ppm	24.2	26.6	**25.4**	27.6	27.9	**27.8**	7.3	8.3	**7.8**	8.0	8.0	**8.0**
b_4 All vitamins	26.6	28.8	**27.7**	30.0	30.2	**30.1**	8.4	9.5	**9.0**	9.1	9.1	**9.1**
b_5 Amino acids at 0.05%	28.8	31.3	**30.1**	32.2	32.4	**32.3**	9.6	10.6	**10.1**	10.1	10.0	**10.0**
b_6 All vitamins + Amino acids	31.3	34.5	**32.9**	34.6	34.8	**34.7**	10.7	12.2	**11.5**	11.1	11.2	**11.2**
Mean (A)	**25.5**	**27.8**		**28.8**	**29.0**		**7.9**	**9.0**		**8.6**	**8.6**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	1.2	1.3	1.8	NS	1.1	1.5	0.9	1.0	1.4	NS	1.0	1.4

Table (7): Effect of fruiting state as well as some vitamins and amino acids on the percentage of fruit retention and number of fruits per tree of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Fruit retention %						Number of fruit/tree					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	0.30	0.41	**0.36**	0.50	0.52	**0.51**	110.0	171.0	**140.5**	200.0	205.0	**202.5**
b_2 Vitamins KEDA at 50 ppm	0.34	0.52	**0.43**	0.55	0.56	**0.56**	132.0	220.0	**176.0**	237.0	242.0	**239.5**
b_3 Vitamins B complex at 50 ppm	0.39	0.64	**0.52**	0.61	0.62	**0.62**	155.0	260.0	**207.5**	269.0	275.0	**272.0**
b_4 All vitamins	0.44	0.71	**0.58**	0..74	0.75	**0.75**	176.0	310.0	**243.0**	305.0	310.0	**307.5**
b_5 Amino acids at 0.05%	0.49	0.88	**0.69**	0.88	0.90	**0.89**	199.0	360.0	**279.5**	345.0	351.0	**348.0**
b_6 All vitamins + Amino acids	0.55	0.94	**0.75**	0.95	0.97	**0.96**	220.0	411.0	**315.5**	411.0	415.0	**413.0**
Mean (A)	**0.42**	**0.68**		**0.71**	**0.72**		**165.3**	**288.7**		**294.5**	**299.7**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.03	0.04	0.05	NS	0.03	0.04	20.0	30.0	42.0	NS	32.0	44.8

Table (8): Effect of fruiting state as well as some vitamins and amino acids on the yield /tree(kg) and average fruit weight (g) of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Yield/tree (Kg.)						Average fruit weight(g)					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	10.9	15.1	**13.0**	19.8	20.4	**20.1**	99.0	88.5	**93.8**	99.0	99.5	**99.3**
b_2 Vitamins KEDA at 50 ppm	14.5	21.7	**18.1**	26.1	26.7	**26.4**	109.9	98.6	**104.3**	110.0	110.5	**110.3**
b_3 Vitamins B complex at 50 ppm	18.6	28.3	**23.5**	32.2	33.3	**32.8**	120.0	106.3	**114.7**	120.0	121.0	**120.5**
b_4 All vitamins	22.9	37.0	**30.0**	39.7	40.6	**40.2**	130.0	119.3	**124.7**	130.0	131.0	**130.5**
b_5 Amino acids at 0.05%	27.9	46.6	**37.3**	48.6	49.7	**49.2**	140.0	128.5	**134.3**	141.0	141.5	**141.5**
b_6 All vitamins + Amino acids	33.0	57.5	**45.3**	62.4	63.1	**62.8**	149.9	140.0	**145.0**	151.9	152.0	**152.0**
Mean (A)	**21.3**	**34.4**		**38.1**	**39.0**		**124.8**	**114.1**		**125.3**	**125.9**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	2.0	2.9	4.1	NS	3.4	4.3	9.5	9.9	13.9	Ns	9.9	13.9

Table (9): Effect of fruiting state as well as some vitamins and amino acids on the fruit height and diameter (cm.) of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Fruit height (cm)						Fruit diameter (cm.)					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	5.09	4.94	**5.02**	5.09	5.08	**5.09**	6.11	5.94	**6.03**	6.10	6.09	**6.10**
b_2 Vitamins KEDA at 50 ppm	5.29	5.14	**5.22**	5.30	5.30	**5.30**	6.31	6.13	**6.22**	6.30	6.28	**6.29**
b_3 Vitamins B complex at 50 ppm	5.50	5.35	**5.43**	5.51	5.51	**5.51**	6.52	6.32	**6.42**	6.41	6.40	**6.41**
b_4 All vitamins	5.70	5.55	**5.63**	5.71	5.71	**5.71**	6.72	6.54	**6.63**	6.52	6.51	**6.52**
b_5 Amino acids at 0.05%	5.88	5.73	**5.81**	5.89	5.88	**5.89**	6.90	6.72	**6.81**	6.66	6.65	**6.66**
b_6 All vitamins + Amino acids	6.10	5.95	**6.03**	6.06	6.07	**6.07**	7.09	6.90	**7.00**	6.81	6.80	**6.81**
Mean (A)	**5.59**	**5.44**		**5.59**	**5.59**		**6.61**	**6.34**		**6.47**	**6.46**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.15	0.17	0.23	NS	0.19	0.27	0.17	0.18	0.25	Ns	0.18	0.25

Table (10): Effect of fruiting state as well as some vitamins and amino acids on the fruit peel% and fruit peel thickness of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Fruit peel weight %						Fruit peel thickness (cm.)					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	21.0	20.0	**20.5**	20.0	19.9	**20.0**	0.33	0.30	**0.32**	0.30	0.29	**0.30**
b_2 Vitamins KEDA at 50 ppm	20.4	19.5	**20.0**	19.1	19.0	**19.1**	0.30	0.27	**0.29**	0.27	0.26	**0.27**
b_3 Vitamins B complex at 50 ppm	19.9	18.8	**19.4**	18.6	18.5	**18.6**	0.27	0.24	**0.26**	0.24	0.23	**0.24**
b_4 All vitamins	18.0	17.5	**17.8**	17.5	17.4	**17.5**	0.24	0.21	**0.23**	0.21	0.20	**0.21**
b_5 Amino acids at 0.05%	17.4	16.8	**17.1**	16.7	16.6	**16.7**	0.21	0.18	**0.20**	0.18	0.17	**0.18**
b_6 All vitamins + Amino acids	16.8	16.0	**16.4**	16.0	15.9	**16.0**	0.18	0.16	**0.17**	0.16	0.15	**0.16**
Mean (A)	**18.9**	**18.1**		**18.0**	**17.9**		**0.26**	**0.23**		**0.23**	**0.21**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.5	0.5	0.7	NS	0.5	0.7	0.03	0.03	0.04	NS	0.03	0.04

Table (11): Effect of fruiting state as well as some vitamins and amino acids on the percentage of total soluble solids and total acidity in the fruits of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	T.S.S %						Total acidity %					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	11.5	11.2	**11.4**	11.6	11.5	**11.6**	1.411	1.430	**1.421**	1.411	1.412	**1.412**
b_2 Vitamins KEDA at 50 ppm	11.8	11.4	**11.6**	11.8	11.9	**11.9**	1.390	1.420	**1.405**	1.388	1.389	**1.389**
b_3 Vitamins B complex at 50 ppm	12.2	11.9	**12.1**	12.2	12.2	**12.2**	1.370	1.390	**1.380**	1.368	1.369	**1.369**
b_4 All vitamins	12.6	12.3	**12.5**	12.6	12.6	**12.6**	1.340	1.361	**1.351**	1.338	1.339	**1.338**
b_5 Amino acids at 0.05%	12.8	12.5	**12.7**	12.9	12.9	**12.9**	1.310	1.333	**1.322**	1.308	1.310	**1.309**
b_6 All vitamins + Amino acids	13.2	12.9	**13.1**	13.3	13.2	**13.3**	1.291	1.311	**1.301**	1.288	1.289	**1.289**
Mean (A)	**12.4**	**12.0**		**12.4**	**12.4**		**1.352**	**1.374**		**1.350**	1.351	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.3	0.3	0.4	NS	0.3	0.4	0.015	0.016	0.022	NS	0.015	0.021

Table (12): Effect of fruiting state as well as some vitamins and amino acids on T.S.S/acid as well as percentage of total sugars in the fruits of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	T.S.S/acid						Total sugars %					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	8.2	7.8	**8.0**	8.2	8.1	**8.2**	7.5	7.1	**7.3**	7.5	7.4	**7.5**
b_2 Vitamins KEDA at 50 ppm	8.5	8.0	**8.3**	8.5	8.6	**8.6**	7.8	7.4	**7.6**	7.9	7.8	**7.9**
b_3 Vitamins B complex at 50 ppm	8.9	8.6	**8.8**	8.9	8.9	**8.9**	8.2	7.8	**8.0**	8.3	8.2	**8.3**
b_4 All vitamins	9.4	9.0	**9.2**	9.4	9.4	**9.4**	8.6	8.2	**8.4**	8.7	8.7	**8.7**
b_5 Amino acids at 0.05%	9.8	9.4	**9.6**	9.9	9.8	**9.9**	9.0	8.6	**8.8**	9.1	9.1	**9.1**
b_6 All vitamins + Amino acids	10.2	9.8	**10.0**	10.3	10.2	**10.3**	9.3	9.0	**9.2**	9.3	9.3	**9.3**
Mean (A)												
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.3	0.3	0.4	NS	0.3	0.4	0.3	0.3	0.4	NS	0.3	0.4

Table (13): Effect of fruiting state as well as some vitamins and amino acids on the percentage of reducing sugars and vitamin C content in the fruits of Balady mandarin trees during 2012 and 2013 seasons.

Antioxidant treatments (B)	Reducing sugars %						Vitamin C content (mg/100me juice)					
	2012			2013			2012			2013		
	Fruiting state (A)											
	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**	a_1 Off	a_2 On	**Mean (B)**
b_1 Control	3.66	3.59	**3.63**	3.71	3.70	**3.71**	33.0	31.1	**32.1**	33.9	33.8	**33.9**
b_2 Vitamins KEDA at 50 ppm	3.79	3.70	**3.75**	3.83	3.83	**3.83**	3.5	32.5	**33.5**	35.0	34.8	**34.9**
b_3 Vitamins B complex at 50 ppm	3.91	3.83	**3.87**	3.95	3.96	**3.96**	36.6	34.5	**35.6**	37.0	36.9	**37.0**
b_4 All vitamins	4.11	4.00	**4.06**	4.15	4.15	**4.15**	38.9	36.7	**37.8**	39.3	39.0	**39.2**
b_5 Amino acids at 0.05%	4.25	4.11	**4.18**	4.30	4.31	**4.31**	40.0	38.2	**39.1**	41.0	40.7	**40.9**
b_6 All vitamins + Amino acids	4.40	4.31	**4.36**	4.45	4.45	**4.45**	42.7	40.8	**41.8**	34.0	42.9	**43.0**
Mean (A)	**4.02**	**3.92**		**4.07**	**4.07**		**37.6**	**35.6**		**38.2**	**38.0**	
New L.S.D. at 5%	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**	**A**	**B**	**AB**
	0.07	0.08	0.11	NS	0.08	0.11	1.0	1.1	1.5	NS	1.1	1.5

4. Discussion

Balady mandarin cv exhibits an extreme cycle of a heavy crop during the on year followed by essentially no or few flowers or yield during the off year. This undesirable phenomenon is namely alternate bearing or binnenial bearing. The main causes of this habit are genetic as well as nutritional, hormonal and environmental factors (**Goldshmidt and Golomb, 1982**). During off year fruiting status, fruits were larger and had higher T.S.S. and total sugars, while they were characterized by smaller and lower T.S.S. and total sugars in on year one (**Mohammed – Afkar, 1991**).

The depletion of carbohydrates reserves and other essential substances during the on year can be responsible for the lack of flowering and fruit setting in the subsequent off season. Using antioxidants allowed starch to reaccumulate before flower bud differentiation (**Monselise and Goldschmidt, 1982**). The medium levels of starch and carbohydrates in the leaves appear to be well correlated with the medium flowering in response to application of antioxidants. Most studies confirmed the hypothesis that low carbohydrate levels are responsible for the lack of flowering during off year. Anitoxidamnt application considerably reduces leaf cellulose activity in abscission zone and ethylene production as well as enhances the translocation of metabolities from leaves to fruits. The absence of spring growth in the on year is largely responsible for the failure of the crop in the following year. Application of antioxidant effectively induced sufficient vegetative growth early in the on year as well as increase flower bud formation during the preceded period of the expected off year consequently producing regular bearing. (**Oretili, 1987; Samiullah *et al.*, 1988 and Prusky, 1998**).

The promoting effect of vitamins and amino acids on growth nutritional status, yield and fruit quality was emphasized by the results of (**Hamad- Mona, 2011, Hegab and Hegab, 2011; Merwad, 2011; Saied, 2011; Roshdy *et al.*, 2011; Masoud and El- Sehrawy, 2012; Abd El- Rahman and El- Masry, 2012; Ahmed *et al.*, 2013, Rizk, 2013, Ibrahiem *et al*, 2013; El- Badawy and Abd El-aal, 2013; Fathalla, 2013 and Al- Wasfy, 2013**).

Conclusion:

Treating Balady mandarin trees especially those under off year fruiting state three times (at growth start1st week of March, just after fruit setting, 2nd week of April and at one month later, 2nd week of May) with a mixture of vitamins and amino acids containing vitamins K, E, D, A and B complex (B_1+ B_2+ B_6 + B_{12}) each at 50 ppm plus the three amino acids namely methionene, tryptophan and cystene at 0.05% had beneficial effect in alleviating the alternate bearing and improving fruit quality.

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5/6/2014