

PHYSIOLOGICAL STUDIES ON THE EFFECT OF FOUR ROOTSTOCKS ON "HERNANDINA" CLEMENTINE FRUITS

I- FRUIT DEVELOPMENT AND MATURATION

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Abstract

This study was carried out on Hernandina fruits were taken from a private farm at Wady El-Mullak region, Ismailia Governorate during two successive seasons (2005:2006 & 2006:2007) to determine the behaviour of Hernandina cultivar fruits on four citrus rootstocks during growth development and maturation under the Egyptian conditions.

Hernandina trees grafted on Sour orange, Carrizo citrange, Cleopatra mandarin and "Swingle" Citrumelo rootstocks were selected for this study. Fruit samples were taken during growth development at the first week of December (210 days from full bloom) and repeated at weekly intervals until commercial harvest (259 and 238 days from full bloom during the first and the second season respectively). Fruit physical and chemical characteristics during growth development and maturation were determined.

Hernandina clementine fruit weight, TSS contents and TSS/total acidity ratio of fruits significantly increased while fruit firmness, total acidity of fruit juice decreased gradually and significantly during growth development. On the other hand, fruit volume, fruit gravity and juice content were nearly constant during the first maturation stages, and then began to decrease with the extension of fruit age, at over ripening stage. Fruit color changed directly from greenish-yellow to yellow then to orange with the increasing of fruit age. Ascorbic acid content of fruit increased gradually and significantly with the advanced time until reached the maximum nearly at the optimum maturity stage, then began to decrease with the increasing of fruit age.

Fruits produced on Carrizo, Cleopatra and Citrumelo rootstocks were heavy weight and more volume and development of color, less gravity, firmness, juice content and total acidity content but higher total soluble solid contents and total soluble solids / total acidity ratio than that produced on Sour orange, while rootstock types had no effect on fruit content of ascorbic acid.

Hernandina fruits on Carrizo and Citrumelo followed by those on Cleopatra rootstocks reached maturation one week earlier than that on Sour orange, when TSS / Acid ratio reached to more than 12-13:1, (nearly after 230-238 days from full bloom, during the first week of January). while that on Sour orange reached after 238:245 days after full bloom. Moreover, data also indicated that fruit quality deteriorated quickly with delayed harvesting process after reaching maturity stage.

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INTRODUCTION

There is a good opportunity chance for citrus species other than orange to increase its exported quantity to Europe countries under the Egyptian Europe Association agreement. The concentration of the Egyptian local mandarin fruit production during a limited period and its sensitivity to post harvest and handling management, obligate to search about new varieties especially early and late ones and has a good ability for marketing and handling process.

There are new mandarin cultivars and hybrids have been introduced to the Egyptian citrus industry such as Marisol, Clemenules, Hernandina, Nova mandarin, Ellendale tangor and others. These cultivars are adopted by the Horticulture private sector, however, there is a lack of information about these new cultivars behavior under the Egyptian conditions concerning production, maturation and post harvest management.

The Hernandina is derived as a spontaneous mutation of "Fina" clementine in 1966 in Spain (*Bono and Cordova, 1978*). Hernandina is a late cultivar, however the internal maturity of fruit takes place before the external one by one month or more with excellent characteristics (*Bono, et al., 1995*). Hernandina is a highly productive clementine cultivar, the fruits are of small to medium, highly contents of juice, total soluble solids and less contents of acidity (*Bassal, 2001*).

Jacquemond et al. (1994) reported that mandarin grafted on Poncirus and its hybrids rootstocks had small fruits than that produced on trees grafted on Sour orange.

It has been reported that Hernandina fruit weight increased gradually during growth and development and reached its maximum on January 15th, then decreased and fruit gravity decreased with growth development (*Bassal, 2001*).

Fallahi and Rodney (1992) mentioned that, Fairchild mandarin fruits from trees on Carrizo citrange had the highest S.S.C while those on Volkamer lemon and Rough lemon had the lowest S.S.C and total acids. Moreover, *D'Hallewin et al. (1994)* indicated that rootstock significantly affected "Avana" mandarin fruit quality in terms of total acidity and ascorbic acid at harvest, but had no effect on total soluble solid content, and trees on Sour orange had the most uniform fruit size.

Fremont tangerine fruit on Sour orange, Rangpur lime and Carrizo citrange reached its maturity earlier than fruits on Volkameriana. On the other side, Fremont tangerine fruit weight on Volkameriana and Rangpur lime were higher than on Sour orange and Carrizo citrange. The highest fruit juice percentage and the best rind color were of fruits on Sour orange (*Ali, 2002*).

The purpose of this study is to determine the influence of Sour orange, Carrizo citrange, Cleopatra mandarin and "Swingle" citrumelo rootstocks on Hernandina Clementine cultivar fruits during growth development and maturation.

MATERIALS AND METHODS

This investigation was carried out during two successive seasons (2004:2006 & 2005 2006 : 2007) at Hort. Res. Institute, Fruit Handling Department, Giza, Egypt.

Trees were grown in a private farm at "Wady El-Mullak" region, Ismailia Governorate. During February 2005, 36 Hernandina trees grafted on Sour Orange, Carrizo citrange, Cleopatra mandarin and Citrumelo rootstocks were selected for this study, (9 trees for each rootstock). Trees were 7 years old, healthy, uniformed vigor growth, planted at 2×5 m in sandy soil, under drip irrigation system and subjected to all agriculture practices as Ministry of Agriculture recommendations.

Fruit samples were taken during growth development starting at the first week of December (210 days from full bloom) and repeated at weekly intervals until commercial harvest (259 and 238 days from full bloom during the first and the second season respectively), for fruit physical and chemical characteristics determination. Each sample had 3 replicates, each replicate had 10 fruits. Fruit weight (g) and volume (cm³) were determined and then gravity (g/cm³) was calculated. Fruit firmness was measured in 6 fruits (3 readings per each fruit) by Lfra texture analyzer instrument using a penetrating cylinder of 1 mm in diameter to a constant distance 5 mm inside the skin of fruits and by a constant speed 2 mm per sec. and the peak of resistance was recorded (g/cm²). Fruit color was measured by a Hunter colorimeter type (Dp-9000) for estimation of "L", "a" and "b" values, then color values as Hue angle were calculated according to *Mc Guire (1992)*.

In addition, juice content was estimated by squeezing 12 fruits (as three replicates) by handy squeezer and then juice percentage (w/w) was calculated. Juice TSS percentage was measured by abbe refractometer, total acidity and ascorbic acid (Vit.C) was determined according to *A.O.A.C. (1995)*, then TSS/acid ratio was calculated.

All data for all studied fruit parameters were analyzed as a complete randomized design with factorial treatments as described by *Snedecor and Cochran, 1980*.

RESULTS AND DISCUSSION

A-Physical properties

1- Fruit weight (g.)

Data presented in Table (1) clearly indicated that Hernandina clementine fruit weight increased significantly during growth development to reach the maximum weight at the optimum maturity stage, nearly after 230 days of full bloom and remained constant for two to three weeks then decreased again with the progressive ripening stage (1stseason).

Data also indicated that fruits produced on Cleopatra and Citrumelo rootstocks were heavier than that produced on Sour orange and Carrizo during the first season, while during the second one fruits on Carrizo rootstock were significantly heavier than those of the other rootstocks. On the other hand, fruits on Sour orange rootstock were the least fruit weight during the two seasons in this work.

These results are in line with those obtained by *Bal and Chohan (1987)* and *Bassal (2001)*, as they reported that clementine fruit weight increased gradually till reaching the maximum at maturity stage then decreased with advanced age.

On the other hand, these results agree with the findings of *Ali (2002)* who found that Fremont mandarin fruit produced on Volkameriana and Rangpur lime were higher than that on Sour orange and Carrizo citrange. In addition, *Jacquemond et al. (1994)* and *Cheng et al. (1996)* mentioned that mandarin fruit weight were different due to rootstock type.

2- Fruit volume (cm³)

According to data shown in Table (2) it is clear that fruit volume was nearly constant during the early maturation period (the second half of December), then began to increase significantly nearly at the second week of January with the extension of fruit age.

Data also indicated that fruits produced on Citrumelo, Cleopatra and Carrizo rootstocks had significantly higher volume than that on Sour orange during the first season, while during the second season, fruits on Carrizo and Citrumelo rootstocks were significantly higher than that on Cleopatra and Sour orange.

These results are in harmony with those obtained by *Bal & Chohan (1987)* and *Bassal (2001)* they mentioned that mandarin fruit volume increased significantly with the extension of fruit age. Also, these results agree with the findings of *D'Hallewin et al. (1994)* and *Cheng et al. (1996)* as they indicated that mandarin fruit size was affected by rootstock type during growth development.

Table 1. Effect of four rootstocks on fruits weight of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	130.0	130.4	148.8	137.4	136.6	210	96.4	127.3	106.9	109.3	110.0
217	121.7	136.7	135.0	150.8	136.0	217	121.8	137.6	114.3	116.7	122.6
224	128.0	120.4	142.0	141.7	133.0	224	123.6	119.6	112.5	128.6	121.1
231	142.1	135.8	141.3	149.0	142.0	231	128.3	133.5	115.4	119.9	124.3
238	145.8	145.8	141.7	135.4	142.2	238	119.3	136.1	129.0	113.9	124.6
245	136.7	139.9	145.7	142.6	141.2	Means	117.9	130.8	115.6	117.7	
252	126.7	114.2	113.3	125.0	119.8	Abbreviations:-					
259	113.3	132.1	125.0	118.3	122.2	1 = Sour orange.		2 = Camzo.			
Means	130.5	131.9	136.6	137.5		3 = Cleopatra.		4 = Citrumelo.			
LSD values at 5 % level						A = Rootstock type		B = Fruit age.			
						a*b = Interaction					
Factor	A	B	a*b			Factor	A	B	a*b		
Values	2.8	3.6	8.0			Values	4.6	4.8	10.2		

Table 2. Effect of four rootstocks on fruits volume of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	121.7	136.3	156.5	147.5	140.5	210	98.0	130.0	108.3	111.8	112.0
217	123.8	145.3	139.2	157.1	141.3	217	122.5	142.5	117.5	113.3	124.0
224	132.1	122.9	144.2	147.5	136.7	224	127.5	123.3	115.8	136.7	125.8
231	145.8	150.0	144.2	156.0	149.0	231	135.8	152.5	128.3	143.3	140.0
238	150.8	156.1	149.3	146.5	150.7	238	130.8	161.7	150.7	136.0	144.8
245	142.5	157.7	155.0	162.7	154.5	Means	122.9	142.0	124.1	128.2	
252	145.3	139.5	136.8	147.6	142.3	Abbreviations:-					
259	138.5	171.9	160.9	151.7	155.7	1 = Sour orange.		2 = Carrizo.			
Means	137.6	147.4	148.2	152.1		3 = Cleopatra.		4 = Citrumelo.			
LSD values at 5 % level						A = Rootstock type		B = Fruit age.			
						a*b = Interaction					
Factor	A	B	a*b			Factor	A	B	a*b		
Values	3.2	4.1	9.1			Values	4.5	4.7	10.0		

3- Fruit gravity (g/cm³)

Hernandina clementine fruit gravity (Table, 3) was nearly constant during maturation (during December), then began to decrease significantly with the extension of fruit age, over ripening stage (during January).

Data also cleared that, gravity of Hernandina clementine fruits produced on studied rootstocks other than Sour orange were significantly lower than that was on Sour orange during the two seasons in this investigation.

Also data indicated that there was a significant interaction among fruit age and rootstock effect on fruit gravity during both seasons.

These results are in harmony with those obtained by *Bassal (2001)* who mentioned that Hernandina, Marisol and Clemenules mandarin fruit gravity decreased with advanced fruit age. In addition, these results are supported by the findings of that mandarin fruits become puffy and loss its gravity when harvest process is delayed (*Pons, et al. (1989), Bono (1993) and Zaragoza (1993)*).

Table 3. Effect of four rootstocks on fruits gravity of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	1.07	0.97	0.95	0.93	0.98	210	0.98	0.99	0.99	0.98	0.98
217	0.99	0.95	0.97	0.97	0.97	217	1.00	0.97	0.97	1.03	0.99
224	0.97	0.98	0.99	0.96	0.97	224	0.97	0.97	0.97	0.94	0.96
231	0.98	0.91	0.98	0.96	0.96	231	0.95	0.89	0.90	0.84	0.89
238	0.97	0.93	0.95	0.93	0.94	238	0.91	0.84	0.86	0.84	0.86
245	0.96	0.89	0.94	0.88	0.92	Means	0.96	0.93	0.94	0.92	
252	0.87	0.82	0.83	0.85	0.84	Abbreviations:-					
259	0.82	0.77	0.78	0.78	0.79	1 = Sour orange.		2 = Carrizo.			
Means	0.95	0.90	0.92	0.91		3 = Cleopatra.		4 = Citrumelo.			
LSD values at 5 % level						A = Rootstock type		B = Fruit age.			
						a*b = Interaction					
Factor	A		B		a*b	Factor	A		B		a*b
Values	0.024		0.030		0.067	Values	0.026		0.027		0.057

4- Fruit color (as Hue angle)

Data shown in Table (4) clear that Hernandina fruits color changed directly from greenish-yellow (Hue angle more than 100) to yellow (Hue angle is around 75) to orange (Hue angle is around 45) with the extended of fruit age.

On the other hand, fruits bearing on Carrizo and Citrumelo had the lowest hue angle value (more color development) in comparison with that bearing on Cleopatra and Sour orange, however fruit bearing on Cleopatra rootstock still had hue angle less than that of fruits on Sour orange rootstock during the two seasons in this investigation. Moreover, data show that there was a significant interaction between these factors under this study.

These results agree with those mentioned by Bassal (2000) who found that clementine fruits (Marisol, Hernandina and Clemenules cultivars) were dark-green at the early growth developmental stages then changed directly to light-green to greenish-orange and red- orange at advanced maturity stages.

In addition, these results partially agree with those demonstrated by Ali (2002) who mentioned that Fremont tangerine fruit on Sour orange rootstock had the best rind color in comparison with that on Rangpur lime, Volkameriana and Carrizo citrange rootstocks.

Table 4. Effect of four rootstocks on fruits color (Hue angle) of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	102.4	95.9	99.4	90.3	97.0	210	92.9	83.0	92.3	86.3	88.6
217	94.0	88.2	92.4	82.9	89.4	217	88.0	80.0	75.5	81.9	81.3
224	89.5	73.0	75.5	75.0	78.3	224	78.4	73.2	76.6	69.3	74.4
231	77.2	64.8	68.7	69.8	70.1	231	68.6	66.4	68.4	65.8	67.3
238	67.7	64.9	62.3	64.1	64.7	238	68.8	63.0	66.1	64.7	65.7
245	57.5	56.9	58.2	59.5	58.0	Means	79.3	73.1	75.8	73.6	
252	57.8	51.0	57.9	52.0	54.7	Abbreviations:- 1 = Sour orange. 2 = Carrizo. 3 = Cleopatra. 4 = Citrumelo. A = Rootstock type B = Fruit age. a*b = Interaction					
259	51.3	45.1	51.2	48.6	49.1						
Means	74.7	67.5	70.7	67.8							
LSD values at 5 % level											
Factor	A	B	a*b			Factor	A	B	a*b		
Values	1.88	2.37	5.31			Values	2.10	2.21	4.68		

5- Fruit firmness (gm/cm²)

Data presented in Table (5) show that fruit firmness significantly decreased with the increasing fruit age during the two seasons of this investigation.

It is clear from the same Table that firmness of fruits produced on Carrizo and Citrumelo rootstocks were significantly less than that were bearing on Sour orange during both seasons. Data also indicated that there was a significant interaction among all factors under study in this work.

6- Fruit juice content

According to data presented in Table (6), fruit juice content was nearly constant during maturation stage, and then began to decrease with the extension of fruit age (over ripening stage).

Data also cleared that fruits produced on Carrizo, Citrumelo and Cleopatra rootstocks had lower juice contents than those produced on Sour orange rootstock during the two seasons of this investigation.

Moreover, data indicated that there was a significant interaction among all factors under study in this investigation.

These results are in accordance with the findings of that juice percentage of clementine fruits gradually increased during growth developmental stages until reached the maximum during the early fruit maturation then slightly decreased at the last stage of maturation *Bassal (2000)*.

On the other hand, these results are in agreement with those obtained by *Ali (2002)* who mentioned that Fremont fruit on Sour orange rootstock had the highest juice content in comparison with that on the other rootstocks.

B- Chemical characteristics

1- Juice contents of total soluble solids (TSS), total acidity and TSS/total acidity ratio

According to data (Tables, 7, 8, and 9), TSS content and TSS/total acidity ratio of fruit significantly increased, while total acidity decreased with the increasing of fruit age during the two seasons of this investigation.

Data also cleared that fruits produced on Carrizo had the highest TSS content, TSS/ total acidity ratio and the lowest total acidity, while fruits on Sour orange had the lowest TSS content, TSS/total acidity ratio and the highest total acidity during both seasons. Moreover, fruits on Cleopatra and Citrumelo rootstocks had significantly higher TSS content, TSS/total acidity ratio and lower total acidity than those on Sour orange.

In addition, data indicated that there was a significant interaction between these factors under study during the two seasons in this work.

Table 5. Effect of four rootstocks on fruits firmness (gm/cm²) of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	152.2	124.1	136.9	125.6	134.7	210	167.5	149.2	160.6	146.5	156.0
217	125.1	116.1	117.8	113.5	118.1	217	140.5	128.2	126.5	127.1	130.6
224	108.1	113.2	110.1	102.5	108.5	224	118.4	116.9	118.6	130.6	121.1
231	107.5	104.6	107.0	113.5	108.2	231	112.2	102.8	112.0	105.9	108.2
238	106.0	94.9	106.6	101.9	102.3	238	104.5	100.9	99.1	97.5	100.5
245	107.8	95.4	101.4	100.1	101.2	Means	128.6	119.6	123.4	121.5	
252	101.5	85.8	99.1	96.5	95.7	Abbreviations:- 1 = Sour orange. 2 = Carrizo. 3 = Cleopatra. 4 = Citrumelo. A = Rootstock type B = Fruit age. a*b = Interaction					
259	95.5	83.6	95.2	91.2	91.4						
Means	113.0	102.2	109.3	105.6							
LSD values at 5 % level											
Factor	A	B	a*b			Factor	A	B	a*b		
Values	3.96	5.01	11.19			Values	3.32	3.49	7.42		

Table 6. Effect of four rootstocks on fruits juice content of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	50.9	49.1	49.0	47.5	49.1	210	46.0	48.0	45.3	46.8	46.5
217	50.0	51.7	50.7	49.9	50.6	217	52.1	51.6	51.2	49.8	51.2
224	51.1	52.2	52.8	50.4	51.6	224	53.7	52.0	55.0	50.5	52.8
231	52.1	48.1	53.6	48.7	50.6	231	50.2	49.2	50.5	50.2	50.0
238	48.8	48.0	48.3	47.1	48.0	238	50.2	47.1	49.8	49.2	49.0
245	50.4	48.3	49.2	48.6	49.1	Means	50.4	49.6	50.4	49.3	
252	47.0	47.4	45.0	47.9	46.8	Abbreviations:- 1 = Sour orange. 2 = Carrizo. 3 = Cleopatra. 4 = Citrumelo. A = Rootstock type B = Fruit age. a*b = Interaction					
259	47.4	45.8	45.9	47.3	46.6						
Means	49.7	48.8	49.3	48.4							
LSD values at 5 % level											
Factor	A		B		a*b	Factor	A		B		a*b
Values	N.S.		1.34		2.99	Values	N.S.		1.48		3.14

Table 7. Effect of four rootstocks on fruits TSS content of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	9.4	10.1	9.5	9.5	9.6	210	9.3	10.7	10.3	10.4	10.2
217	9.4	10.2	9.5	9.8	9.7	217	10.1	10.8	10.6	10.7	10.6
224	9.5	10.8	9.9	10.1	10.1	224	10.4	11.4	10.8	11.2	11.0
231	10.0	11.0	10.1	10.7	10.5	231	11.0	11.1	11.2	11.3	11.2
238	10.2	11.1	10.9	11.2	10.8	238	11.5	12.3	11.8	11.9	11.9
245	10.9	11.6	11.2	11.5	11.3	Means	10.5	11.3	11.0	11.1	
252	11.5	12.2	11.8	12.1	11.9	Abbreviations:- 1 = Sour orange. 2 = Carrizo. 3 = Cleopatra. 4 = Citrumelo. A = Rootstock type B = Fruit age. a*b = Interaction					
259	11.7	12.9	12.2	12.5	12.3						
Means	10.3	11.2	10.6	10.9							
LSD values at 5 % level											
Factor	A		B		a*b	Factor	A		B		a*b
Values	0.17		0.22		0.49	Values	0.17		0.18		0.38

Table 8. Effect of four rootstocks on fruits total acidity content of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	1.00	0.84	0.92	0.86	0.91	210	1.34	1.24	1.22	1.24	1.26
217	1.04	0.86	0.89	0.88	0.92	217	1.15	0.91	1.00	1.04	1.02
224	0.94	0.72	0.77	0.76	0.80	224	0.93	0.74	0.88	0.76	0.83
231	0.84	0.72	0.76	0.74	0.76	231	0.78	0.71	0.72	0.66	0.72
238	0.83	0.70	0.72	0.65	0.73	238	0.72	0.63	0.66	0.63	0.66
245	0.74	0.63	0.64	0.63	0.66	Means	0.98	0.84	0.90	0.87	
252	0.65	0.56	0.62	0.59	0.61	Abbreviations:-					
259	0.56	0.53	0.54	0.58	0.55	1 = Sour orange.		2 = Carrizo.			
Means	0.83	0.69	0.73	0.71		3 = Cleopatra.		4 = Citrumelo.			
						A = Rootstock type		B = Fruit age.			
LSD values at 5 % level						a*b = Interaction					
Factor	A		B		a*b	Factor	A		B		a*b
Values	0.027		0.035		0.077	Values	0.033		0.035		0.074

Table 9. Effect of four rootstocks on fruits TSS/total acid ratio of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	9.6	12.0	10.3	11.2	10.8	210	7.0	8.7	8.5	8.4	8.1
217	9.3	12.0	10.7	11.3	10.8	217	8.8	12.0	10.7	10.3	10.5
224	10.4	15.0	12.8	13.4	12.9	224	11.3	15.6	12.4	14.8	13.5
231	12.0	15.4	13.5	14.6	13.8	231	14.2	15.7	15.6	17.3	15.7
238	12.3	15.9	15.2	17.2	15.2	238	16.0	19.6	18.0	19.1	18.2
245	14.8	18.5	17.4	18.2	17.2	Means	11.5	14.3	13.0	14.0	
252	17.8	21.9	19.2	20.5	19.8	Abbreviations:-					
259	21.0	24.6	22.7	21.5	22.4	1 = Sour orange.		2 = Carrizo.			
Means	13.4	16.9	15.2	16.0		3 = Cleopatra.		4 = Citrumelo.			
						A = Rootstock type		B = Fruit age.			
LSD values at 5 % level						a*b = Interaction					
Factor	A		B		a*b	Factor	A		B		a*b
Values	0.45		0.58		1.28	Values	0.51		0.54		1.15

These results are in agreement with those illustrated by Bassal (2000), who indicated that total soluble solids and total soluble solids/total acidity ratio of Marisol, Hernandina and Clemenules mandarin cultivars fruits increased while total acidity contents of fruit juice decreased with the advanced of fruit age . Furthermore, these results are supported by the findings of that rootstock types had an obvious effect on

clementine fruits juice contents of TSS, total acidity, TSS/total acidity ratio and ascorbic acid during growth development and maturation (*Fallahi and Rodney, 1992*). Also these results partially agree with those reported by *D'Hallewin et al. (1994)* who mentioned that rootstocks significantly affect "Avana" mandarin fruit quality in terms of total acidity and ascorbic acid at harvest, but had no effect on TSS content.

2- Ascorbic acid (V.C) content

Ascorbic acid content of fruits (Table 10) increased gradually and significantly with the increasing of fruit age during the two seasons of this study until reaching the maximum nearly at 235 – 240 days of age, then began to decrease gradually and significantly with the increasing of fruit age during the first season, but during the second season this trend was not clear because the samples were ended after 238 days of fruit age.

Data also cleared that rootstock types had no clear effect on fruit contents of ascorbic acid during both seasons. In spite of fruits produced on Carrizo, Cleopatra and Citrumelo had ascorbic acid contents higher than that on Sour orange during the second season. While during the first season, fruits on Carrizo rootstock only had ascorbic acid contents higher than that on the other rootstocks.

These results are in agreement with those illustrated by *Bassal (2000)*, who mentioned that ascorbic acid increased during the early developmental stages while decreased with delaying harvesting process.

Furthermore, these results are supported by the findings of that rootstock types had an obvious effect on clementine fruit juice contents of ascorbic acid during growth development and maturation (*Cohen, 1985* and *Fallahi and Rodney, 1992,*).

Table 10. Effect of four rootstocks on fruits V.C content of "Hernandina" Clementine fruits at various stages of development in 2005/2006 and 2006/2007 seasons.

First season (2005: 2006)						Second season (2006:2007)					
Fruit age (days)	Rootstock types (a)					Fruit age (days)	Rootstock types (a)				
	1	2	3	4	Means		1	2	3	4	Means
210	11.1	9.9	10.4	11.1	10.6	210	18.8	20.0	18.4	21.4	19.6
217	17.0	16.4	16.8	16.8	16.8	217	20.9	23.9	23.6	23.0	22.9
224	17.7	18.3	17.0	16.5	17.4	224	23.8	20.5	22.8	25.1	23.0
231	18.6	18.3	19.4	18.5	18.7	231	23.1	24.5	23.9	22.8	23.6
238	19.5	19.8	17.1	19.3	18.9	238	21.6	24.0	23.3	21.7	22.6
245	18.3	18.7	18.4	19.6	18.7	Means	21.6	22.6	22.4	22.8	
252	16.2	17.5	17.3	17.2	17.1	Abbreviations:- 1 = Sour orange. 2 = Carrizo. 3 = Cleopatra. 4 = Citrumelo. A = Rootstock type B = Fruit age. a*b=Interaction					
259	15.8	15.9	16.2	15.1	15.8						
Means	16.8	16.9	16.6	16.8							
LSD values at 5 % level											
Factor	A		B		a*b	Factor	A		B		a*b
Values	N.S.		0.47		1.04	Values	N.S.		0.33		0.71

C- Fruit maturity stage

From previous illustrated data especially those related to fruit juice quality, it could be conclude that Hernandina fruits bearing on Carrizo and Citrumelo followed by those on Cleopatra rootstocks reached maturation one week earlier than that on Sour orange (nearly after 230 : 235 days from full bloom, during the first week of January). Moreover, data also indicated that fruit quality deteriorated quickly with the delaying of harvesting process after reaching maturity stage.

These results are in line with those obtained by *Ball and Chohan (1987)*, *Jiang and Jiang (1996)* and *Ali (2002)* as they indicated that rootstock types had an obvious effect on maturity stage of clementine fruits.

Table 11. Effect of four rootstocks on properties of "Hernandina" Clementine fruits at maturity stage in 2005/2006 and 2006/2007 seasons.

fruit properties*	First season (2005: 2006)				Second season (2006:2007)			
	Rootstock types				Rootstock types			
	1	2	3	4	1	2	3	4
fruit age (days)	238:242	230:238			238:242	230:238		
fruit weight (g)	145.8	145.8	141.7	135.4	119.3	136.1	129	113.9
fruit gravity (g/cm ³)	0.97	0.93	0.95	0.93	0.91	0.84	0.86	0.84
(Colour) Hue Angle	67.7	64.9	62.3	64.1	68.6	63	66.1	64.7
Fruit firmness (g/cm ²)	106	94.9	106.6	101.9	104.5	100.9	99.1	97.5
juice %	48.8	48	48.3	47.1	50.2	47.1	49.6	49.2
T.S.S	10.2	11.1	10.9	11.2	11.5	12.3	11.8	11.9
Acidity %	0.83	0.7	0.72	0.65	0.72	0.63	0.66	0.63
TSS / Acid ratio	12.3	15.9	15.2	17.2	16	19.6	18	19.1
V.C (mg/ 100ml)	19.5	19.8	17.1	19.3	21.6	24	23.3	21.7
1 = Sour orange		2 = Carrizo		3 = Cleopatra		4 = Citrumelo		
* =The above fruit properties recorded at 238 days of fruit age.								

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دراسات فسيولوجية على تأثير اربعة من الأصول على ثمار

الكليمنتين صنف ارناندينا

١- تطور الثمار ووصولها إلى اكتمال النمو

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تعتبر الموالح من المحاصيل التصديرية الهامة بالنسبة للدخل القومى المصرى. يزرع فى مصر ٣٨٢٠٢٧ فدان من الموالح (إحصاء ٢٠٠٦) بينما تصل المساحة المثمرة منها إلى ٣٤١٧١٨ تنتج ٣٢١١٧٠٩ طن. كما وان هناك هناك فرصة كبيرة لزيادة المصدر من الموالح غير التقليدية إلى السوق الأوروبيه.

أجريت هذه الدراسة بمعهد بحوث البساتين - قسم بحوث تداول الفاكهة خلال الموسم الزراعي ٢٠٠٥:٢٠٠٦ و ٢٠٠٦:٢٠٠٧ تهدف هذه الدراسة إلى تحديد تأثير نوع الأصل على تطور ثمار الكليمنتين صنف ارناندينا ووصولها إلى اكتمال النمو تحت الظروف المصرية. جمعت الثمار دوريا كل أسبوع من أشجار عمر ٧ سنوات منزرعة فى تربه رملية بمنطقة وادى الملاك و مطعومة على أصول النارج - اليوسفى كليوباترا - الكاريزو سترانج - سوينجل ستروميلو ابتداء من شهر ديسمبر ولمدة ثمانية أسابيع فى الموسم الأول وخمسة أسابيع فقط فى الموسم الثانى. تم فحص الثمار لدراسة التغيرات فى الخواص الطبيعية والكيميائية للثمار. وقد تبين من الدراسة ما يلى:-

زاد وزن وحجم الثمار تدريجيا بتقدم الثمار فى العمر وكذلك نسبة المواد الصلبة الذائبة ونسبة المواد الصلبة الذائبة إلى نسبة الحموضة ومحتوى الثمار من العصير ومن فيتامين ج وعلى العكس من ذلك نقصت الكثافة النوعية للثمار وكذلك صلابة الثمار ومحتوى الثمار من الأحماض الكلية

كما اوضحت الدراسة تغير لون الثمار من الأخضر الداكن إلى الاخضر الفاتح ثم الأصفر المخضر الى الأصفر مع زيادة عمر الثمار. كما انخفض وزن الثمار و كثافة الثمار مع تاخر جمع الثمار بعد الوصول الى مرحلة اكتمال النمو كذلك تبين أيضا ان ثمار الكليمنتين صنف ارناندينا المطعومة على الأصل كاريزو او الستروميلو متنوعة بتلك المطعومة على أصل يوسفى كليوباترا تصل مبكرا الى النضج لفترة قد تصل الى اسبوع مقارنة بالمطعومة على أصل النارج.

ثمار اليوسفى ايرناندينا المطعومة على الأصل كاريزو وكليوباترا و الستروميلو كانت اكبر وزنا و حجما ومتقدمه بالنسبه للتطور اللونى كما تحتوى على نسبة اعلى من المواد الصلبة للكلية الذائبة و اقل كثافة نوعيه و صلابه ومحتوى من الحموضه والعصير بالمقارنه بتلك المطعومه على الاصل النارج.

حددت حالة اكتمال النمو فى ثمار اليوسفى ارناندينا خلال الأسبوع الاول من شهر يناير عندما تصل نسبة المواد الصلبة الذائبة الى الحموضه الى اكبر من ١٢-١٣ الى ١ اى بعد حوالى ٢٣٨:٢٣٠ يوما من التزهير الكامل وذلك بالنسبة للثمار المطعومة على أصل الكاريزو و الستروميللو ويوسفى كليوباترا بينما تصل ثمار الأشجار المطعومة على أصل النارنج الى اكتمال النمو خلال الاسبوع الثانى من شهر يناير وذلك بعد حوالى ٢٤٢:٢٣٨ يوما من اكتمال التزهير. كما خلصت الدراسة الى اهمية الاسراع من حصاد ثمار اليوسفى كليمنتين صنف ارناندينا بعد وصولها الى مرحلة اكتمال النمو حتى لاتتعرض خصائص الجودة للتدهور نتيجة نقص المحتوى من العصير وكذلك فيتامين ج وكذلك الجزء الماكول من الثمار (اللحم) وانفصال القشرة عن اللحم وانتفاخ الثمار (نقص الكثافة النوعية).