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SOME FACTORS AFFECTING ORANGE FRUIT SPLITTING OF WASHINGTON NAVEL ORANGE UNDER KAFR ELSHEIKH CONDITIONS.
A- THE EFFECT OF ROOTSTOCK.

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ABSTRACT

This study was carried out during 2010 and 2011 seasons on 14 years old Washington navel orange trees (*C. sinensis*, L.) grown on two citrus rootstocks (Volkamer lemon and Sour orange) and spaced at 5x5 m in private orchard at Kafrelshikh Governorate, to study the effect of these two rootstocks on fruit splitting under Kafrelshikh climatic conditions. The obtained results showed that, trees on Volkamer lemon rootstock gave a highest value of yield, peel thickens, and fruit and navel shape and less % of splitting when compared with those on Sour orange rootstock in both seasons. Also, the results showed a positive relationship between crop load and the percentage of fruit splitting. Fruit splitting is greatest when crop load is heavy from season to season. The results also cleared that the large number of splitted fruit was counted among a large sized of fruit. The splitting fruit recorded less value of peel thicknes when compared with healthy one for both rootstocks. Also, peel thickness at stylar end measured least values for both healthy and splitted fruit. Leaf analysis recorded the highest values of N, K, Ca and Mg concentrations and least values of P and Na on Volkamer lemon with subordinate % of splitting when compared with Sour orange rootstock, which exhibited higher values. Also, Leaf analyses in this study did not show any deficient in these nutrients. Peel analysis recorded lower values of Ca and Mg in the peel of splitted fruit when compared with those in the peel of healthy one. These inadequate values of Ca and Mg in the peel of splitted fruit may be a factor responsible for inducing splitting of Washington Navel orange fruits.

INTEODUCTION

Washington Navel orange (*Citrus sinensis*, L) occupies an important position among other orange cultivars grown in Egypt; due to it has good productive potential and acceptable juice quality. This cultivar as well as many citrus fruit is susceptible to splitting.

Fruit splitting is a major preharvest physiological disorder in various citrus species, leading to annual yield losses of up to 30% (Rabe *et al* 1990, and Barry and Bower 1997).

Fruit splitting is a complex phenomenon which may be controlled by a combination of factors.

MATERIALS AND METHODS

The present study was carried out at the private orchard in Kafrelshikh governorate during 2010 and 2011 seasons on 14 years old Washington Navel orange trees budded on two citrus rootstocks ie.,Volkamer lemon (*C. volkcmariana*) and Sour Orange (*C. aurantium*). The trees are grown in clay soil and spaced at 5X5 meter in a randomized complete design with three replicates each of three trees. Mechanical and chemical analysis of the experimental soilwas done as shown inTable(1).

Table (1): Mechanical and Chemical analysis of experimental field

Mechanical			Chemical			Available ppm			DTPA extractable ppm				
Sand (%)	Silt (%)	Clay (%)	Structure	pH	EC	O.M %	N %	P %	K %	Ca %	Mg %	Na %	Fe ppm	Zn ppm
9.65	32.15	58.20	Clay	8.0	3.35	1.90	0.0018	0.0007	0.0237	0.0011	0.0005	0.0025.	20.09	9.97

The experimental trees have been subjected to similar fertilization, irrigation and pest control practices usually done in that district.

At harvest time (on 15 December) in both seasons, yield of each tree was determined as number and weight (kg) of fruits/tree, then the number of splitted fruit was counted and the percentage of splitting was estimated in relation to the total number of harvested fruit per experimental tree in both seasons.

To determine fruit quality, 10 fruits were taken at random from each tree and prepared for determination of physical and chemical characteristics. Fruit were examined for the incidence of splitting and divided into splitted and healthy fruit for measuring some fruit parameters such as (fruit and navel length, diameter (Cm) fruit and navel shape (D/L ratio) -peel thickness (mm).

In September of both season, 50 mature mid shoot leaves per tree were sampled, washed and oven dried at 70°C to constant weight, the dried leaves were ground and digested by H_2SO_4 and H_2O_2. According Evenhuis and Dewaard (1980), peel samples from splitted and healthy fruit were prepared from each fruit (4desks/fruit) to determination of leaf and peel mineral contents as follows:

- Nitrogen was determined by micro-kjeldahl method (AOAC, 1967)
- K and Na were determined by flame photometer. (Jackson , 1967).
- P by spectrophotometer according to Murrphy and Riely(1962).
- Ca, Mg, were assayed with atomic absorption spectrophotometer (Jackson and Unican 1959).

Statistical analysis was done as analysis of variance according to the method described by Snedecor and Cochran (1967). The least significant differences (LSD at 5% level) and F.test were used to compare between means

RESULTS AND DISCUSSION

1- Splitting evidence of Washington Navel orange as affected by rootstock. Data in Table (2) showed clear influents of the used rootstock on fruit splitting. In this respect, it was clear that Volkamer lemon rootstock recorded less percentage of fruit splitting when compared with Sour orange rootstock with significant differences between them in both seasons.

Table (2) : fruit splitting as affected by used rootstocks of Washington Navel orange under Kaferelshikh climatic conditions in 2010 and 2011seasons.

Rootstock Yield	Yield K/tree 2010		
	Kg/tree	No fruit/tree	% splitted
Sour Orange	67.12	361.00	26.8 2
Volkamer lemon	71.47	389.50	18.02
F- test	*	*	*
2011			
Sour Orange	76.00	370.39	30.90
Volkamer lemon	79.98	406.60	24.23
F- test	*	*	*

***= significant**

This influence can be attributed to the vigorous effect of Volkamer lemon rootstock. This rootstock produced fruit with larger size and also thicker pee when compared to those on Sour orange rootstock. Volkamer lemon exhibited less fruit splitting than Sour orange rootstock, this effect may be due to increase peel thickness on Volkamer lemon rootstock than that obtained on sour orange (Table 3). Also the results cleared significant differences between splitted and healthy fruit in peel thicken. Healthy fruits have thicker peel than splitted ones. Also, data in table (3) showed that peel thickness at stylar end measured the least values while it was the thickest at pedicel end followed by that in the middle which was in between for both healthy and splitted fruits, the differences were significant in most cases in both seasons.

Table (3) Splitting (%) as affected by peel thickness (mm) at different parts of Washington Navel orange fruits grown on tow rootstocks under Kaferelshikh climatic conditions in 2010 and 2011seaso ns.

Rootstocks	Peel thickness 2010								
	Stylar end			Middle			Pedicel end		
	Healthy	Splitted	Mean	Healthy	Splitted	Mean	Healthy	Splitted	Mean
Sour Orange	2. 10	1.14	1.62	2.51	1.24	1.88	3.04	2.19	2.62
Volkamer lemon	2.66	1.52	2.09	2.95	1.71	2.33	3.99	2.52	2.36
Mean	2.38	1.33		2. 73	1.48		3.52	2.36	
Rootstocks		0. 11			0.14			0.11	
LSD5%Fruit type		0. 12			0.14			0.17	
Interaction (RXF)		0.17			0.19			0.24	
						2011			
Sour Orange	2.66	1.52	2.09	2.67	1.52	2.30	3.61	2.05	2.83
Volkamer lemon	2.57	1.71	2.14	3.14	1.99	2.57	3.99	2.66	2.33
Mean	2.62	1.62		2.91	1.76		3.80	2.36	
Rootstocks		0.52			0.10			0.11	
LSD 5%Fruit typeI		0.35			0.13			0.17	
Interaction (RXF)		0.50			0.70			0.25	

These results agree with those of Chen and Zhang(1995), they found that rootstock was shown to have an important effect on the percentage of cracking, which reached 70.6% with *poncirus trifoliata* rootstock, contrary to Yucheng (*Citrus aurantium*) rootstock, which recorded only 5.5% of cracked fruit on it.

2- Splitting as affected by fruit load.

Data in Table (4) showed that, tree yield as Kg or number of fruit per tree was greatest on Volkamer lemon rootstock than on Sour orange rootstock and the differences were significant between them in both seasons.

Table (4)- Fruit splitting as affected by fruit load as weight (kg / tree) and number fruit / tree of Washington Nave l orange fruit grown on two rootstocks under Kaferelsheikh climatic conditions in 2010 and 2011 seasons.

Rootstocks	Yield 2010						
	Kg / tree			No / tree			
	Healthy	Splitted	Mean	Healthy	Splitted	Mean	Splitting%
Sour orange	49.12	18.00	33.56	264.18	96.82	180.50	26.82
Volkamer lemon	58.59	12.88	35.74	319.31	70.19	194.75	18.02
Mean	53.86	15.44		291.75	187.63		
Rootstocks	0.29				1.85		
LSD 5% Fruit type	2.76\				14.99		3.28
Interaction (RXF)	7.81				42.39		
	2011						
Sour orange	52.52	23.48	38.00	255.91	114.48	185.20	30.90
Volkamer lemon	61.09	18.89	39.99	308.08	98.52	203.30	24.23
Mean	56.81	21.19		281.99	106.50		
Rootstocks		0.26			2.50		
LSD 5% Fruit type		2.56			12.57		1.24
Interaction (RXF)		7.23			35.34		

These results are similar to those of (Chikazumi, 1989 and haruled, 2007). As for fruit splitting data in table (4) showed that, splitting is greatest where crop load is heavy from season to season. When yield (Healthy and Splitted) on Volkamer lemon rootstock as number of fruit per tree was (389.6 and 406,6) in both seasons respectively. At the same time, splittlg % recorded 18.02 and 24.23, respectively. These results agree with those of Valbuen(1996) who found that, yield as fruit number or weight per tree of Persian lime was greater on Volkamer lemon than on Cleopatra mandarin,and crop load is effective in inducing fruit splitting. In this respect (Barry and Bower, 1997) reported that the severity of citrus fruit splitting is very much dependent on final crop load. Also, Chen et al (2003) found a close relationship between fruit load and the percentage of splitting in Pomelo citrus variety. Also (Gilfillan and Stevenson et al., 1984; Barry and Bower 1997) they reported that, a high percentage of split fruit occurred at very high crop loads and little or no splitting in years of low crop loads. Lenz and Cary (1969) reported a decrease in fruit size and more importantly, a decrease in rind thickness of Washington Navel orange with an increased crop load per tree.

3- Fruit Splitting as affected by fruit size.

Fruit size is one of the most important factors of quality for citrus fresh_consumption; Data in table (5) clear the relationship between fruit size and splitting % and showed the effect of the used rootstock was more pronounced on Volkamer lemon than on Sour orange rootstock in both seasons.

Table (5): Fruit splitting as affected by fruit size (cm) of Washington Navel orange on tow rootstocks under Kaferelshikh climatic conditions in 2010 and 2011 seasons.

Rootstocks	2010 Fruit number /tree								
	Small Fruit(> 5 cm)			Medium fruit(5-7cm)			Large fruit(< 7 cm)		
	Healthy	Splitted	Mean	Healthy	splitted	Mean	Healthy	splitted	Mean
Sour orange	123.50	13.25	68.38	133.00	24.00	78.5	85.50	28.50	57.00
Volkamer lemon	182.50	12.00	15.25	122.50	12.25	67.38	95.00	14.25	54.63
Mean	153.00	12.63		127.75	18.13		90.25	21.38	
Rootstocks	6.89			2.38			0.51		
LSD 5% Fruit type	16.30			12.90			8.22		
Interaction (RXF)	23.05			18.25			11.62		
	2011								
Sour orange	177.65	15.20	96.43	118.75	19.00	68.88	76.00	20.90	48.45
Volkamer lemon	161.00	10.00	85.50	127.30	11.40	69.35	85.50	14.25	49.88
Mean	169.33	21.6		123.03	15.20		161.5	17.58	
Rootstocks		0.82			10.10			2.31	
LSD5% Fruit type		18.77			12.71			7.68	
Interaction (RXF)		26.54			17.98			10.86	

Also, the results showed that the large number of splitted fruit was counted among a large size of fruit which had a diameter of <7 (cm),the least number of splitted fruit was recorded for small sized fruit >5 (cm) followed by medium size fruit 5-7cm)in both season. On the other hand, data in table (2) exhibited heavy yield on Volkamer lemon with lower number of splitted fruit when compared with Sour orange rootstock and the differences were significant in both seasons, these results agree with Mongi and Rouse (2002), lima and Davis, (1984).

4-Splitting as affected by Fruit and Navel dimensions

Data in table (6) showed that, fruit shape as expressed by D/L ratio recorded lower values with healthy fruit when compared with splitting fruit on the two tested rootstocks, the differences were significant between them in both seasons. Also, data showed that, the effect of used rootstock was more clearly on Volckamer lemon rootstock. In this respect, fruits on Volckamer lemon rootstock recorded the highest values of fruit diameter and fruit shape when compared with those on Sour orange rootstock in both seasons, this effect can be attributed to vigorous effect of Volkamer lemon rootstock. These results agree with peet, (1992), Opera et al., (2000) and Harald (2007). Although fruit shape is specific to a cultivar, certain factors such as warm temperature, relative humidity, as well as rapid water uptake by the tree may accelerate fruit growth. This could alter the fruit shape (increase the D/L ratio).

Table (6): Fruit diameter (cm), fruit length (cm) and fruit shape (D/L) of Washington Navel orange fruit grown on two rootstocks under Kaferelshikh conditions in 2010 and 2011seasons.

Rootstocks	2010								
	Fruit Shape (Cm)								
	Diameter			Length			D/L		
	Healthy	Splitted	Mean	Healthy	Splitted	Mean	Healty	Splitted	Mean
Sour orange	5.51	5.80	5.66	5.99	5.42	5.71	0.93	1.07	1.00
Volkamer lemon	5.89	5.77	5.83	6.08	5.32	5.70	0.97	1.08	1.03
Meam	5.70	5.79		6.04	5.37		0.95	1.08	
Rootstocks		0.04			3.61			0.02	
LSD 5% Fruit type		0.03			0.08			0.01	
Interaction (RXF)		0.04			0.11			0.02	
	2011								
Sour orange	5.43	5.94	5.69	5.98	5.10	5.54	0,92	1.16	1.04
Volkamer lemon	6.39	6.08	6.24	6.27	5.29	5.78	1.02	1.15	1.09
Mean	5.91	6.01		6.13	5.20		0.97	1.56	
Rootstocks		0.12			1.24			0.02	
LSD 5% Fruit Type		0.05			0.92			0.01	
Interaction (RXF)		0.07			1.29			0.02	

In this respect, the initiation of splitting corresponds with the rapid increase in fruit diameter (Garcia- Luis *et al*., (1994). Also, data in tables(3and 5)show that Volkamer lemon produced fruit with larger size and thicker peel when compared with those produced on Sour orange rootstock in both seasons. On the other hand, data in table (7) showed that navel shape as D/L ratio recorded lower values with healthy fruit than those recorded for splitted one. These results were true either for the produced fruits on Sour Orange or Volkamer lemon rootstocks in both seasons. Also, data in table (7) clear that fruit on Volkamer lemon rootstock had a larger navel than those on Sour Orange rootstock in both seasons, the differences were significant between them in most cases.

The obtained results are in line with those obtained by (Harald, 2007, Storey and Treeby, 1999).they reported that some citrus varieties are more susceptible to splitting than other and Navel orange is the most susceptible to splitting. This conclusion indicates that the size of navel may play a role in the susceptibility of Washington Navel orange to splitting.

Also, previous studies related to(Garcia Luis *et al*.,2001; Goldschmidt *et al*., 1992) reported that the split begins near at the navel where the peel is thinner and the split progresses vertically from this point.Thus the largest navel size, is the highest susceptible to splitting.

Table (7): Navel dimensions and its shape (D/L) as affected by rootstock in relation to fruit splitting under Kaferelshekh climatic conditions in 2010 and 2011 seasons.

Rootstocks	Navel Shape 2010								
	Diameter (mm)			Length (mm)			D/L ratio		
	Healthy	Splitted	Mean	Healthy	Splitted	Mean	Healthy	Splitted	Mean
Sour Orange	0.67	1.71	1.19	1.81	2.09	1.95	0.37	0.82	0.43
Volkamer Lemon	1.34	1.75	1.55	1.66	1.06	1.36	0.81	1.66	1.24
Mean	1.01	1.72		1.74	1.58		0.59	1.24	
Rootstocks		0.08			0.13			0.01	
LSD 5% Fruit type		0.09			0.06			0.01	
Interaction (RXF)		0.14			0.08			0.12	
	2011								
Sour orange	1.05	2.28	1.67	1.81	2.75	2.28	0.57	0.84	0.71
Volkamer Lemon	0.55	1.81	1.18	0.90	1.19	1.05	0.62	1.52	1.07
Mean	0.80	2.05		1.36	1.97		0.60	1.18	
Rootstocks		0.10			0.26			0.05	
LSD 5% Fruit type		0.15			0.08			0.02	
Interaction (RXF)		0.21			0.12			0.03	

5– Effect of leaf and peel mineral contents on fruit splitting (%):

a –Leaf:

Data in table (8) show higher values of leaf N, K Ca and Mg on Volkamer Lemon related with lower percentage of fruit splitting(18.02 - 24.23%) when Compared with those values on Sour orang e rootstock (26.82 – 30.90%) in both seasons respectively. The differences were significant between them. Higher leaf Nitrogen content obtained on Volkamer lemon could be explained by its vigorous effect on increasing vegetative growth of the tree canopy. On the contrary, other leaf nutrients (p and Na) recorded less values on Volkamer lemon when compared with those on sour orange rootstock without Significant differences between them in both Seasons. Leaf analyses in this study did not show any deficient of all nutrients as shown in table (8). These results could explained on light of those obtained on peel thickness in table (3) it show that healthy and splitted fruit on Volkamer lemon have the thickest peel comparing with that on Sour orange rootstock. In addition, the imbalances in potassium (k) and phosphorous (p) levels can contribute to cause thin or weak rind. In this respect Mongi and Rouse (2002) indicated that low to deficient K level resulted in thin peel promoting fruit to splitting. This results agree with Almela et al., 1994, on Nova mandarin fruit and Morgan et al., 2005 on Hamlin orange fruit.

Table (8): Leaf mineral contents (%) of Washington Navel orange trees grown on two rootstocks under Kaferelshekh climatic conditions in 2010 and 2011.

Rootstock	Leaf mineral contents (% D.W.T)						
	N	P	K	Ca	Mg	Na	% Splitting
2010							
Sour orange	2.29 b	0.16 a	1.16 b	3.29 b	0.70 b	0.27 a	26.82 a
Volkamer lemon	2.62 a	0.15 b	1.85 a	3.92 a	0.93 a	0.24 b	18.02 b
F test	*	*	*	*	*	*	*
2011							
Sour orange	2.33 b	0.15 a	1.67 b	3.40 b	0.49 b	0.26 a	30.90 a
Volkamer lemon	2.63 a	0.12 b	1.89a	3.67 a	0.70 a	0.20 b	24.23 b
F test	*	*	*	NS	*	*	*

*** = significant NS = Non sidnificant**

b-Peel:

Data in tables (9 and10) show that the peel of splitted or healthy fruits Contained higher values of most nutrient elements on Volkamer lemon rootstock than on Sour orange rootstock in both seasons. These increases may resulted because Volkamer lemon is more vigorous than sour orange rootstock. This rootstock produced fruit with thicker peel than those produced on Sour orange rootstock. This conclusion could explain why Volkamer lemon rootstock exhibited less percentages of fruit splitting than those recorded for Sour orange rootstock in both seasons.

It was clear that the concentration of peel Ca and Mg were lower in the peel of Splitted fruit than those in healthy one on both rootstocks. The differences were significant between them in both seasons as shown in table (10). Such results may through light on the relation between splitting and Ca and Mg content in fruit peel which may affected the level of calcium pectate and magnesium pectate in the middle lamella in cell walls of peel tissues.

It seems that the deficiency or imbalanced levels of Ca and Mg in peel tissues most likely involved in the incidence of splitting of Washington Navel orange fruits either on Volkamer lemon or Sour orange

rootstocks in both seasons. In this connection, similar results were obtained by De Cicco et al., (1988) and Almela et al., (1994). As for peel P and N contents the data did not show any constant trend in both seasons as shown in table (9).

Table (9): Peel N - P and K (%) of healthy and splitted fruit of Washington Navel orange fruit grown on two rootstocks under kafrelshekh climatic conditions in 2010 and 2011.

Rootstocks	2010									
	N (%)			P (%)			K (%)			Splitting
Fruit type	Healthy	Splitted	Mean	Healthy	Splitted	Mean	Healthy	Splitted	Mean	%
Sour Orange	2.31	2.49	2.40	0.05	0.04	0.05	0.84	0.86	0.85	26.82
Volkamer lemon	2.68	2.81	2.75	0.06	0.05	0.06	0.93	0.96	0.95	18.02
Mean	2.49	2.65		0.06	0.05		0.89	0.91		
Rootstocks		0. 07			0.01			0.02		
LSD5% Fruit type		0. 02			0.01			0.01		3.29
Interaction(RXF)		0.02			0.01			0.01		
				2011						
Sour Orange	2.22	2.71	2.47	0.04	0.03	0.04	0.81	0.88	0.85	30.90
Volkamer lemon	2.63	2.84	2.74	0.05	0.06	0.06	0.84	0.94	0.89	24.23
Mean	2.43	2.78		0.05	0.05		0.83	0.91		
Rootstocks		0.05		0.	0.01			0.01		
LSD 5% Fruit type		0.04			0.01			0.01		1.24
Interaction(RXF)		0.06			0.01			0.01		

Table (10): Peel Ca- Mg and Na (%) of healthy and splitted fruit of Washington navel orange fruit grown on tow rootstocks under kafrelshikh Climatic conditions in 2010 and 2011 seasons.

Rootstocks	2010									
	Ca (%)			Mg (%)			Na (%)			
Fruit type	Healthy	Splitted	Mean	Healthy	Splitted	Mean	Healthy	Splitted	Mean	Splitting %
Sour Orange	0.69	0.53	0.61	0.74	0.58	0.91	0.02	0.02	0.02	26.82
Volkamer lemon	1.29	1.02	1.16	0.93	0.88	0.91	0.01	0.02	0.02	18.02
Mean	0.98	0.78		0.84	0.73		0.02	0.02		
Rootstocks		0. 15			0.04			0.01		
LSD5% Fruit type		0. 03			0.05			0.01		3.29
Interaction (RXF)		0.04			0.04			0.01		
				2011						
Sour Orange	0.69	0.57	0.63	0.38	0.36	0.37	0.02	0.02	0.02	30.90
Volkamer lemon	0.89	0.88	0.89	0.34	0.25	0.30	0.01	0.02	0.02	24.23
	0.79	0.73		0.36	0.31		0.02	0.02		
Rootstocks		0.05		0.	0.02			0.01		
LSD 5% Fruit type		0.01			0.01			0.01		
Interaction (RXF)		0.02			0.01			0.01		1.24

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بعض العوامل المؤثره على تشقق ثمار البرتقال ابو سره صنف واشنطن تحت ظروف كفر الشيخ
أ - تأثير الأصل على التشقق.

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قسم الموالح - محطة بحوث البساتين بسخا – كفر الشيخ – مصر

اجرى هذا البحث خلال موسمى ٢٠١٠ - ٢٠١١ على اشجر البرتقال ابوسره صنف واشنطن عمرها ١٤ عام مطعومه على اصلى ليمون الفولكاماريانا و النارنج و ناميه فى مزرعه خاصه بمحافظه كفر الشيخ و ذلك لدراسه تاثير كل من الاصل المستخدم و الظروف المناخيه السائده على التشقق فى ثمار البرتقال ابوسره.

وقد اظهرت النتائج مايلى :

١- اعطت اشجار البرتقال ابوسره المطعومه على اصل الفولكاماريانا اعلى قيم للمحصول مع زياده معنويه فى طول و قطر كل من الثمره و السره و سمك القشره بالمقارنه بالثمار المطعومه على اصل النارنج ، كما اوضحت النتائج ان هناك علاقه طرديه بين المحصول والنسبه المئويه للتشقق.

٢- اشجار البرتقال ابو سره المطعومه على اصل الفولكاماريانا اظهرت اقل نسبه مئويه للتشقق عند مقارنتها بالاشجار المطعومه على اصل النارنج خلال موسمى الدراسه.

٣- سجلت الثمار المشققه قيم منخفضه فى سمك القشره مقارنه بالثمار السليمه وكان اقل سمك للقشره عند النهايه الزهريه(السره) للثمار يليها المنطقه الوسطيه ثم النهايه القريبه من العنق سواء فى الثمار السليمه او المشققه واظهرت النتائج ان نهايه الثمره من جهه السره هى اضعف نقطه فى القشره على كلا الاصلين كما اعطت الثمار المشققه حجم سره االكبر من الثمار السليمه مما يدل على ان ضعف منطقه السره و كبر حجم السره يذيد من قابليه الثمار للتشقق.

٤- اظهرت النتائج ان نسبه التشقق كانت اعلى فى الثمار كبيره الحجم وكانت اكثر و ضوحا فى اصل الفولكاماريامًا عن اصل النارنج

٥- اظهر تحليل الاوراق مستويات عاليه لكل من : النتروجين – البوتاسيوم – الكالسيوم - الماغنيسيوم ومستويات منخفضه من الفوسفور و الصوديوم على اصل الفولكاماريانا عند مقارنتها بالاوراق على اصل النارينج فى نفس الوقت كانت نسبه التشقق اقل على الفولكاماريانا مقارنه باصل النارنج

٦- اوضحت نتائج تحليل القشره بصفه عامه ان قشره الثمار المشققه احتوت على مستويات منخفضه من الكالسيوم –الماغنيسيوم مقارنه بقشره الثمار السليمه. كما اظهرت النتائج ان قشره الثمار التى على اصل الفولكاماريانا احتوت على مستوى اعلى من الكالسيوم و الماغنيسيوم عن قشره الثمار على اصل النارينج الذى سجل نسبه اعلى من النشقق