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Characteristics of Some Grape Cultivars as Affected by Some Grape Rootstocks

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ABSTRACT

This investigation was carried out during two successive seasons (2012 and 2013) on three vine cultivars namely, Flame seedless, Superior seedless and Early sweet. The three studied cultivars were grafted onto Salt Creek, Freedom and Harmony rootstocks in addition to own rooted cultivars (control). Vines were 3 years old grown in a sandy soil and drip irrigated. Results revealed that yield (kg)/vine, cluster weight (gm), length and width of cluster (cm) were markedly increased in grafted vines onto all the three rootstock compared with ungrafted ones. Superior seedless and Early sweet cultivars grafted onto Harmony rootstock resulted in significant high values in berry weight (gm), berry size (cm^3), length/ diameter ratio of berry and Juice volume of 100 berry (cm^3). However, physical characteristics of Flame seedless cultivar were improved when grafted onto Freedom rootstock. Best chemical berries characteristic including SSC percentage, low acidity and high SSC/acid ratio were generally noticed when Flame seedless cultivar grafted onto Harmony rootstock and Superior seedless grafted onto Salt Creek rootstock. Early sweet cultivar grafted onto Harmony followed the similar trend except of juice acidity which recorded high percentage values compared with other grafted rootstocks. Flame seedless and Early sweet cultivars recorded higher fruiting bud percentage when grafted onto Harmony rootstock compared with the own rooted ones and other rootstocks. Meanwhile, highest bud burst percentage and fruiting bud percentage in Superior seedless cultivar was obtained when grafted onto Salt creek rootstock. Generally, yield, cluster and berry characteristics of grafted vines on Salt creek, Freedom and Harmony rootstocks were better compared with own rooted vines.

Key word: grapevine, rootstock, grafting, yield and fruit quality

Introduction

Grape (Vitis vinifera L.) is one of the most wildly cultivated fruit crop all over the world, covering an area of more than 10 million hectares. In Egypt, it is one of the most important fruit crops of temperate zone, it is considered the second most important fruit crop after citrus. The planted area reached 188543 fedan in 2013 producing 1378815 tons (Ministry of Agriculture statistics). The production of grapes increased as a result of interdiction new varieties and rootstocks improved culture practices, post harvest handling as well as a new marketing.

Rootstocks have been used in vineyards since the second half of 19^{th} century as a consequence of the phylloxera (Daktulosphaira vitifoliae) invasion in Europe. Rootstocks, as a link between the soil and the scion, play an important role in vine adaptation to environmental factors.

Choosing the rootstock is one of the most important decisions when establishing vineyards. Rootstocks are employed in grape cultivation to overcome several biotic stresses (phylloxera, nematodes, root diseases, etc.), abiotic stresses (soil and water salinity, water scarcity, frost tolerance, etc.) and, to a limited extent, for controlling vegetative growth, precocity and fruit quality. Numerous studies have shown that rootstocks can affect tree growth, flower development, yield and fruit quality (Seeley *et al.*, 1979; Hirst & Ferree, 1995; Bica *et al*., 2000; Ollat *et al.*, 2003 and Turker & Ak, 2010).

Rootstocks affect vine growth, yield and fruit quality through the interactions between the environmental factors, the physiology of scions and rootstock cultivars employed. Cluster weight, berry size and soluble solids content were also affected by rootstocks (Zhiyuan, 2003). As well as influencing mineral absorption, grapevine rootstocks can affect yield and fruit quality (Grant & Matthews, 1996; Muñoz & Ruiz, 1998; Bavaresco *et al.*, 2003 and Nikolaou *et al.*, 2003).

Little information in Egypt is available about the importance of using grafted vines. The present work was planned and carried out to study the effect of three different rootstocks on yield, cluster and berry characteristics of Flame seedless, Superior seedless and Early sweet cultivars. The ultimate target of this investigation is to determine the difference between grafted cultivars versus ungrafted ones.

Material and Methods

This study was carried out through two successive years (2012 and 2013). In a private vineyard at Bani Salama region, Giza Governorate, Egypt. The experiment included Flame seedless, Superior seedless and Early

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sweet cultivars grafted onto the Salt Creek, Freedom and Harmony rootstocks, in addition to the same ungrafted cultivars (own rooted cultivars) which served as control. Vines were 3 years old and grown in a sandy soil and drip irrigated. Forty-eight vines were selected and arranged into four similar groups (Blocks), each of four vines (replicate). The experimental vines were arranged in complete randomized block design.

The Spanish Barron system was used as a trellising system. Flame seedless and Early sweet cultivars were spur pruned (90 eyes/vine were left), whereas, Superior seedless cultivars were cane pruned (120 eyes/vine were left, 10 canes x 12 buds /vine). All cultural practices were applied according to the recommendations of the Ministry of Agriculture

The following determinations were studied:

1-Bud burst:

Bud burst percentage was calculated by dividing bursted buds on total number of bud and multiplied by 100

2- Fruiting buds:

Fruiting buds percentage was calculated by dividing fruiting buds on total number of buds burst and multiplied by 100

3- Total yield:

Clusters were harvested in each season when SSC % the berry juice of the vines reached 16% for Flame seedless, 13-14 % for Superior seedless and 14-15% for Early Sweet. Yield per vine (kg) were recorded.

4- Cluster and berry physical properties:

Four cluster/vine were employed determined average cluster weight (gm), cluster length and width (cm), then 100 berries/cluster were used to determined the following, average berry weight (g), berry size (cm^3), berry length/ diameter ratio , Juice volume of 100 berry (cm^3) and Berry color was estimated used a Hunter colorimeter model DP-9000 as described by (Mcgire 1992).

5- Fruit chemical properties:

Hundred berries/cluster were used to determined the following, soluble solids content (SSC %) was determined using a hand refractometer. Total titratable acidity (as grams tartaric acid per 100 milliliters of juice) was carried out by titration (A.O.A.C. 1980). SSC/acid ratio was calculated.

6- Statistical analyses:

The data were subjected to analysis of variance and Duncan's multiple rang test was used to differentiate means at 5% (Duncan, 1955).

Results and Discussion

Yield and physical characteristics of clusters:

Data in Tables (1 & 2) show yield, cluster weight, length and width of cluster and shot berries/cluster ratio of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2012 and 2013 seasons. Average yield and cluster weight of the three cultivars was varied significantly among the used rootstocks. Vines grafted on Salt creek and Freedom rootstocks produced the highest yield and cluster weight followed by vines grafted on Harmony rootstocks, which produced intermediate values, while ungrafted vines produced significant lowest yield and cluster weight in both seasons. On the other hand, among the three cultivars, Early sweet produced the highest yield and cluster weight compared with the other cultivars in both seasons.

Concerning interaction between the cultivars and rootstocks, data indicated that, Flame seedless cultivar grafted on Freedom and Salt creek rootstocks gave a significant highest yield followed by Harmony rootstocks than own rooted vines. With respect to Superior seedless cultivar, data in Tables (1 & 2) indicated that grafting on different rootstocks showed insignificant differences of yield and cluster weight, while the ungrafted vines (own rooted) showed a significant reduction in yield and cluster weight. Early sweet

cultivar grafted on Harmony and Salt creek rootstocks gave a significant highest values for yield followed by Freedom rootstock then own rooted vines. Similar trend was noticed in the second season.

As for cluster length of the three cultivars, there was no significant difference between Flame seedless and Early Sweet cultivars, while Superior seedless cultivar gave a significant lower value. Average of cluster length of the three cultivars was varied significantly among the used rootstocks, whereas, Salt creek and Freedom rootstocks gave great increase values compared with Harmony rootstock and own rooted vines. Concerning interaction between cultivars and rootstocks, Flame seedless cultivars grafted on Salt creek rootstock gave a significant higher value of cluster length than other rootstocks. On the other hand the own rooted vines gave the lowest value of cluster length. Superior seedless cultivars grafted on Salt creek and Freedom rootstocks gave a significant increase value of length cluster compared with Harmony rootstock and own rooted vines. Early sweet cultivars grafted on Salt creek and Freedom rootstocks showed significant highest values of cluster length followed by Harmony rootstock and own rooted vines. Similar trend was noticed in the second season.

Concerning cluster width of the three cultivars, Flame seedless cultivar gave a significant highest value, while there was no significant difference between Superior seedless and Early Sweet cultivars. Average of cluster width of the three cultivars was varied significantly among the used rootstocks, whereas, Salt creek and Freedom rootstocks gave great increase values compared with other rootstocks. On the other hand own rooted vines gave the lowest value of cluster width. Concerning interaction between cultivars and rootstocks, Flame seedless cultivars grafted on Salt creek rootstock gave a significant higher value of cluster width than other rootstocks. On the other hand the own rooted vines gave the lowest value of cluster width. With respect to Superior seedless cultivar grafted on Salt creek and Freedom rootstocks, results showed a significant increase value of width cluster compared with Harmony rootstock and own rooted vines. With respect to Early sweet cultivars grafted on Harmony and Freedom rootstocks data showed a significant higher values of cluster width followed by Salt creek rootstock then own rooted vines. Similar trend was noticed in the second season.

The obtained results referring to a positive effect of rootstocks on the length and width of cluster are in agreement with those reported by Önder (2012) who found that the cluster length of 'Round seedless' cultivar was 23.7 cm in vines grafted on 1613C and 20.7 cm in vines grafted on 1616C, whereas, cluster width was 11.0 cm in vines grafted on110R & 1613C and 9.8 cm in vines grafted on 41B.

With respect to value of shot berries per cluster within the three cultivars, Early sweet cultivar recorded the highest value compared with other cultivars in the study. With regards to the effect of rootstocks on number of shot berries per cluster, results indicated that Harmony rootstock gave a significant highest value followed by Salt creek and Freedom rootstocks, where ungrafted vines recorded the lowest values. The data of interaction between the cultivars and rootstocks cleared that, Flame seedless cultivar grafted on Freedom and Harmony rootstocks gave a significant lower number of shot berries per cluster compared with the vines grown on Salt creek rootstock and own rooted vines. As for Superior seedless cultivar, all studied rootstocks showed insignificant differences on number of shot berries per cluster. Concerning Early sweet cultivar, the different types of rootstocks showed a great increase the number of shot berries per cluster compared with own rooted vines, Harmony rootstock gave the highest values followed by Freedom then Salt creek rootstocks. Similar trend noticed in the second season.

Table 1: Yield as kg/vine, cluster weight (gm), length of cluster (cm), width of cluster (cm) and number of shot berries/cluster of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2012 season.

Cultivar	Rootstocks	yield (kg) /vine	Mean	cluster weight (gm)	Mean	Length of cluster (cm)	Mean	Width of cluster (cm)	Mean	No. shot berries/cluster	Mean
Flame seedless	Salt creek	18.05 a	14.94 B	897.26 a	746.47 B	31.9 a	28.17 A	28.0 a	24.4 A	12.05 e	7.03 B
	Freedom	19.39 a		969.18 a		28.1 bc		26.2 b		3.35 g	
	Harmony	12.03 d		601.22 bc		26.8 cd		22.3 c		3.74 g	
	Own rooted	10.51 e		525.23 c		25.9 de		20.6 d		8.98 f	
Superior seedless	Salt creek	9.57 f	9.02 C	478.15 c	450.56 C	24.3 ef	22.50 B	19.4 d	17.93 B	1.20 g	3.28 C
	Freedom	9.82 f		490.60 c		23.0 f		19.2 d		4.30 fg	
	Harmony	9.67 f		482.65 c		22.2 g		17.8 e		1.10 g	
	Own rooted	7.03 g		350.84 d		20.5 g		15.3 f		6.50 f	
Early sweet	Salt creek	17.99 a	15.49 A	899.35 a	773.77 A	29.6 b	26.35A	19.5 d	19.18 B	62.02 c	68.17 A
	Freedom	14.02 c		700.65 b		28.8 b		21.2 c		73.10 b	
	Harmony	19.01 a		949.32 a		24.7 ef		22.5 c		95.21 a	
	Own rooted	10.92 e		545.74 c		22.3 g		13.5 g		42.36 d	
Salt creek		15.12 A		755.92 A		28.60 A		22.30 A		25.09 B	
Freedom		14.41 A		720.14 A		26.63 A		22.53 A		26.92 B	
Harmony		13.06 B		677.73 B		24.56 B		20.87 B		33.35 A	
Own rooted		9.99 C		473.94 C		22.90 B		16.47C		19.28 C	

Means having the same letters within a column are not significantly different at 5% level.

The obtained results are similar to those achieved by Hedberg (1986) who found that yield of all grafted cultivars were much higher than those of the own rooted vines, especially on 'Ramsy' and 'Dogridge' rootstocks. Ferree *et al.* (1996) reported that an increase in the yield was obtained in grafted 'Cab.erent Franc' and 'White Riesling' than own rooted vines. Ezzahouani and Lany (1997) recorded that more vigour was detected from the Italia cultivar grafted on 101-11 and Rupestris du Lot, while the highest yield was

recorded from vines grafted on 11 0 Rand 11 03 P rootstocks. Also, Lovicu *et al.* (1999) observed significant differences among rootstocks, yield of Chardonnay and Tocai cultivars being highest when grafted on 420 A rootstock, followed by the same cultivars on Rupestris du Lot rootstock. On the other hand, Boselli *et al.* (1992) recorded negative or indifferent effects of rootstocks on scion vigour and yield. Chardonnay vines grafted on rootstocks 5C, Kober 5 BB, Gl3, Teleki 8B, S04, l103P and 41B had no significant effect on yields when compared to that from own rooted vines.

Table 2: Yield as kg/vine cluster weight (gm), length of cluster (cm), width of cluster (cm) and number of shot berries/cluster ratio of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2013 season.

Cultivar	Rootstocks	yield (kg) /vine	Mean	cluster weight (gm)	Mean	Length of cluster	Mean	width of cluster	Mean	No. shot berries/cluster	Mean
Flame seedless	Salt creek	18.75 a	14.96 B	936.25 ab	748.13 B	27.1 a	23.9 A	21.2 a	18.5 A	17.14 d	11.99 B
	Freedom	19.80 a		988.96 a		23.6 cd		19.9 b		10.24 e	
	Harmony	9.76 g		486.35 e		22.9 de		17.2 c		8.35 e	
	Own rooted	11.54 c		575.87 de		22.0 e		15.6 de		12.21 e	
Superior seedless	Salt creek	15.96 b	13.91 B	797.69 cd	695.25 C	20.7 f	19.1 B	14.8 ef	13.4 B	1.60 g	2.98 C
	Freedom	16.45 b		820.36 bc		19.4 g		14.4 f		4.10 fg	
	Harmony	16.06 b		802.58 c		18.9 gh		13.2 g		1.00 g	
	Own rooted	7.15 d		355.97 e		17.5 h		11.2 h		5.20 f	
Early sweet	Salt creek	19.61 a	17.27 A	979.54 a	861.93 A	25.2 b	22.45 A	14.7 ef	14.5 B	37.58 c	48.25 A
	Freedom	15.66 b		781.63 cd		24.5 bc		16.3 cd		53.61 b	
	Harmony	20.48 a		1018.22 a		21.1 f		17.1 c		84.21 a	
	Own rooted	13.32 c		664.36 d		19.0 g		10.0 i		17.58 d	
Salt creek		18.11 A		905.33 A		24.3 A		16.90 A		18.77 C	
Freedom		17.30 A		865.17 A		22.5 A		16.87 A		22.65 B	
Harmony		15.43 B		769.74 B		21.0 B		15.83 B		31.19 A	
Own rooted		10.67 C		533.50 C		19.5 B		12.27 C		11.66 D	

Means having the same letters within a column are not significantly different at 5% level.

Physical characteristics of berries:

Data in Tables (3 & 4) show some physical characteristics of berries of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2012 and 2013 season. Averages of berry weight and berry size of the three cultivars were varied significantly among different rootstocks. Harmony produced a significant higher berry weight and berry size compared with other rootstocks, while own rooted vines produced a significant lower value. On the other hand, berry weight and berry size among the three cultivars, Early sweet and Superior seedless produced the highest values compared with Flame seedless cultivar.

Concerning interaction between cultivars and rootstocks, Flame seedless vines grafted on Harmony rootstock gave a significant lower berry weight and berry size than vines grafted on any other rootstock and the own rooted vines. While Superior seedless and Early sweet cultivars grafted on Harmony rootstock gave a significant higher values of berry weight and berry size compared with vines grafted on the other rootstocks and the own rooted vines.

Average length/ diameter berry ratio for varieties in Tables (3 & 4) showed that Flame seedless gave a significant lower value, while, the values were not affected significantly among Superior seedless and Early Sweet cultivars. Length/ diameter ratio of berry was affected by different types of rootstocks, where, berries of ungrafted vines gave a significant lower values compared with the other rootstocks. Concerning interaction between the cultivars and rootstocks, data indicated that the own rooted Flame seedless, Superior seedless and Early sweet cultivars gave a significant lowere value of length/ diameter berry ratio than other grafted ones.

Juice volume of Flame seedless berries gave a significant lower values, while, values was not affected significantly among Superior seedless and Early Sweet cultivars. Juice volume of berries of the three cultivars was varied significantly among the used rootstocks. Vines ungrafted gave the lowest value compared with the other rootstocks, while grafted on Harmony rootstock gave the highest values. Concerning interaction between the cultivars and rootstocks, data indicated that the own rooted Flame seedless, Superior seedless and Early sweet cultivars gave a significant lowere value of juice volume of berries than other grafted ones.

The obtained results referring to a positive effect of rootstocks on the physical characteristics of berries are in agreement with those reported by Satisha *et al.* (2010) who found that bigger and heavier berries, as indicated by higher berry diameter and berry weight, were recorded on vines grafted on to Doy Ridge rootstocks as compared to own rooted vines. Ilhan *et al.* (1998) found that the berry weight of 'Round seedless' cultivar was 1.06 g in vines grafted on Ramsey, 1.04 g in vines grafted on 1613C and 1.03 g in vines grafted on 110R

Average Hue angle (increased berry red color density) and lightness values of berry for Flame seedless in Table (5) showed that vines grafted on Harmony rootstock gave a significant highest values, while, the values were not affected significantly among other rootstocks and own rooted vines.

The influence of rootstock on berry composition has been studied by several workers, Cirami *et al.* (1984) recorded higher fruits had greater color density and more anthocyanines in Shiraz grafted onto Ramisey, Dog Ridge, Harmony, Schwartzman and 1613 C than in own rooted vines. In addition, Kubota *et al.* (1993) grafted Fujimori grapes onto seven different rootstocks and found that the highest level of skin anthocyanin was

observed in berries from vines grafted onto 3306C. Similarly, grafted Shiraz recorded higher color hue than own rooted vines Walker *at al.* (2002).

Table 3: Some physical characteristics of berry of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2012 season.

Cultivar	Rootstocks	Berry weight (gm)	Mean	Berry size(cm^3)	Mean	Length/diameter ratio of berry	Mean	Juice volume of 100 berry (cm^3)	Mean
Flame seedless	Salt creek	2.01 e	2.03 B	1.95 de	1.95 B	0.96 g	0.90 B	150.2 f	145.45 B
	Freedom	2.24 de		2.17 cd		0.95 g		140.8 f	
	Harmony	1.86 f		1.80 e		0.80 i		182.3 e	
	Own rooted	1.99 ef		1.82 e		0.85 h		108.5 g	
Superior seedless	Salt creek	3.08 c	3.50 A	2.71 b	3.22 A	1.14 de	1.19 A	392.5 c	392.38 A
	Freedom	3.51 b		3.26 a		1.12 e		384.2 c	
	Harmony	4.64 a		4.45 a		1.31 b		452.1 a	
	Own rooted	2.76 c		2.47 bc		1.18 cd		340.7 d	
Early sweet	Salt creek	3.51 b	3.31 A	3.42 a	3.16 A	1.15 de	1.20 A	354.2 d	380.45 A
	Freedom	2.82 c		2.75 b		1.21 c		349.4 d	
	Harmony	4.54 a		4.36 a		1.39 a		425.9 b	
	Own rooted	2.37 d		2.11 de		1.04 f		392.3 c	
Salt creek		2.87 B		2.69 B		1.08 B		298.97 B	
Freedom		2.86 B		2.73 B		1.09 B		291.47 B	
Harmony		3.68 A		3.54 A		1.17 A		353.43 A	
Own rooted		2.37 C		2.13 C		1.06 C		280.5 C	

Means having the same letters within a column are not significantly different at 5% level.

Table 4: Some physical characteristics of berry of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2013 season.

Cultivar	Rootstocks	Berry weight (gm)	Mean	Berry size(cm^3)	Mean	Length/ diameter ratio of berry	Mean	Juice volume of 100 berry(cm^3)	Mean
Flame seedless	Salt creek	1.82 fg	1.85 B	1.69 ef	1.66 B	0.94 e	0.92 B	160.0 h	156.68 B
	Freedom	2.07 f		1.63 ef		0.91 ef		152.5 h	
	Harmony	1.51 g		1.35 f		0.88 f		198.3 g	
	Own rooted	1.98 f		1.71 e		0.84 e		115.9 i	
Superior seedless	Salt creek	3.53 c	3.74 A	3.26 c	3.49 A	1.20 ab	1.16 A	331.7 d	351.10 A
	Freedom	3.81 b		3.68 b		1.15 bc		322.5 d	
	Harmony	4.64 a		4.30 a		1.25 a		445.0 a	
	Own rooted	2.99 de		2.71 d		1.05 d		305.2 e	
Early sweet	Salt creek	3.77 bc	3.25 A	3.28 c	3.02 A	1.07 d	1.11 A	348.3 c	336.98 A
	Freedom	2.95 e		2.87 d		1.10 cd		340.2 c	
	Harmony	4.18 a		3.99 b		1.17 b		363.5 b	
	Own rooted	2.08 f		1.95 e		1.08 d		295.9 f	
Salt creek		3.04 B		2.74 B		1.07 B		280.0 B	
Freedom		2.94 B		2.72 B		1.05 B		271.7 B	
Harmony		3.44 A		3.21 A		1.10 A		335.6 A	
Own rooted		2.35 C		2.12 C		1.02 C		239.0 C	

Means having the same letters within a column are not significantly different at 5% level.

Table 5: Berry color (Hue angle) and lightness (L) of Flame seedless as affected by different tested rootstocks in 2012-2013 seasons.

Rootstocks	Hue angle		Value of lightness	
	2012	2013	2012	2013
Salt creek	10.23 b	26.57 b	10.50 b	26.96 b
Freedom	12.04 b	27.17 b	11.24 b	28.89 b
Harmony	17.83 a	33.40 a	16.21 a	30.90 a
Own rooted	13.33 b	26.86 b	12.69 b	26.94 b

Means having the same letters within a column are not significantly different at 5% level.

- Higher Hue angle = more red color
- Higher value of lightness = more brightness

Chemical characteristics of berries:

Data in Tables (6 & 7) show some chemical characteristics of berries for Flame seedless, Superior seedless and Early sweet cultivars as affected by different tested rootstocks in 2012 and 2013 seasons. Average values for rootstocks effect on berries SSC%, acidity% and SSC/acid ratio of the three cultivars were varied significantly. Berries of vines grafted on Harmony rootstock produced significant higher values of SSC

percentage and SSC/acid ratio followed by berries of vines grafted on Salt creek, Freedom rootstocks then ungrafted. With regard to acidity of juice, berries of vines grafted on Harmony rootstock gave a significant lower values compared with the other rootstocks. On the other hand, average values for varieties effect on berries SSC percentage, SSC/acid ratio and acidity of juice percentage, Early sweet cultivar produced a significant higher values of SSC percentage and SSC/acid ratio and low acidity of juice percentage compared with the other cultivars in both seasons.

Interaction between cultivars and rootstocks, Flame seedless cultivars grafted on Harmony and Freedom rootstocks gave a significant higher value of SSC percentage compared with other rootstocks, while the own rooted vines gave the lowest value of SSC percentage. However, vines grafted on Harmony and Freedom rootstocks gave a significant lower values of juice acidity percentage compared with other rootstocks. Whereas, vines grafted on Harmony rootstock gave a great increase value of SSC/acid ratio compared with other rootstocks. With respect to Superior seedless cultivar grafted on Salt creek and Freedom rootstocks was obtained a significant increase value of SSC percentage compared with Harmony rootstock and own rooted vines. The own rooted vines gave the lowest value. SSC/acid ratio was significantly increased when Superior seedless grafted on Harmony and Salt creek rootstocks followed by Freedom rootstock and own rooted vines. Concerning acidity of juice berries percentage, own rooted vines of Superior seedless cultivar gave a significant highest values followed by Superior seedless grafted on Freedom, Salt creek and Harmony rootstocks. As for Early sweet cultivar grafted on Harmony rootstock data showed a significant highest values of SSC percentage and acidity of juice berries percentage compared with other rootstocks, whereas vines grafted on Salt creek and Harmony rootstocks revealed great increase of SSC/acid ratio followed by Freedom rootstock and own rooted vines in both seasons.

Table 6: Some chemical characteristics of berries of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2012 season.

Cultivar	Rootstocks	SSC %	Mean	Juice acid content %	Mean	SSC/acidity	Mean
Flame seedless	Salt creek	16.2 d	16.35 B	0.52 d	0.49 B	31.15 e	33.61 B
	Freedom	17.4 b		0.47 ef		37.02 c	
	Harmony	17.5 b		0.44 fg		39.54 b	
	Own rooted	14.3 e		0.54 d		26.48 g	
Superior seedless	Salt creek	16.8 c	15.95 C	0.65 b	0.66 A	25.85 g	24.26 C
	Freedom	16.6 c		0.67 b		24.77 h	
	Harmony	15.9 d		0.61 c		26.07 g	
	Own rooted	14.5 e		0.71 a		20.42 i	
Early sweet	Salt creek	17.1 bc	16.48 A	0.47 ef	0.47 B	36.38 c	35.31 A
	Freedom	16.0 d		0.46 f		34.78 d	
	Harmony	18.5 a		0.51 de		36.27 c	
	Own rooted	14.3 e		0.42 g		28.04 f	
Salt creek		16.70 B		0.56 A		31.13 B	
Freedom		16.67 B		0.55 A		32.07 B	
Harmony		17.30 A		0.50 B		33.96 A	
Own rooted		14.37 C		0.55 A		25.08 C	

Means having the same letters within a column are not significantly different at 5% level.

Table 7: Some chemical characteristics of berries of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2013 season.

Cultivar	Rootstocks	SSC %	Mean	Juice acidity %	Mean	SSC/acidity ratio	Mean
Flame seedless	Salt creek	16.5 d	16.67 B	0.63 b	0.57 B	26.19 f	30.22 B
	Freedom	17.5 bc		0.56 d		31.25 c	
	Harmony	17.8 b		0.51 ef		34.90 a	
	Own rooted	14.9 e		0.60 c		23.28 h	
Superior seedless	Salt creek	16.9 d	15.95 C	0.59 c	0.61 A	28.64 d	26.51 C
	Freedom	17.1 c		0.62 bc		27.58 e	
	Harmony	15.7 e		0.54 de		29.07 d	
	Own rooted	14. 1 g		0.68 a		20.74 i	
Early sweet	Salt creek	17.6 b	16.78 A	0.50 fg	0.49 B	35.20 a	35.39 A
	Freedom	16.3 d		0.48 g		33.75 b	
	Harmony	18.6 a		0.52 ef		35.77 a	
	Own rooted	14.6 f		0.44 h		33.18 b	
Salt creek		17.00 B		0.57 A		29.31 B	
Freedom		16.97 B		0.55 A		30.58 B	
Harmony		17.37 A		0.52 B		33.41 A	
Own rooted		14.53 C		0.57 A		26.05 C	

Means having the same letters within a column are not significantly different at 5% level.

The present results are in harmony with the findings of El-Gendy (2013) who found that Flame seedless grafted on Freedom rootstock had a highest percentage of SSC%, SSC / acid ratio and the lowest percentage of acidity of berry juice. On the other hand, Reynolds and Wardle (2001) through working on grafting nine wine grape cultivars on four different rootstocks found few significant differences in titratable acidity among rootstocks over eight years.

Bud burst and fruiting buds percentage:

Data in Tables (8& 9) show bud burst and fruiting bud percentage of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2012 and 2013 seasons. Average of bud burst percentage of the three cultivars was varied significantly among the used rootstocks. Vines grafted on Salt creek rootstock and own rooted vines produced a significant highest value of bud burst percentage followed by vines grafted on Freedom and Harmony rootstocks. On the other hand, among the three cultivars, Superior seedless produced significant highest bud burst percentage compared with the other cultivars in both seasons.

Concerning interaction between the cultivars and rootstocks, data indicated that, Flame seedless cultivar ungrafted (own rooted) gave a significant highest bud burst percentage followed by Salt creek, Freedom and Harmony rootstocks. With respect to Superior seedless cultivar, data in Tables (8 & 9) indicated that grafted on Salt creek and Harmony rootstocks showed a significant high value of bud burst percentage, while the ungrafted vines gave a significant reduction in bud burst percentage. As for ungrafted Early sweet cultivar gave a significant highest values for bud burst percentage followed by Harmony, Salt creek then Freedom rootstocks. Similar trend was noticed in the second season.

Table 8: Bud burst % and fruiting bud (%) of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2012 season.

Cultivar	Rootstocks	Bud burst (%)	Mean	Fruiting bud (%)	Mean
Flame seedless	Salt creek	59.6 f	54.73 C	46.61 c	48.84 A
	Freedom	51.8 i		51.48 b	
	Harmony	45.4 k		55.74 a	
	Own rooted	62.1 e		41.52 d	
Superior seedless	Salt creek	74.6 a	65.45 A	30.77 f	27.55 C
	Freedom	68.2 b		27.19 g	
	Harmony	75.7 a		28.43 g	
	Own rooted	63.3 de		23.83 h	
Early sweet	Salt creek	53.4 h	58.08 B	46.88 c	41.05 B
	Freedom	47.4 j		35.37 e	
	Harmony	55.8 g		51.77 b	
	Own rooted	65.7 c		30.19 f	
Salt creek		62.53 A		41.42 B	
Freedom		55.80 C		38.01 C	
Harmony		58.97 B		45.31 A	
Own rooted		62.70 A		31.85 D	

Means having the same letters within a column are not significantly different at 5% level.

Table 9: Bud burst % and fruiting bud (%) of Flame seedless, Superior seedless and Early sweet as affected by different tested rootstocks in 2013 season.

Cultivar	Rootstocks	Bud burst (%)	Mean	Fruiting bud (%)	Mean
Flame seedless	Salt creek	65.6 d	56.93 C	47.43 d	50.49 A
	Freedom	50.5 gh		52.52 b	
	Harmony	42.7 i		60.06 a	
	Own rooted	68.9 c		42.93 f	
Superior seedless	Salt creek	82.4 a	76.23 A	32.25 g	27.83 C
	Freedom	79.8 b		28.35 i	
	Harmony	82.4 a		29.23 i	
	Own rooted	60.3 f		21.49 j	
Early sweet	Salt creek	51.8 g	58.03 B	48.99 c	43.75 B
	Freedom	49.9 h		44.59 e	
	Harmony	62.3 e		52.04 b	
	Own rooted	68.1 c		29.37 h	
Salt creek		65.97 A		42.89 B	
Freedom		60.70 C		41.82 C	
Harmony		62.47 B		46.78 A	
Own rooted		65.77 A		30.93 D	

Means having the same letters within a column are not significantly different at 5% level.

With respect to value of fruiting bud percentage within three cultivars, Flame seedless cultivar recorded a significant highest value compared with the other cultivars in the study. In regards the effect of rootstocks on fruiting bud percentage, results indicated that Harmony rootstock gave a significant highest value followed by Salt creek then Freedom rootstocks, where ungrafted vines recorded the lowest values. The data of interaction between the cultivars and rootstocks cleared that, Flame seedless cultivar grafted on Harmony rootstock gave a significant higher value of fruiting bud percentage than the other rootstocks. As for Superior seedless cultivar, vines grafted on Salt creek gave a great increase values compared with other rootstocks, while vines grafted on Freedom and Harmony rootstocks showed insignificant differences of fruiting bud percentage. Own rooted vines gave a significant lowest value of fruiting bud percentage. Concerning Early sweet cultivar, all rootstocks increased fruiting bud percentage, while ungrafted vines gave the lowest values. Similar trend noticed in the second season.

Some of the obtained result of this study are in agreement with those obtained by Prakash and Reddy (1990) who studied the effect of different rootstocks ('St. George', 'Gulabi', 'Teleki 5A', '1616', '1613' and 'Dog Ridge') on bud break of grapevine 'Anab-e-Shahi', they found that the overall duration of bud break was not significantly affected by rootstock although the number of days required for bud break was shorter with 'Gulabi' and longer with 'Dog Ridge'.

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