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# Performance of some Table Grape Cultivars Grafting on Different Rootstocks in El-Nubaria Region

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## ABSTRACT

This study had made in El-Nubaria region at the desert street Alex, Cairo 75 km during 2012 and 2013 seasons. Three different scions from Europe grape vine on three different rootstocks are used in this study, their age is six years old in private orchard, sandy clay loom soil on spaced at 2×3 m and irrigated by drip. The results showed that, Flame seedless scion grafted on different rootstocks gave the earliest time for bud burst time, flowing time, time of cluster flower setting, berry coloring time and time of berry ripening comparing with Superior and Thompson scions and ungrafted cultivars. Moreover, data showed that Superior seedless and Thompson seedless cultivars scions on Freedom, Polcin1103 and salt Greek rootstocks gave the better number for internodes/cane per vine comparing to Flame seedless cultivars grafted on Freedom, Polcin1103 and salt Greek rootstocks in both seasons. Flame seedless and Superior seedless cultivars grafted on Freedom, Polcin 1103 and salt Greek rootstocks gave the better berry adherence strength per vine, yield and yield components in contract to Thompson seedless cultivars grafted on Freedom, Polcin 1103 and salt Greek rootstocks in two seasons. Leaf mineral contents in scions understudy did not clearly affected with type of rootstocks comparing with ungrafted scions, Polcin1103 rootstock increased all leaf mineral contents understudy followed by Freedom, salt Greek stock and finally ungrafted scion. Also, leaf of Superior seedless contained the highest values of elements followed by Thompson seedless and Flame seedless regardless the type of rootstocks.

**Key words:** Grape, rootstocks, flame seedless, ungrafted

## INTRODUCTION

Grapes (*Vitis vinfera* L.) are one of the important fruit crops grown in the world and are cultivated widely in temperate and subtropical climates. Even though their origin was in temperate regions, they perform equally well in a tropical climate in Egypt, where they are grown as an evergreen vine without undergoing dormancy. Rootstocks are used in most grape growing countries to overcome biotic stresses like nematodes, phylloxera, root lice, etc. The use of rootstocks in *Vitis*, however, was not extensively used until 1880 because it was the only effective method to combat the devastating root louse phylloxera, *Phylloxera vitifoliae* (Coombe, 1995). In California, grape growers have been using rootstocks for over 100 years (Foott *et al*., 1989). The major reason to use rootstocks is in their resistance to some severe biotic problems such as phylloxera and nematodes. Reynolds and Wardle (2001) outlined seven major criteria for choosing rootstocks in the order of importance as phylloxera resistance, nematode resistance, adaptability to high pH soils, adaptability to saline soils, adaptability to low pH soils, adaptability to wet or poorly drained soils and adaptability to drought. Numerous reports have also proved that rootstocks affect vine growth, yield, fruit quality and wine quality. These effects take place in a more or less indirect manner and are consequences of interactions between environmental factors and the physiology of the scion and rootstock cultivars employed. Due to numerous available rootstocks and the difficulty in predicting the interaction of scion and rootstocks at short as well as long term, make it difficult to choose the suitable rootstock (Cus, 2004; Loreti and Massai, 2006). Because of a different affinity of rootstocks for the scions, the right choice of appropriate rootstock is of great importance for the quality of grafted grapevines. Ampelography and ampelometry based on morphological differences between the varieties are known methods for varietal identification. A lot of molecular markers have been employed to characterize grape varieties and rootstocks (Satisha *et al*., 2008; Dzhambazova *et al*., 2007). It was found that the stocks affect on scion cultivates in one hand and the scion affect on stock growth on the other in different ways such as: size and growth habit, rootstock can be classified as dwarf, semi dwarf vigorous and very vigorous rootstock based on their effect on a scion cultivator. If a scion is drafted on dwarf rootstock the graft combination will be dwarf while he same cultivar grafted on very rootstock would grow very vigorously (Todic *et al*., 2005). Precocity in flowering and fruiting, the time taken from planting to fruiting (precocity) is influenced by rootstocks. Many studies have been undertaken across several decades in an attempt to improve the knowledge of rootstock effect on scion growth and other yield and quality parameters (Bica *et al*., 2000; Ollat *et al*., 2003). Several studies in the past have shown that rootstocks are known to influence many physiological and biochemical reactions in the grafted scions. Leaves of Flame Seedless and Shared Seedless vines grafted on Dog ridge rootstock were known to accumulate more ABA at 50% moisture stress, resulting in increased water use efficiency, than own rooted vines of the same cultivars (Satisha *et al*., 2007). Bica *et al*. (2000) observed a significant effect of rootstock on leaf area, chlorophyll content, stomata conductance and quantum yield in Pinot Noir and Chardonnay grapevines.

Therefore, the present investigation was, carried out to study the effect of grafting different rootstocks-scions grapes on some phonological parameters, vegetative growth, fruitfulness and chemical status using List of descriptors of grapes (IPGRI, Descriptors of grapevine (*Vitis* spp.), (IPGRI., 1997).

## MATERIALS AND METHODS

This trial was carried out during two successive seasons (2012 and 2013) to study of three different grape cultivars (Flame seedless, Superior seedless and Thompson seedless) witch budded on three different rootstocks (Freedom, Polcin 1103 and salt Greek moreover control) the three scions are also used as cuttings with out budded as control. The grape vine was 6 years old at the start of experiment. The grape vines were planted at 2×3 m in apart under drip irrigation system and grown on sandy clay loam soil in private orchard located at EL-Nubaria (75 km Alexandria Cairo desert road) Behera Governorate. Evaluation process of selected scions was conducted by following scientific assessment rules used by Intern. Board Plant Gen. Research. The following parameters were determined.

**Phenological characteristics:** Bud burst time of scions under study was recorded in both seasons (Aliami, 1987). Flowering time was recorded when bud medium length became 5 cm in all brands. Time of cluster flower setting was recorded on transformation into fruit cluster in various scions in both study seasons. Berry coloring time was recorded at period started on coloring 50% of fruit cluster berries and finally, time of berry ripening was recorded after berry reaches suitable growth stage as color suitable for scion and berry reaching its maximum size.

**Morphological characteristics:** Many morphological properties were studied which could help in recognizing and distinguishing scions. Internodes length (cm) and Internodes thickness (cm) were measured by using (Vernier caliper). Number of internodes/cane, average internodes number present in cane of various scions was taken by dividing average can length on average internodes length. Cane length (cm) measured by taking average length of 10 various canes per vine. Pruning weight (kg/vine), was weighed during pruning season which started in mid December in both of study seasons and finally leaf area ($cm^2$) was estimated by using leaf area Meters LI-Cor Model LI-3000 Ano. Pam 1671 on 25 fully grown leaves per vine.

**Yield and yield components**

**Yield:** Yield of grape scions under study was estimated in both seasons at point of fruit full growing to determine yield parameters. Five fruit cluster taken per vine were and following estimations were made according to usual procedures. Number of cluster/vine, cluster weight (g), yield (kg/vine): The produced cluster yield on each replicate grapevine resulting under study was expressed as number of cluster/vine and weight of cluster in kg/vine. Yield (t/feddan), was expressed by multiply the weight of cluster/vine x number of vine/feddan. Finally, berry adherence strength (g) was expressed by gram necessary to separate berry from cluster. Methods used for this purpose was done by Barbary *et al*. (1994) and Mattheou *et al*. (1995).

**Yield components:** Hundred berries per vine were weighed then average berry weight was taken in grams. Berry volume ($cm^3$) was estimated from a random sample composed of 100 berries/vine by removing water. Juice volume ($cm^3$), was estimated from 100 berries taken from each ($cm^3$) cluster. Some chemical properties of various scions berries were estimated by using methods followed in AOAC (1980). Hundred berry juices were taken from each vine by using mixer and filtering juice by band then following chemical properties were estimated. Total Soluble Solids (TSS %), measured by hand refractometer, total acidity (%), by titrating a known volume of juice with 0.1 NaOH using phenolphthalein as indicator. Then TSS/acid (ratio) was calculated. Also, Moisture (%) was estimated via weight of 50 g of fruit flesh after cutting into small pieces then dried in an oven at 70°C for period of 72 h or till weight got stable.

**Determination of leaf minerals composition:** Samples of twenty leaves/vine were taken at random from the previously tagged shoots, the leaf samples were washed with tap water and distilled water and them oven dread at 70°C to constant weight and them ground. To determine the leaf mineral contents, ground martial of each sample was digested with $H_2SO_4$ and $H_2O_2$ according to Wolf (1988). In the digested material, total nitrogen and phosphorus were determined calorimetrically according to Murphy and Riley (1962), respectively and potassium was determined by Flame photometer as described by Cheng and Bray (1951). Micronutrients (Fe, Zn and Mn) leaf contents were determined by Perkin EL mer atomic absorption spectrophotometer according to Carter (1993). The concentration of N, P and K, were expressed as percent, while those of Fe, Zn and Mn were expressed as parts per million, on dry weight basis.

**Statistical analysis:** The design used was a completely randomized design in a factorial experiment as described by Snedecor and Cochran (1980) at 5% probability level. Data obtained was statistically analyzed using MASTAT computer program and means were compared by Duncan's Multiple Range Test (Duncan, 1955).

## RESULTS AND DISCUSSION

**Effect of some table grape scions grafted on different rootstocks on phenological characteristics:** The data in Table 1 showed the effect of some table grape scions grafted on different rootstocks on phenological characteristics for both experimental seasons. As for time of bud burst, data showed that Flame seedless scions grafted on Freedom, Polcin 1103, salt Greek and ungrafted started to bud burst time in 1-5th February, 1-5th February, 1-5th February and 5-10th February, respectively. Also, ungrafted Superior seedless beginning the time bud burst earlier 5 days as compared with Superior seedless scions grafted on different rootstocks in both seasons understudy. Regarding, time of flowering, the results revealed that Flame seedless scions ungrafted and grafted on Freedom, Polcin 1103 and salt Greek started to time of flowering on 5-10th march, 10-15th march, 10-15th march, 10-15th march to Freedom, Polcin 1103 and salt Greek rootstocks in both reasons, respectively. No, different on time of flowering of Polcin 1103 and salt Greek rootstocks in both seasons. In all rootstocks no different effect of cultivar Thompson seedless in 2012 and 2013 seasons. Concerning time of cluster flowering, it was found that, in both seasons, Flame seedless, Superior seedless and Thompson seedless scions grafted or ungrafted started on time of flowering cluster in 1-5th April. For time of berry coloring the data of both experimental seasons indicated that, Flame seedless cultivars scions ungrafted and grafted on Freedum, Polcin 1103 and salt Greek rootstocks started to time berry coloring in 15-30th May No different effect of Superior seedless scions and Thompson seedless scions grafted on Freedum, Polcin 1103 and salt Greek rootstocks on the beginning on time of berry coloring in both seasons. Data showed as for time of berry ripening that, ungrafted Flame seedless started to time of berry ripening on 10-15th June 2012 season and 5-10th June 2013 season. Also, Flame seedless scions grafted on Freedum, Polcin 1103 and salt Greek rootstocks started to time of berry ripening on 1-5thJune in both seasons, while Superior seedless started to time of berry ripening on 5-10th June, 1-5th June and 1-5th June for three rootstocks, respectively. The same trend of results were reported by Mattheou *et al.* (1995), Shah *et al.* (1993) and Osman *et al.* (1997).

Table 1: Bud burst time, flowering time, cluster flower time, berry coloring time, berry ripening time and days from flowering to ripening of different grape scions budded on different rootstocks at 2012 and 2013 seasons

| | Bud burst time | | Flowering time | | Cluster flower time | | Berry coloring time | | Berry ripening time | |
|---|---|---|---|---|---|---|---|---|---|---|
| Scions and rootstocks | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| **Flame seedless** | | | | | | | | | | |
| Control (ungrafted) | 1-5 Feb. | 5-10 Feb. | 5-10 Mar. | 5-10 Mar. | 1-5 Apr. | 25-30 Mar. | 25-30 May | 25-30 May | 10-15 June | 5-10 June |
| Freedum | 1-5 Feb. | 5-10 Feb. | 1-5 Mar. | 1-5 Mar. | 1-5 Apr. | 25-30 Mar. | 20-25 May | 20-25 May | 1-5 June | 1-5 June |
| Polcin1103 | 1-5 Feb. | 5-10 Feb. | 1-5 Mar. | 1-5 Mar. | 1-5 Apr. | 25-30 Mar. | 20-25 May | 20-25 May | 1-5 June | 1-5 June |
| Salt Greek | 1-5 Feb. | 5-10 Feb. | 1-5 Mar. | 1-5 Mar. | 1-5 Apr. | 25-30 Mar. | 20-25 May | 20-25 May | 1-5 June | 1-5 June |
| **Superior seedless** | | | | | | | | | | |
| Control (ungrafted) | 10-15 Feb. | 10-15 Feb. | 1-5 Mar. | 1-5 Mar. | 5-10 Apr. | 5-10 Apr. | 20-25 May | 20-25 May | 5-10 June | 5-10 June |
| Freedum | 10-15 Feb. | 10-15 Feb. | 25-28 Feb. | 25-28 Feb. | 5-10 Apr. | 5-10 Apr. | 15-20 May | 15-20 May | 1-5 June | 1-5 June |
| Polcin1103 | 10-15 Feb. | 10-15 Feb. | 25-28 Feb. | 25-28 Feb. | 5-10 Apr. | 5-10 Apr. | 15-20 May | 15-20 May | 1-5 June | 1-5 June |
| Salt Greek | 10-15 Feb. | 10-15 Feb. | 25-28 Feb. | 25-28 Feb. | 5-10 Apr. | 5-10 Apr. | 15-20 May | 15-20 May | 1-5 June | 1-5 June |
| **Thompson seedless** | | | | | | | | | | |
| Control (ungrafted) | 10-15 Mar. | 5-10 Mar. | 20-25 Mar. | 20-25 Mar. | 10-15 Apr. | 10-15 Apr. | 10-15 June | 10-15 June | 5-10 July | 5-10 July |
| Freedum | 10-15 Mar. | 5-10 Mar. | 20-25 Mar. | 20-25 Mar. | 10-15 Apr. | 10-15 Apr. | 5-10 June | 10-15 June | 1-5 July | 1-5 July |
| Polcin1103 | 10-15 Mar. | 5-10 Mar. | 20-25 Mar. | 20-25 Mar. | 10-15 Apr. | 10-15 Apr. | 5-10 June | 5-10 June | 1-5 July | 1-5 July |
| Salt Greek | 10-15 Mar. | 5-10 Mar. | 20-25 Mar. | 20-25 Mar. | 10-15 Apr. | 10-15 Apr. | 5-10 June | 5-10 June | 1-5 July | 1-5 July |

Table 2: Internode length, internode thickness, number of internodes/cane, cane length, pruning wood weight and leaf area as affected of different scion-stocks of grapes vine at 2012 and 2013 seasons

| | Internode length (cm) | | Internode thickness (cm) | | No. of internodes/cane | | Cane length (cm) | | Pruning wood weight (kg vine$^{-1}$) | | Leaf area (cm$^2$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scions and rootstocks | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| **Flame seedless** | | | | | | | | | | | | |
| Control (ungrafted) | 7.70$^{d}$ | 7.83$^{d}$ | 0.93$^{ab}$ | 0.93$^{ab}$ | 7.77$^{d}$ | 8.06$^{d}$ | 79.5$^{b}$ | 82.10$^{ab}$ | 5.73$^{b}$ | 5.92$^{a}$ | 148$^{bcd}$ | 156$^{a}$ |
| Freedom | 8.27$^{b}$ | 8.54$^{a}$ | 0.96$^{a}$ | 0.96$^{a}$ | 7.90$^{d}$ | 8.200$^{c}$ | 83.6$^{a}$ | 84.20$^{a}$ | 6.44$^{a}$ | 6.21$^{a}$ | 149$^{abc}$ | 151$^{ab}$ |
| Polcin1103 | 8.58$^{a}$ | 8.60$^{a}$ | 0.94$^{a}$ | 0.86$^{bc}$ | 8.17$^{c}$ | 8.33$^{b}$ | 84.6$^{a}$ | 84.90$^{a}$ | 6.12$^{a}$ | 6.20$^{a}$ | 162$^{a}$ | 160$^{a}$ |
| Salt Greek | 8.33$^{b}$ | 8.30$^{b}$ | 0.97$^{a}$ | 0.94$^{abc}$ | 8.14$^{c}$ | 8.07$^{d}$ | 84.80$^{a}$ | 84.50$^{a}$ | 6.31$^{a}$ | 6.27$^{a}$ | 152$^{ab}$ | 152$^{ab}$ |
| **Superior seedless** | | | | | | | | | | | | |
| Control (ungrafted) | 8.06$^{c}$ | 8.27$^{bc}$ | 0.93$^{ab}$ | 0.95$^{a}$ | 7.93$^{d}$ | 8.07$^{d}$ | 83.40$^{a}$ | 80.5$^{b}$ | 4.91$^{c}$ | 4.91$^{bc}$ | 156$^{ab}$ | 152$^{ab}$ |
| Freedom | 8.17$^{bc}$ | 8.16$^{c}$ | 0.96$^{a}$ | 0.96$^{a}$ | 8.33$^{bc}$ | 8.30$^{b}$ | 83.50$^{a}$ | 83.40$^{ab}$ | 5.22$^{c}$ | 5.30$^{b}$ | 155$^{ab}$ | 160$^{a}$ |
| Polcin1103 | 8.37$^{b}$ | 8.40$^{b}$ | 0.93$^{ab}$ | 0.96$^{a}$ | 8.19$^{c}$ | 8.33$^{b}$ | 83.40$^{a}$ | 83.00$^{ab}$ | 5.17$^{c}$ | 5.2$^{b}$ | 160$^{ab}$ | 160$^{a}$ |
| Salt Greek | 8.30$^{b}$ | 8.30$^{b}$ | 0.96$^{a}$ | 0.95$^{a}$ | 8.71$^{a}$ | 8.21$^{c}$ | 82.9$^{ab}$ | 84.00$^{a}$ | 4.89$^{c}$ | 5.27$^{b}$ | 154$^{ab}$ | 160$^{a}$ |
| **Thompson seedless** | | | | | | | | | | | | |
| Control (ungrafted) | 7.84$^{d}$ | 7.97$^{d}$ | 0.85$^{c}$ | 0.84$^{c}$ | 8.19$^{c}$ | 8.13$^{cd}$ | 79.90$^{b}$ | 80.40$^{b}$ | 4.30$^{d}$ | 4.32$^{c}$ | 135$^{d}$ | 144$^{b}$ |
| Freedom | 8.20$^{bc}$ | 8.40$^{b}$ | 0.86$^{c}$ | 0.86$^{c}$ | 8.45$^{b}$ | 8.46$^{a}$ | 81.60$^{ab}$ | 80.50$^{b}$ | 4.38$^{d}$ | 4.47$^{c}$ | 147$^{bcd}$ | 144$^{b}$ |
| Polcin1103 | 8.17$^{bc}$ | 8.40$^{b}$ | 0.86$^{c}$ | 0.84$^{c}$ | 8.49$^{b}$ | 8.30$^{b}$ | 81.40$^{ab}$ | 83.60$^{ab}$ | 4.50$^{d}$ | 4.79$^{bc}$ | 138$^{cd}$ | 144$^{b}$ |
| Salt Greek | 8.20$^{bc}$ | 8.30$^{b}$ | 0.88$^{bc}$ | 0.86$^{bc}$ | 8.40$^{b}$ | 8.50$^{a}$ | 81.80$^{ab}$ | 83.60$^{ab}$ | 4.33$^{d}$ | 4.38$^{c}$ | 148$^{bcd}$ | 155$^{a}$ |

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability

It can be mentioned from the above data that, grafted any scions understudy on Freedom as a rootstock enhanced and earliest fruit ripening time about 10 days as compared with other stocks or ungrafted cultivar.

**Effect of some table grape scions grafted on different rootstocks on morphological characteristics:** Concerning internode length, data in Table 2 revealed that grafted Flame seedless grape vine on Polcin 1103 or Freedom rootstocks increased internode length but the control rootstocks gave the lowest internode length in both season. Whereas, Freedom and salt Greek enhanced in this parameter in both seasons. Also, data revealed that Superior seedless and Thompson seedless cultivars grafted on Polcin 1103 and salt Greek gained the highest values in the two seasons of the study. As for internode thickness (cm), data showed the evaluation of some table grape cultivars scions grafted on different rootstocks, Flame seedless and Superior seedless cultivars grafted on Freedom, Polcin 1103 and salt Greek rootstocks gave the better internode thickness per vine in contract to Thompson seedless cv. Grafted on Freedom, Polcin 1103 and salt Greek rootstocks in both seasons. Moreover, data illustrated in Table 2 showed that Superior seedless and Thompson seedless cultivars scions on Freedom, Polcin1103 and salt Greek rootstocks gave the data better number for internodes/cane per vine control to Flame seedless cultivars grafted on Freedom, Polcin1103 and salt Greek rootstocks in both seasons. Concerning cane length, data indicated that grafted Flame seedless, Superior seedless grapevine on Freedom, Polcin1103 and salt Greek rootstocks are Superior in this respect and enhanced of cane length during the two studied seasons. Also, data revealed that Thompson seedless scion on Freedom; Polcin1103 and salt Greek rootstocks were found to record the lowest values in the two seasons of the study. Data concerning the effect of tested treatment on Pruning wood weight, Table 2 disclosed that grafted Flame seedless, Superior seedless grapevine on Freedom, Polcin1103 and salt Greek rootstocks are Superior in this respect and enhanced of Pruning wood weight during the two studied seasons. Also, data revealed that Thompson seedless grafted on Freedom, Polcin1103 and salt Greek rootstocks were found to record the lowest values in the two seasons of the study. Smith *et al*. (1992) mentioned that differences in pruning weight within Semillon brand breeds coned be due to visible differences in vine growth strength as result of various hereditary factors or as result of differences in attack with viral diseases among these scions in the scion (Reynolds *et al*., 1994) found that pruning weight in Riesling brand becomes less lineally with green growth density

Table 3: Cluster/vine, cluster weight, yield, yield and berry adherence strength as affected of different scion-stocks of grapes vine at 2012 and 2013 seasons

| | Cluster/vine number | | Cluster weight(g) | | Yield (t $f^{-1}$) | | Yield (t $f^{-1}$) | | Berry adherence strength (g) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Scions and rootstocks | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| **Flame seedless** | | | | | | | | | | |
| Control (ungrafted) | $32.70^{b}$ | $33.33^{b}$ | $520^{bc}$ | $530^{b}$ | $16.17^{de}$ | $17.66^{bc}$ | $11.319^{c}$ | $12.362^{b}$ | $396^{b}$ | $397^{abc}$ |
| Freedom | $38.00^{a}$ | $38.00^{a}$ | $550^{a}$ | $560^{a}$ | $20.90^{ab}$ | $21.28^{a}$ | $14.630^{a}$ | $14.896^{a}$ | $416^{ab}$ | $385^{bc}$ |
| Polcin1103 | $39.33^{a}$ | $39.33^{a}$ | $559^{a}$ | $550^{a}$ | $21.99^{a}$ | $21.63^{a}$ | $15.393^{a}$ | $15.141^{a}$ | $422^{ab}$ | $406^{abc}$ |
| Salt Greek | $35.00^{ab}$ | $33.66^{b}$ | $555^{a}$ | $550^{a}$ | $19.43^{bc}$ | $18.51^{b}$ | $13.601^{b}$ | $12.957^{b}$ | $410^{ab}$ | $405^{abc}$ |
| **Superior seedless** | | | | | | | | | | |
| Control (ungrafted) | $21.33^{c}$ | $23.33^{e}$ | $505^{c}$ | $500^{c}$ | $10.77^{g}$ | 11.67f | $7.539^{e}$ | $8.169^{e}$ | $400^{ab}$ | $395^{abc}$ |
| Freedom | $22.33^{b}$ | $29.00^{c}$ | $518^{bc}$ | $530^{b}$ | $11.57f^{g}$ | $15.37^{cd}$ | $8.099^{e}$ | $10.759^{c}$ | $431^{a}$ | $426^{a}$ |
| Polcin1103 | $32.33^{b}$ | $32.66^{b}$ | $558^{a}$ | $560^{a}$ | $18.04^{c}$ | $18.29^{b}$ | $12.628^{b}$ | $12.803^{b}$ | $425^{ab}$ | $425^{a}$ |
| Salt Greek | $25.33^{c}$ | $29.00^{c}$ | $550^{a}$ | $557^{a}$ | $13.93^{f}$ | $16.15^{bcd}$ | $9.751^{d}$ | $11.305^{c}$ | $421^{ab}$ | $423^{a}$ |
| **Thompson seedless** | | | | | | | | | | |
| Control (ungrafted) | $23.60^{c}$ | $24.33^{e}$ | $510^{c}$ | $510^{c}$ | $12.04^{fg}$ | $12.41^{ef}$ | $8.428^{de}$ | $8.687^{de}$ | $364^{b}$ | $365^{c}$ |
| Freedom | $26.00^{c}$ | $26.33^{d}$ | $530^{b}$ | $535^{c}$ | $13.78^{f}$ | $14.09^{def}$ | $9.646^{d}$ | $9.863^{d}$ | $380^{b}$ | $393^{abc}$ |
| Polcin1103 | $26.33^{c}$ | $26.66^{d}$ | $546^{a}$ | $549^{a}$ | $14.38^{e}$ | $14.64^{de}$ | $10.066^{c}$ | $10.248^{c}$ | $370^{b}$ | $394^{abc}$ |
| Salt Greek | $24.70^{c}$ | $25.00^{ed}$ | $555^{a}$ | $558^{a}$ | $13.70^{f}$ | $13.95^{def}$ | $9.590^{d}$ | $9.765^{d}$ | $367^{b}$ | $373^{c}$ |

Means not sharing the same letter (s) within each column for each are significantly different at 0.05 level of probability

increase and fruit clusters on each growth. The ameliorative effect of the grafting on pruning wood weight could be attributed to the high efficiency of the root system of rootstocks in absorbing and transporting the water and minerals via the grafted union to the shoots of Flame scion and to the favorable reciprocal relationship between scion and stock. As for leaf area, the data in Table 2 disclosed that grafted Flame seedless, Superior seedless grapevine on Freedom, Polcin1103 and salt Greek rootstocks are Superior in this respect and enhanced of Leaf area during the two studied seasons. Also, data revealed that Thompson seedless grafted on Freedom, Polcin1103 and salt Greek rootstocks were found to record the lowest values in the two seasons of the study. Parallel results were obtained by Grant and Matthews (1996), who found that the grape cultivars. Kraphuna had the largest leaf surface area per vine when it was grafted on chasselasx Barlandien rootstock. In addition Carrera *et al*. (1996) reported that rootstocks 110R, SO4 and 140 Ruggeri had the most productive scions. Also, Ezzahouani and Larry (1997) found that the scion cultivar Italla was most vigorous on rootstocks 101-14 and Rupestris dulot.

It can be mentioned from the above data that, regardless the type of scions, Polcin1103 rootstock enhanced all vegetative growth parameters followed by Freedom and salt Greek and finally the ungrafted cultivar. Also, Thompson seedless, regardless the type of rootstocks gave the best vegetative growth followed by Superior seedless Flame seedless grapevine.

**Effect of some table grape scions grafted on different rootstocks on yield and yield components:** Results in Table 3 showed the evaluation of some table grape cultivars scions grafted on different rootstocks on cluster/vine number at 2012 and 2013 seasons. Flame seedless and Superior seedless cultivars grafted on Freedom, Polcin1103 and salt Greek rootstocks, the data revealed better cluster/vine number per vine in contract to Thompson seedless cultivars grafted on Freedom, Polcin 1103 and salt Greek rootstocks in both seasons. Many researchers found differenced in number of clusters/vine and mentioned that this depended on soil type, green growth density fertility factor and number (Reynolds *et al*., 1994). On the other hand, Mattheou *et al*. (1995) mentioned that cluster number/vine cane was slightly more in very late growth types and that fertility factor was morally couples to yield. As for cluster weight, data indicated that grafted Flame seedless grapevine on Freedom, Polcin1103 and salt Greek rootstocks are enhanced of cluster weight during the two studied seasons. Also, data revealed that Superior seedless and Flame seedless cultivars grafted on Polcin1103 and salt Greek rootstocks the highest values in the

Table 4: Berry weight, berry volume, juice volume (cm$^3$)/100 berries, total soluble solid, acidity, total soluble solids/acidity (ratio) and moisture as affected of different scion-stocks of grapes vine at 2012 and 2013 seasons

| | Berry weight (g) | | Berry volume (cm$^3$) | | Juice volume/ 100 berries (cm$^3$) | | TSS (%) | | Acidity (%) | | TSS/acidity (ratio) | | Moisture (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scions and rootstocks | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| **Flame seedless** | | | | | | | | | | | | | | |
| Control (ungrafted) | 4.39$^{c}$ | 4.35$^{b}$ | 3.75$^{f}$ | 3.68$^{e}$ | 227$^{h}$ | 230$^{g}$ | 17.5$^{a}$ | 17.5$^{ab}$ | 0.45$^{c}$ | 0.44$^{c}$ | 38.9$^{a}$ | 39.8$^{a}$ | 81.60$^{a}$ | 80.53$^{a}$ |
| Freedom | 4.33$^{c}$ | 4.48$^{b}$ | 4.52$^{d}$ | 4.55$^{dc}$ | 242$^{g}$ | 244$^{f}$ | 18.0$^{a}$ | 18.2$^{a}$ | 0.51$^{bc}$ | 0.55$^{b}$ | 35.3$^{ab}$ | 33.1$^{bc}$ | 80.93$^{a}$ | 80.33$^{a}$ |
| Polcin1103 | 4.36$^{c}$ | 4.13$^{bc}$ | 4.58$^{d}$ | 4.37$^{d}$ | 275$^{e}$ | 265$^{d}$ | 17.8$^{a}$ | 17.9$^{ab}$ | 0.57$^{ab}$ | 0.55$^{b}$ | 31.2$^{ac}$ | 33.5$^{bc}$ | 80.73$^{a}$ | 81.10$^{a}$ |
| Salt Greek | 4.23$^{c}$ | 4.14$^{bc}$ | 4.00$^{e}$ | 3.77$^{e}$ | 260$^{f}$ | 256$^{e}$ | 17.8$^{a}$ | 17.6$^{abc}$ | 0.50$^{bc}$ | 0.49$^{bc}$ | 35.6$^{ab}$ | 36.0$^{ab}$ | 84.47$^{a}$ | 83.90$^{a}$ |
| **Superior seedless** | | | | | | | | | | | | | | |
| Control (ungrafted) | 5.05$^{b}$ | 5.11$^{ab}$ | 5.78$^{c}$ | 5.75$^{c}$ | 410$^{d}$ | 407$^{c}$ | 16.4$^{b}$ | 16.3$^{c}$ | 0.64$^{a}$ | 0.64$^{a}$ | 25.6$^{de}$ | 25.5$^{de}$ | 83.23$^{a}$ | 82.63$^{a}$ |
| Freedom | 4.98$^{b}$ | 4.97$^{a}$ | 6.18$^{c}$ | 6.28$^{b}$ | 431$^{c}$ | 432$^{b}$ | 16.3$^{b}$ | 16.7$^{bc}$ | 0.65$^{a}$ | 0.67$^{a}$ | 25.0e | 24.9$^{de}$ | 82.53$^{a}$ | 82.63$^{a}$ |
| Polcin1103 | 5.37$^{a}$ | 5.28$^{a}$ | 6.55$^{a}$ | 6.61$^{a}$ | 440$^{a}$ | 442$^{a}$ | 16.0$^{b}$ | 16.6$^{bc}$ | 0.68$^{a}$ | 0.70$^{a}$ | 23.5e | 23.7e | 83.10$^{a}$ | 82.73$^{a}$ |
| Salt Greek | 5.14$^{b}$ | 5.20$^{a}$ | 6.38$^{b}$ | 6.31$^{b}$ | 435$^{b}$ | 432$^{b}$ | 16.3$^{b}$ | 16.6$^{bc}$ | 0.68$^{a}$ | 0.68$^{a}$ | 24.0e | 24.4$^{de}$ | 83.67$^{a}$ | 83.33$^{a}$ |
| **Thompson seedless** | | | | | | | | | | | | | | |
| Control (ungrafted) | 3.86$^{d}$ | 3.86$^{c}$ | 3.18$^{h}$ | 3.15$^{f}$ | 110$^{k}$ | 110$^{k}$ | 17.7$^{a}$ | 18.0$^{a}$ | 0.63$^{a}$ | 0.63$^{a}$ | 28.0$^{cde}$ | 28.6$^{cd}$ | 81.00$^{a}$ | 81.03$^{a}$ |
| Freedom | 3.84$^{d}$ | 3.90$^{c}$ | 3.59$^{g}$ | 3.60$^{e}$ | 129$^{i}$ | 130$^{i}$ | 15.1$^{a}$ | 18.1$^{a}$ | 0.64$^{a}$ | 0.66$^{a}$ | 23.6$^{e}$ | 27.4$^{de}$ | 81.50$^{a}$ | 82.17$^{a}$ |
| Polcin1103 | 3.86$^{d}$ | 3.81$^{c}$ | 3.55$^{g}$ | 3.57$^{e}$ | 127$^{j}$ | 125$^{j}$ | 18.0$^{a}$ | 18.4$^{a}$ | 0.63$^{a}$ | 0.67$^{a}$ | 28.6$^{cde}$ | 27.5$^{de}$ | 81.50$^{a}$ | 81.47$^{a}$ |
| Salt Greek | 3.99$^{d}$ | 3.98$^{c}$ | 3.56$^{g}$ | 3.60$^{e}$ | 131$^{i}$ | 132$^{h}$ | 18.4$^{a}$ | 18.4$^{a}$ | 0.60$^{ab}$ | 0.66$^{a}$ | 30.7$^{bcd}$ | 28.0$^{de}$ | 81.57$^{a}$ | 81.87$^{a}$ |

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability

two seasons of the study. These results corresponded with Reisch *et al.* (1990). Also, grafted Flame seedless grapevine on Freedom and Polcin1103 rootstocks are Flame seedless in respect and enhanced of yield per vine during the two studied seasons, while Superior seedless and Thompson seedless cultivars grafted on Polcin1103 and salt Greek gained the highest values in the two seasons of the study. Parallel results were found showing yield difference/brands difference by Tomer (1990). The results given in Table 3 revealed that grafted Flame seedless grapevine on Freedom and Polcin1103 rootstocks are Flame seedless in respect and enhanced of yield (kg/Feddan) during the two studied seasons. Also, data revealed that Superior seedless and Thompson seedless cultivars grafted on Polcin1103 and salt Greek gained the highest values in the two seasons of the study. Flame seedless and Superior seedless cultivars grafted on Freedom, Polcin 1103 and salt Greek rootstocks gave the better berry adherence strength per vine in contract to Thompson seedless cultivars grafted on Freedom, Polcin 1103 and salt Greek rootstocks in two seasons. Aliami (1987) found that berry adherence strength in Baiady ranged from 38-373 g, while it was weak in Razeky and Nekhel (250 and 203 g). Barbary *et al.* (1994) mentioned in a study on Red Seedless brand that berry adherence strength ranges between 180-200 g. Mattheou *et al.* (1995) found positive corollary relation between weight and fruit adherence strength (r = 0.50) and fruit length and v (r = 0.45). He mentioned that among objectives of modern grape cultivators is getting berries with high adherence and compactness to bear marketing and storing. That is why brands with berry adherence strength are considered as important characteristics from marketing and exporting viewpoint.

It can be mentioned from the above data that, regardless the type of scions, Polcin1103 rootstock increased yield parameters followed by Freedom, ungrafted scion and finally salt Greek stock. Also, Flame seedless grapevine gave the highest yield regardless the type of rootstocks followed by Superior seedless and Thompson seedless cultivars.

Data illustrated in Table 4 showed that, Flame seedless and Thompson seedless cultivars grafted on control, Freedom, Polcin1103 and salt Greek rootstocks gave the lowest berry weight in both seasons, but Superior seedless cultivars grafted on Freedom, Polcin1103 and salt Greek rootstocks gave the highest values of second seasons. Moreover, grafted Superior seedless grapevine on Polcin1103 rootstock gave the highest values of berry volume in the two seasons of the study, while Thompson seedless and Flame seedless cultivars grafted on control, Freedom, Polcin1103 and salt Greek rootstocks gave the lowest values in the two seasons of the study. Tomer (1990) found

Table 5: Macro and micro elements as affected of different rootstocks at 2012 and 2013 seasons

| | N (%) | | P (%) | | K (%) | | $F_e$ (ppm) | | $Z_n$ (ppm) | | $M_n$ (ppm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scions and root stocks | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| **Flame seedless** | | | | | | | | | | | | |
| Control (ungrafted) | $2.37^{c}$ | $2.39^{bc}$ | $0.38^{b}$ | $0.38^{b}$ | $1.39^{e}$ | 1.41e | $145^{abc}$ | $143^{b}$ | $37^{c}$ | $38^{c}$ | $62.1^{c}$ | $62.7^{bc}$ |
| Freedom | $2.39^{bc}$ | $2.42^{abc}$ | $0.40^{ab}$ | $0.39^{ab}$ | $1.47^{cd}$ | $1.47^{cd}$ | $146^{abc}$ | $145^{ab}$ | $40^{bc}$ | $39^{bc}$ | $66.8^{a}$ | $66.1^{ab}$ |
| Polcin1103 | $2.43^{ab}$ | $2.43^{ab}$ | $0.41^{ab}$ | $0.40^{ab}$ | $1.47^{cd}$ | $1.47^{bcd}$ | $151^{a}$ | $150^{a}$ | $40^{bc}$ | $41^{bc}$ | $66.8^{a}$ | $67.1^{a}$ |
| Salt Greek | $2.41^{abc}$ | $2.42^{abc}$ | $0.43^{ab}$ | $0.41^{ab}$ | $1.46^{d}$ | $1.45^{de}$ | $148^{ab}$ | $146^{ab}$ | $42^{b}$ | $42^{b}$ | $61.8^{c}$ | $60.9^{c}$ |
| **Superior seedless** | | | | | | | | | | | | |
| Control (ungrafted) | $2.42^{abc}$ | $2.44^{ab}$ | $0.39^{ab}$ | $0.38^{b}$ | $1.46^{d}$ | $1.47^{bcd}$ | $145^{abc}$ | $145^{ab}$ | $35^{c}$ | $36^{c}$ | $62.8^{bc}$ | $63.1^{bc}$ |
| Freedom | $2.46^{a}$ | $2.45^{a}$ | $0.43^{ab}$ | $0.43^{ab}$ | $1.48^{bcd}$ | $1.50^{abcd}$ | $150^{ab}$ | $150^{a}$ | $40^{bc}$ | $38^{c}$ | $65.8^{ab}$ | $63.8^{abc}$ |
| Polcin1103 | $2.45^{a}$ | $2.47^{a}$ | $0.42^{ab}$ | $0.43^{ab}$ | $1.50^{abcd}$ | $1.51^{abc}$ | $150^{ab}$ | 150a | 42b | $42^{b}$ | $63.1^{bc}$ | $63.4^{bc}$ |
| Salt Greek | $2.44^{ab}$ | $2.46^{a}$ | $0.41^{ab}$ | $0.43^{ab}$ | $1.52^{abc}$ | $1.53^{a}$ | $146^{abc}$ | $145^{ab}$ | 37c | $38^{c}$ | $63.2^{bc}$ | $63.3^{bc}$ |
| **Thompson seedless** | | | | | | | | | | | | |
| Control (ungrafted) | $2.37^{c}$ | $2.37^{c}$ | $0.39^{ab}$ | $0.38^{b}$ | $1.47^{cd}$ | $1.46^{cde}$ | $140^{c}$ | $140^{b}$ | $43^{b}$ | $44^{ab}$ | $64.5^{abc}$ | $63.1^{bc}$ |
| Freedom | $2.43^{ab}$ | $2.44^{ab}$ | $0.42^{ab}$ | $0.43^{ab}$ | $1.54^{a}$ | $1.53^{a}$ | $141^{c}$ | $140^{b}$ | $46^{a}$ | $47^{a}$ | $63.2^{bc}$ | $63.1^{bc}$ |
| Polcin1103 | $2.43^{ab}$ | $2.45^{a}$ | $0.44^{a}$ | $0.44^{a}$ | $1.50^{abcd}$ | $1.52^{ab}$ | $144^{bc}$ | $144^{ab}$ | $47^{a}$ | $47^{a}$ | $64.7^{abc}$ | $65.5^{ab}$ |
| Salt Greek | $2.39^{bc}$ | $2.42^{abc}$ | $0.43^{ab}$ | $0.43^{ab}$ | $1.53^{a}$ | $1.52^{ab}$ | $144^{bc}$ | $143^{b}$ | $48^{a}$ | $48^{a}$ | $64.6^{abc}$ | $64.3^{abc}$ |

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability

that brands differ in size as Cardinal brand recorded highest berry size, followed by Alamwick. Difference was moral, whereas seedless brands recorded leasser berry size such as Pusa Seedless. Also, data indicated that grafted Superior seedless grapevine on Polcin1103 rootstock gave the highest values of juice volume, but Thompson seedless and Flame seedless cultivars grafted on control, Freedom, Polcin1103 and salt Greek rootstocks gave the lowest values in the two seasons of the study. Hamady *et al*. (2008) also found that juice volume/100 berries of Red Roumy and White Seedless were 127.7 and 66.3 $cm^3$, successively. Regarding total soluble solid, Thompson seedless cultivars grafted on four rootstocks gave the better total soluble solid and acidity per vine in contact to Flame seedless cultivars grafted on Freedom rootstock in both seasons, but Superior seedless cultivars grafted on four rootstocks gave the lowest values in both seasons. Thompson seedless and Superior seedless cultivars grafted on Freedom Polcin1103 and salt Greek rootstocks gave the lowest TSS/acidity in both seasons, while Flame seedless cultivars grafted on control and salt Greek rootstocks gave the highest values TSS/Acidity in the two seasons of the study. Smith *et al*. (1992) didn't find any differences among some grape breeds in percentage that influence on berry juice from acidity and TSS. Ewart *et al*. (1993) found that there was correlation between acidity and TSS in all breeds used while they found that breeds affect acidity percentage and such differences could be due to differences in yield quantity. Reynolds *et al*. (1994) found that TSS percentage in grape juice became less with green growth and cluster number increase per each green growth while acidity was not affected. Data also showed that, no significant differences between table grape cultivars scions grafted on different rootstocks in moisture percentage in during the two seasons of the study.

**Effect of some table grape scions grafted on different rootstocks on leaf mineral contents:** Concerning total nitrogen, data in Table 5 disclosed that grafted Superior seedless grapevine on Freedom and Polcin1103 rootstocks are Thomson seedless in respect and enhanced of total nitrogen during the two studied seasons. Also, data revealed that Superior seedless and Thomson seedless cultivars grafted on Polcin1103 gained the highest values in the two seasons of the study. No found significant differences between table grape cultivars scions grafted on different rootstocks in during the two seasons of the study in P content. Also, the Flame seedless cultivars grafted on control gave the lowest values in both seasons. Tangolar *et al*. (1998) and Ibacache and Sierra (2009) on grafted grapes found the same results. Superior seedless and Thompson seedless cultivars grafted on Freedom, Polcin1103 and salt Greek rootstocks gave better potassium content, while Flame seedless cultivars grafted on control gave the lowest values in both seasons. Dog ridge and Harmony stocks led to very high concentrations of potassium in petioles even in the absence of salt treatment (Bavaresco and Lovisolo, 2000). Concerning iron, data in Table 5 showed that grafted Flame seedless grapevine on Polcin1103 rootstock increased iron content while Thompson seedless cultivars grafted on Freedom gave the lowest values in the two seasons of the study. Grafted Thompson seedless grapevine on Freedom, Polcin1103 and salt Greek rootstocks increased leaf zinc content, while Flame seedless and Superior seedless cultivars grafted on Freedom and salt Greek gave the lowest values of iron in the two seasons of the study. At the same time, grafted Flame seedless grapevine on Freedom and Polcin1103 rootstocks enhanced of manganese content during the two studied seasons. Also, data revealed that Superior seedless and Thompson seedless cultivars grafted on Polcin1103 and salt Greek gained the highest values in the two seasons of the study. Tangolar *et al*. (1998) grafted Gruner Veltliner onto 10 rootstocks and concluded that leaf Fe, Zn, Mn levels were similar for scions on all rootstocks. Bavaresco and Lovisolo (2000) pointed out that rootstocks with lime resistance have a strategy to overcome chlorosis with high root iron uptake and reducing capacity relevance for irrigated horticultural areas along the River Murray, for which the ionic composition of the watering medium was formulated and for situations where saline wastewater is to be reutilized.

## CONCLUSION

Flame seedless scion grafted on different rootstocks gave the earliest time for bud burst time, flowing time, time of cluster flower setting, berry coloring time and time of berry ripening comparing with Superior and Thompson scions and ungrafted cultivars. Moreover, data showed that Superior seedless and Thompson seedless cultivars scions on Freedom, Polcin1103 and salt Greek rootstocks gave the better number for internodes/cane per vine comparing to Flame seedless cultivars grafted on Freedom, Polcin1103 and salt Greek rootstocks in both seasons.

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