Impact of Gibberellic Acid Enhancing Treatments on Shortening Time to Budding of Citrus Nursery Stocks

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Abstract: Screen house experiment was conducted to study the application of gibberellic acid (GA_3) at different concentrations on budding shortening time of Volkamer lemon (*C.Volkameriana* Ten & Pasq) and Sour orange (*C.aurantium L.)* rootstocks in two seasons (2008-2009). Shortening the period to reach suitable diameter for budding seedling would benefit nurserymen by reducing various production inputs and their costs. The results indicated that, the highest success rate of suitable seedlings for budding was in mid-July. This time led to shortening the period for budding about 8 months, whereas, resulting seedlings could be budded because their stem diameter reached of a pencil size (5.4 mm) or larger. Also, this study revealed that, Volkamer lemon rootstock was superior as compared to sour orange rootstock in terms of vegetative growth, root distribution, leaf mineral content and percent of suitable seedlings for budding, while leaves of sour orange contained higher chlorophyll and total carbohydrate. It could be recommended to use T_5 (Soaked seeds and treated seedling with GA_3 at 200 ppm) for giving the best vegetative growth and suitable seedlings for budding in mid July. [Journal of American Science 2010;6(12):410-422]. (ISSN: 1545-1003).

Keywords: Screen house; gibberellic acid (GA_3); lemon; vegetative growth

1. Introduction

Citrus seedlings are normally used as rootstocks for the more desirable varieties; Citrus seed germination is usually slow and erratic. A number of reasons can contributed to the slow germination of citrus seeds, e.g. presence of growth inhibitors and physical resistance of seed coat to radical protrusion (Cohen, 1956). There is considerable evidence that gibberellins may promote the germination of various seeds in different ways. Several workers reported that gibberellic acid (GA) increases either germination rates (i.e. the rapidity of germination) for instance in Sweet orange (Burns and Coggins, 1969), Cleopatra mandarin and Sour orange (Abou Rawash, *et al*, 1980). Also, a concentration of 500 ppm has been reported as having improved the germination of sweet lime (*C.Limettoides Tan.*) (Achituv and Mendal, 1973) , as well as 1000 ppm that of Sweet orange (Burns and Coggins, 1969). Moreover, 250ppm of GA, improve germination (Though not significant) on Trifoliate orange rootstock (Suzuki and Konakahara, 1985). The time required to grow citrus seedlings to a suitable size for budding may be as long as 1 or 2 years, therefore, shortening this time is considered very important.

Application of gibberellic acid (GA) to plants influences on growth vigor. Increased plant height (Misra, *et al*, 1982) on Malta common seedlings (*Citrus Sinensis*), (Suzuki and Konakahara, 1985) on Trifoliate orange seedlings, (Mehouochi, *et al*, 1996) on Carrizo Citrange rootstock , internode length, (Monselise and Halevy, 1962) and (Eshghi and Tafazoli, 2007) on citrus seedlings and stem diameter (Ismael and Young, 1982) on Sour orange seedlings have been reported.

Also, spray of GA_3 on citrus seedlings decreased chlorophyll content of leaves on Sweet lime (Monselise and Halevy, 1962), moreover, (Mauk, *et al*, 2004) showed that spray of Sour orange and Trifoliate orange seedlings with both BA and GA_3 decreased chlorophyll (a,b) . Concerning the effect of spray GA_3 on citrus seedlings on root system, (Monselise and Halevy, 1962) indicated that dry weight of leaves and roots were decreased on sweet lime seedlings sprayed with gibberellic acid, also, GA_3 decreased root tip width and reduced all parameters related to radial expansion (Tadeo, *et al.*, 1997).

Regarding the effect of GA_3 on total carbohydrates of leaves, the action of GA_3 in stimulating growth is mediated by an accumulation of sugars in shoots and consequently an increase in carbon supply (Mehouachi *et al.*, 1996) on "Carrizo" Citrange rootstock seedlings, (Miyamoto, *et al*, 1993) on Pea seedlings and (Mostafa and Baninasab, 2008) on two almond rootstock seedling (*Prunus amygdaluw and P.Webbii).* Respecting, the effect of application of GA_3 on leaf mineral content, (Monge *et al*, 1994) studied that foliar sprays of 1000 mg L-1 GA_3 to adult peach trees and found that leaves had a significantly lower concentration of N, Ca and Mn slightly greater concentration of K.

This study aims to assess effect GA3 at different concentrations on budding shortening period

of some citrus rootstocks (Sour orange and Volkamer lemon) to be benefit for nurserymen by reducing various production inputs and their costs.

2. Materials and Methods

The present study was carried out during 2007/2008 and 2008/2009 seasons to investigate the effect of different concentrations of gibberellins on budding shortening period of two citrus rootstocks e.g. Sour orange (*C.aurantium)* and Volkamer lemon (*C.Volkameriana*) in Screen house in the experimental farm of the Horticulture Research Institute, Giza, Egypt.

Mature fruits of citrus rootstocks were collected. Freshly extracted seeds were shade dried and treated with Rizolex-T ® 50 % WP as a fungside and stored in 5°C tell planting time (mid April), some seeds (300 seeds for rootstock each) were soaked in GA_3 at 750 ppm for 24 h. before planting and other untreated (control). The time limit for germination was after 23 days from planting for Volkamer lemon and after 30 days from planting for sour orange. At the end of September for each season (2008 and 2009) experimental seedling rootstocks were individually planted in plastic black bags (17 x 30 cm) filled with (25% peat-moss +75% sandy soil) in the screen house and were routinely irrigated whenever it is needed. Moreover, ammonium sulfate (20.6 %) solution (1.0 gm / L) was added weekly as liquid fertilizer with tap water. Also Greenzit* (* Ciba- Geigy , Basel , Switzerland, a foliar nutrient solution) was sprayed fortnightly at 1 ml / L were applied to all seedlings under study.

All seedlings were topping (cut their stem top about 5 cm) when stem length reached in about 55 cm and stem diameter >3.00 mm. ,and all lateral shoots removal when they were growing (Suckering process) .Some seedlings were foliar spray of GA_3 at 200 ppm and other at 400 ppm after one month from transplanting in plastic bags. In foliar spray treatments, each treatment contained a wetting agent (0.1% triton B) and was applied by spraying each seedling to run-off. Seedlings were budded with "Valencia" orange (*Citrus Sinensis* L. Osbeck) using T-budding method at a height of 30-35 cm above soil surface in the pot at three time intervals (mid June, mid July and mid August) according for stem diameter of seedlings in both seasons of the study.

Treatments: Treatments were carried out for 2 rootstocks (Sour orange, Volkamer lemon) under study as follow:

1- T_1 - Control (untreated seeds and seedlings by GA_3).
2- T_2 - Seedlings were treated by GA_3 at 200 ppm from untreated seeds.
3- T_3 - Seedlings were treated by GA_3 at 400 ppm from untreated seeds.
4- T_4 - Seedlings were untreated and soaked seeds by gibberellins (750 ppm).
5- T_5 - Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins (750 ppm).
6- T_6 - Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins (750 ppm).

The GA_3 source was Berelex 10% w/w powder formulation, a trademark of imperial Chemical Industries Pic Frenhurst, Haselemer Surney, England.

Experimental parameters:

1- Germination percentage: Percent germination of two citrus rootstock seeds after pre-plant soaking of gibberellins was count and measured for two studied seasons.

2- Vegetative growth parameters: It has been carried out at the end of every season for both rootstock and scion.

a. Rootstock measures: Stem length, leaf numbers, leaf area and stem diameter. Stem length was estimated from the soil surface to the end of the growing point. All leaves on each seedling were numbered and measured. Leaf area was measured (cm^2) according to (Singh and Snyder, 1984). Stem diameter was measured at 30-35 cm above the soil surface. Rootstock measures were taken just before budding time.

b. Scion measures: Stem length, leaf number, leaf area and shoot number. All shoots on each scion were numbered and measured.

3- Total root dry weight (gm). The seedlings from each treatment were dissected at the end of study. The planting media was carefully removed from the plastic black bag then roots were washed thoroughly with tap water. Total roots were oven dried at 70° for 72 hr. and total root dry weight were recorded.

4- Leaf chlorophyll a, b (μ/cm^2): Leaf samples from two citrus seedling rootstocks were washed three times with tap water, and then washed again with distilled water, and it was determined according to (Moran and Porath, 1980) method and then total chlorophyll was calculated.

5- Leaf total carbohydrates (%): Total carbohydrates content of two citrus seedling rootstocks were determined as percent of dry weight according to (Dubois *et al.*, 1956).

6- Leaves mineral content: Leaf samples six months age from two citrus seedling rootstocks were individually collected. These samples were washed several times with distilled water and then dried at 70°c for dry matter estimation. Dried samples has

been milled for determine leaf content of N, P, K, Fe, Zn and Mn .

a. Total nitrogen (%): was determined in 0.2 g of dried substance of the leaves as percentages using microkjeldahl method according to (Pregl, 1945); (Chapman and Pratt, 1978).

b. Phosphorus (%): was determined as percentages colourimetrically using stannous chloride- sulfuric acid method according to (Troug and Meyer, 1939).

c. Potassium (%): was determined as percentages using the flame photometric method according to (Brown and Lilliland, 1966).

d. Iron, Zinc and Manganese (ppm): were determined as PPM Using Atomic Absorption according to (Carter, 1993).

7- Percent of suitable seedlings amenable for budding: Percent of suitable seedlings amenable for budding were count and measured at three time intervals (mid June, mid July and mid August).

Statistical analysis of the data: The experiment was designed in a completely randomized block design and the study comprised six treatments for each rootstock and each treatment was presented by three replicates (20 seedlings per replicate).The obtained data of both seasons were subjected to analysis of variance according to (Clarke and Kempson, 1997) and the means were differentiated using Duncan multiple range test at 5% level (Duncan, 1955).

3. Results and Discussion:

1- Percent Germination of two citrus rootstock seeds. It is clear from Table (1) that, there were no significant differences effect in final percentage germination for Volkamer lemon and Sour orange rootstock seeds. It is also noticed that, the soaked seeds by gibberellins (at 750 ppm) improved germination but not significant. These results might be attributed to that there is no dormancy in citrus seeds which make a problem for germination (Schneider, 1968). Similar results were reported by (Suzuki and Konakahara, 1985) who found that, the application of GA_3 at 250 ppm did not affect in the final percentage of germination on Trifoliate orange rootstock. Also, (Soetisna *et al*., 1985) reported that GA_3 has little or no effect on lemon seed germination. Moreover the same results were found by (Muhammad, *et al*., 2002) on some citrus species.

Table (1). Percent germination of two citrus rootstock seeds after pre-plant soaking of gibberellins.

	Season, 2008			Season, 2009		
	Germination (%)					
	Rootstocks(R)			Rootstocks(R)		
Treatments(T)	SO	VO	Mean (T)	SO	VO	Mean (T)
Control(untreated seeds and seedlings by GA_3)	80.57 a	82.52 a	81.54 a	80.25 a	82.21 a	81.23 a
Soaked seeds by gibberellins (750 ppm)	83.21 a	85.34 a	84.28 a	81.18 a	83.37 a	82.28 a
Means (R)	81.89 a	83.93 a		80.72 a	82.79 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

2- Vegetative growth parameter of rootstocks.

Data concerning vegetative growth of the two studied rootstock seedlings, i.e. Sour orange (SO) and Volkamer lemon (VO) as affected by foliar GA_3 indicated that, there were significant differences between all treatments in the two seasons of study.

a. Stem length (cm): Data in Table (2a) showed that, the maximum values of stem length were produced by Volkamer lemon (122.51 and 124.51 cm) with T6 treatment followed by Volkamer lemon (115.44 and 117.44 cm) with T5 treatment, while, the lowest significant values were with Sour orange (40.31 and 42.31 cm) under control treatment followed by (67.53 and 65.97 cm) under T2 treatment (Seedlings were treated by GA_3 at 200 ppm) in the first and second seasons, respectively.

b. Leaf number: Data presented in Table (2a) showed that, GA_3 application did not influence number of leaves and there were no significant differences between all treatments and rootstocks during the two studied seasons (2008 and 2009).

c. Leaf area (cm^2): Data in Table (2b) showed that, GA_3 application decreased leaf area, whereas, Sour orange recorded the greatest average of leaf area (35.51 and 33.59 cm^2) under control treatment. Meanwhile, the lowest vigorous were belonged to Volkamer lemon (25.75 and 23.75 cm^2) with T6, but the other treatments gave the intermediate values for the first and second seasons respectively, Table (2).

d. Stem diameter (mm): Data tabulated in Table (2b) showed that, GA_3 application increased stem diameter whereas; the higher significant values for stem diameter were belonged to Volkamer lemon (7.22 and 7.55 mm) with T6 followed by Volkamer lemon (6.68 and 7.50 mm) under T3 (seedlings were treated by GA_3 at 400 ppm), while the lower significant values for stem diameter were belonged to Sour orange (4.53 and 4.00 mm) under control treatment. Meanwhile, the other treatments gave the intermediate values in this regard in the two seasons under study.

Table (2a). Effect of foliar spray with gibberellic acid (GA_3) on some vegetative growth parameters of two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	Stem length (cm)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	40.31 h	65.97 g	53.14 f	42.31 h	70.42 fg	56.36 f
Seedlings were treated by GA_3 at 200 ppm - (T_2)	67.53 g	70.42 fg	68.97 e	65.97 g	80.32 def	73.15 e
Seedlings were treated by GA_3 at 400 ppm – (T_3)	70.63 fg	95.25 cd	82.94 d	72.63 efg	90.38 cd	81.51 d
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	75.40 ef	100.46 c	87.93 c	76.40 efg	105.46 b	90.93 c
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	80.32 e	115.44 b	97.88 b	82.32 de	117.44 a	99.88 b
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	90.38 d	122.51 a	106.4 a	95.38 bc	124.51 a	109.94 a
Means (R)	70.76 b	95.01 a		72.50 b	98.09 a	
Leaf number						
Control (untreated seeds and seedlings by GA_3) - (T_1)	34.36 ab	38.38 ab	36.37 a	36.34 a	40.78 a	38.56 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	33.51 ab	36.44 ab	34.98 a	34.60 a	39.62 a	37.11 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	35.43 ab	39.78 a	37.61 a	36.38 a	37.90 a	37.02 a
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	32.17 b	34.50 ab	33.33 a	34.60 a	38.31 a	36.46 a
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	35.90 ab	34.55 ab	35.23 a	35.60 a	36.24 a	35.92 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	34.60 ab	35.44 ab	35.02 a	37.78 a	36.36 a	37.07 a
Means (R)	34.33 a	36.51 a		35.84 a	38.20 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

Table (2b). Effect of foliar spray with gibberellic acid (GA_3) on some vegetative growth parameters of two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	Leaf area (cm^2)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	35.51 a	30.20 abc	32.85 a	33.59 a	28.57 abcd	31.08 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	32.20 abc	28.57 bc	30.39 ab	30.57 abc	26.88 bcd	28.73 ab
Seedlings were treated by GA_3 at 400 ppm – (T_3)	31.39 abc	26.44 c	28.92 ab	29.44 abcd	25.75 bcd	27.59 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	33.59 ab	29.39 abc	31.49 ab	31.39 ab	27.44 abcd	29.42 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	30.57 abc	27.88 bc	29.23 ab	28.44 abcd	24.36 cd	26.40 ab
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	29.44 abc	25.75 c	27.59 b	27.75 abcd	23.75 d	25.75 b
Means (R)	32.12 a	28.04 b		30.20 a	26.13 b	
Stem diameter (mm)						
Control (untreated seeds and seedlings by GA_3) - (T_1)	4.53 e	4.76 de	4.65 b	4.00 d	5.00 cd	4.53 d
Seedlings were treated by GA_3 at 200 ppm - (T_2)	5.90 abcde	5.34 bcde	5.62 a	5.50 bc	6.34 abc	5.92 bc
Seedlings were treated by GA_3 at 400 ppm – (T_3)	5.33 bcde	6.68 ab	6.01 a	5.91 bc	7.50 a	6.71 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	4.93 cde	6.50 abc	5.72 a	5.00 cd	5.10 bcd	5.05 cd
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	6.18 abcd	6.44 abc	6.13 a	6.11 abc	6.35 abc	6.23 ab
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	5.00 cde	7.22 a	6.11 a	6.50 ab	7.55 a	7.03 a
Means (R)	5.31 b	6.16 a		5.50 b	6.31 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

3- Vegetative growth parameter of Valencia orange scion.

Data concerning the vegetative growth of Valencia orange scion on the two studied rootstocks, i.e. Sour orange (SO) and Volkamer lemon (VO) as affected by foliar spray of GA_3 are presented in Table (3a&b).

a. Stem length (cm): Data in Table (3a) indicated that, application of GA_3 increased stem length of Valencia orange scion, whereas, stem length of Valencia orange scion on Volkamer lemon with T6

had higher significant values (30.35 and 36.26 cm) while, scion on Volkamer lemon under control treatment had lower values (20.44 and 25.41 cm). Meanwhile, the other treatments scored the intermediate values in this regard for 2008 and 2009 seasons, respectively Table (3a).

Table (3 a).Effect of foliar spray with gibberellic acid(GA_3) on some vegetative growth parameters of Valencia orange scion budded on two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	Stem length (cm)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	21.68 ab	20.44 b	21.06 b	26.40 b	25.41 b	25.91 b
Seedlings were treated by GA_3 at 200 ppm - (T_2)	23.52 ab	24.32 ab	23.92 ab	27.53 b	27.43 b	27.48 b
Seedlings were treated by GA_3 at 400 ppm – (T_3)	26.55 ab	28.32 ab	27.44 ab	28.55 ab	31.66 ab	30.10 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	22.59 ab	21.31 ab	21.95 b	27.27 ab	28.39 ab	28.06 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	25.50 ab	28.29 ab	26.90 ab	29.69 ab	33.26 ab	31.48 ab
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	27.55 ab	30.35 a	28.95 a	31.47 ab	36.26 a	33.87 a
Means (R)	24.57 a	25.51 a		28.56 a	30.40 a	
Leaf number						
Control (untreated seeds and seedlings by GA_3) - (T_1)	24.51 a	23.54 a	24.03 a	27.43 a	28.50 a	27.96 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	23.57 a	24.54 a	24.05 a	26.55 a	27.38 a	26.97 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	24.62 a	23.31 a	23.97 a	27.40 a	29.23 a	28.32 a
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	25.47 a	25.57 a	25.52 a	26.50 a	26.27 a	26.39 a
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	24.42 a	26.64 a	25.53 a	28.32 a	27.22 a	27.77 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	25.47 a	24.53 a	25.00 a	26.69 a	28.07 a	27.38 a
Means (R)	24.68 a	24.69 a		27.15 a	27.78 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

b. Leaf number: Data tabulated in Table (3a) indicated that, GA_3 application did not show any distinctive effect on leaf number of Valencia orange scion during 2008 and 2009 seasons.

c. Leaf area (cm^2): Data presented in Table (3b) showed that, leaf area of Valencia orange scion decreased by increasing GA_3 concentrations, whereas, the highest significant values was in scion on Sour orange under control treatment (26.59 and 27.62 cm^2) while, the lowest values was in scion on Volkamer lemon (17.58 and 19.38 cm^2) with T6.

d. Shoot number: Data presented in Table (3b) showed that, shoot number of Valencia orange scion increased by increasing GA_3 concentration. However, scion on Volkamer lemon with T6 scored the greatest values(3.07 and 3.30) followed in descending order by scion on Sour orange with T5 (Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins.) (2.43 and 2.50) while, scion on Sour orange under control treatment gave the lowest values (1.67 and 2.00). On the other hand, the other treatments had the intermediate values for this regard in 2008 and 2009 seasons, respectively.

Generally, the above results clarified that increasing concentrations of GA_3 as shown in T6 (Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins 750 ppm) progressively increased stem length, shoot number and stem diameter, did not influence number of leaves and decreased leaf area. These results are in harmony with (Suzuki and Konakahara, 1985) they reported that the application of GA_3 on Trifoliate orange increased plant height. Also, the same results were found by (Mehouochi, *et al*., 1996) on Carrizo Citrange rootstock.

Moreover, (Ismael and Young, 1982) indicated that, Sour orange seedlings treated by GA_3 increased stem diameter. Furthermore, the same trend was observed by (Monselise and Halevy, 1962) who found that, spraying of GA_3 on sweet lime seedlings decreased leaf area.

Also, our results indicated that Volkamer lemon was superior for giving the highest values for vegetative growth as compared with Sour orange rootstock. These results are in line with those obtained by (Dawood, 1996 and Mohamed-Hoda, 2007). They mentioned that, Volkamer lemon is suitable citrus rootstock for most citrus scion varieties for their vigorous growth.

Table (3b). Effect of foliar spray with gibberellic acid (GA_3) on some vegetative growth parameters of Valencia orange scion budded on two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	Leaf area (cm^2)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	26.59 a	24.40 a	25.49 a	27.62 a	26.36 abc	26.99 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	24.42 a	22.53 a	23.47 a	26.54 ab	25.37 abc	25.96 ab
Seedlings were treated by GA_3 at 400 ppm – (T_3)	22.30 a	20.52 a	21.41 a	24.30 abc	24.16 abc	24.23 abc
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	24.58 a	22.52 a	23.55 a	26.48 abc	25.29 abc	25.89 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	22.59 a	20.61 a	21.60 a	22.29 abc	21.26 abc	21.77 bc
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	20.63 a	17.58 a	19.10 a	20.39 bc	19.38 c	19.89 c
Means (R)	23.52 a	21.36 a		24.60 a	23.64 a	
Shoot number						
Control (untreated seeds and seedlings by GA_3) - (T_1)	1.67 d	1.83 cd	1.75 d	2.00 c	2.50 abc	2.25 b
Seedlings were treated by GA_3 at 200 ppm - (T_2)	1.80 cd	2.15 bcd	1.97 cd	2.17 bc	2.67 abc	2.42 ab
Seedlings were treated by GA_3 at 400 ppm – (T_3)	2.10 bcd	2.53 abc	2.32 bc	2.50 abc	3.00 ab	2.75 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	1.91 bcd	2.33 abcd	2.12 bcd	2.15 bc	2.60 abc	2.38 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	2.43 abc	2.63 ab	2.53 ab	2.50 abc	3.30 a	2.90 ab
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	2.65 ab	3.07 a	2.86 a	2.75 abc	3.30 a	3.06 a
Means (R)	2.09 b	2.42 a		2.35 b	2.89 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

4- Total root dry weight (gm.).

Data presented in Table (4) showed the effect of foliar spray GA_3 on total root dry weight of Sour orange (SO) and Volkamer lemon (VO) rootstock seedlings in 2008 and 2009 seasons and indicated that, total root dry weights were decreased over all GA_3 concentrations. However, Volkamer lemon under control treatment had the highest significant values (8.50 and 9.50 gm), while, Sour orange produced the lowest significant values (3.79 and 5.17 gm) with T6 (Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins) and the other treatments gave in between significant values for total root dry weight in 2008 and 2009 seasons, respectively. Table(4).

Table (4) Effect of foliar spray with gibberellic acid GA_3 on total root dry weight of two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	Total root dry weight (gm)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	6.37 abcd	8.50 a	7.44 a	7.34 ab	9.50 a	8.42 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	5.86 bcde	8.06 a	6.96 ab	7.00 ab	8.12 ab	7.56 ab
Seedlings were treated by GA_3 at 400 ppm – (T_3)	4.58 de	7.61 ab	6.26 abc	6.67 ab	7.14 ab	6.90 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	5.07 cde	8.03 ab	6.55 abc	6.81 ab	7.67 ab	7.24 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	4.03 e	7.06 abc	5.57 bc	5.90 b	7.05 ab	6.48 ab
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	3.79 e	6.56 abc	5.18 c	5.17 b	6.43 ab	5.80 b
Means (R)	4.96 b	7.69 a		6.48 b	7.65 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

Generally, it could be concluded that, foliar spray GA_3 of Sour orange and Volkamer lemon rootstocks reduced total root dry weight and there were differences between rootstocks in this response.

These results are in line with those reported by (Monselise and Halevy, 1962) who studied the effect of foliar spray of gibberellins (GA_3) at concentrations ranging between (50 and 1600 ppm)

for sweet lime seedlings and found that dry weights of roots were decreased for all concentrations.

Also, (Tadeo *et al*., 1997) indicated that GA_3 decreased root tip width and reduced all parameters related to radial expansion.

Furthermore, the effect of GA_3 on root growth is indirect, by means of its effect on the growth of the aerial part, because of the action exerted by GA_3 on cell elongation (Tanimoto, 1990).

5- Leaf chlorophyll content (μ/cm^2): Data presented in Table (5) showed the effect of GA_3 application on chlorophyll (a,b) of two citrus rootstocks (Sour orange and Volkamer lemon) in 2008 and 2009 seasons, data indicated that chlorophyll content of leaves decreased by increasing GA_3 concentrations.

Table (5) Effect of foliar spray with gibberellic acid (GA_3) on Leaf chlorophyll (a & b) contents of two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	Chlorophyll a (μ/cm^2)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	91.37 a	84.50 ab	87.93 a	86.71 a	78.38 ab	82.55 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	87.40 ab	80.54 abc	83.97 a	83.45 ab	75.39 abc	79.42 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	82.41 abc	75.37 abc	78.89 ab	79.37 ab	71.42 abc	75.39 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	85.50 ab	78.62 abc	82.06 ab	80.30 ab	70.21 bc	75.26 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	80.46 abc	73.17 bc	76.82 ab	76.35 abc	69.74 bc	73.04 ab
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	75.55 abc	65.45 c	70.00 b	70.78 abc	60.67 c	65.72 b
Means (R)	83.78 a	76.28 b		79.49 a	70.97 b	
Chlorophyll b (μ/cm^2)						
Control (untreated seeds and seedlings by GA_3) - (T_1)	33.72 a	27.66 abc	30.69 a	31.51 a	27.52 abc	29.52 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	30.53 ab	25.47 abcd	28.00 ab	29.52 ab	25.53 abc	27.52 ab
Seedlings were treated by GA_3 at 400 ppm – (T_3)	28.62 abc	22.48 bcd	25.55 ab	26.49 abc	21.43 bc	23.96 abc
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	29.85 ab	24.48 bcd	27.16 ab	27.65 abc	24.59 abc	26.21 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	26.87 abcd	20.59 cd	23.73 b	23.54 abc	20.54 bc	22.04 bc
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	25.75abcd	18.52 d	22.13 b	20.83 bc	18.52 c	19.67 c
Means (R)	29.22 a	23.20 b		26.59 a	23.02 b	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

It is also clear that Sour orange under control treatment gave the greatest averages for chlorophyll (a, b), While the lowest averages were belonged to Volkamer lemon with T6, on the other hand, the other treatments gave the intermediate values for the first and second seasons, respectively, Table (5).Our results showed that, reduction of chlorophylls (a) and (b) as a result of foliar spray of gibberellins GA_3 on leaves of citrus rootstock seedlings. These results are in harmony with those obtained by (Monselise and Halevy 1962) who reported that chlorophyll content was decreased when sweat lime seedlings treated by GA_3. Moreover, (Mauk *et al.*, 1987) found that GA_3 enhanced chlorophylls (a, b) but sharply reduced on Trifoliate orange and Sour orange rootstocks. Similar results were reported by (Monge, *et al.*, 1994), they studied the effect of spray of 1000 mg/L^{-1} GA_3 on adult peach trees {*Prunus persica (L.) Batsch}* and found that GA_3 significantly reduced the concentrations of chlorophylls (a, b).On the other hand, our results indicated that Sour orange rootstock had higher leaf chlorophyll content as compared with Volkamer lemon; these results are in line with the conclusion of (Mohamed-Hoda, 2007).

6- Leaf total carbohydrates (%):

The results were given in Table (6) showed the leaf total carbohydrates of two citrus rootstock seedlings as influenced by foliar spray of GA_3 in 2008 and 2009 seasons.

Data indicated that, GA_3 application increased leaf total carbohydrates, whereas, Sour orange with T6 scored the highest significant values for leaf total carbohydrates (35.72 and 37.76 %).While, Volkamer lemon under control treatment had the lowest values (20.59 and 22.27 %), meanwhile, the other treatments scored in between values of leaf total carbohydrate for the first and second seasons, Table (5).

Generally, it seems from the foregoing results that GA_3 application increased vegetative growth and leaf total carbohydrates, also topping and

suckering processes led to carbohydrate accumulation in rootstock stem. These finding agree with those obtained by (Miyamoto *et al.*, 1993) who reported that, there is positively correlation between vegetative growth and carbohydrate accumulation in leaves, whereas, seedling growth is enhanced by trans located sucrose, also, GA_3 promoted growth may be mediated by accumulation of soluble sugars, starch and cell wall polysaccharides. Also, (Mehouachi, *et al*, 1996) reported that GA_3 stimulated growth and synthesis and turnover of sugars, increasing carbon supply in shoots, furthermore GA_3 shifted the assimilates to the shoot which probably resulted in increased shoot growth and development in Carrizo Citrange rootstock. Moreover, (Mostafa and Baninasab, 2008) studied the effect of GA_3 on carbohydrate accumulation in shoots and roots of two almond rootstock seedlings and found that high level of soluble sugars and starch in the shoot and root were observed when GA_3 application on both rootstocks. On the other hand, our results indicated that Volkamer lemon scored the lowest significant values for leaf total carbohydrates as compared with Sour orange rootstock this decrease in carbohydrate values could be attributed to active vegetative growth which consumes higher amounts of carbohydrates.

Similar pattern of response was found by (Dawood, *et al*., 2002) who reported that, leaves of scions on Volkamer lemon and Rough lemon had lower carbohydrate level. However, trees on Sour orange like Troyer Citrange rootstock recorded intermediate values in this respect. These conclusions agree with those obtained by (Abdel-Kader and Hayat, 1989) and (Mohamed- Hoda, 2007).

Table (6) Effect of foliar spray with gibberellic acid (GA_3) on Leaf total carbohydrates (%) contents of two citrus rootstock seedlings in 2008 and 2009 seasons

Treatments(T)	Season, 2008			Season, 2009		
	Total carbohydrates (%)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	24.54 bc	20.59 c	22.57 c	26.62 bcd	22.27 d	24.45 c
Seedlings were treated by GA_3 at 200 ppm - (T_2)	27.62 abc	24.62 bc	26.12 bc	29.45 abcd	25.45 cd	27.45 bc
Seedlings were treated by GA_3 at 400 ppm – (T_3)	30.67 ab	27.63 abc	29.15 ab	32.66 abc	29.68 abcd	31.17 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	26.56 bc	22.65 bc	24.61 bc	28.70 abcd	24.40 cd	26.55 bc
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	31.34 ab	28.40 abc	29.87 ab	33.61 abc	31.75 abc	32.68 ab
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	35.72 a	31.57 ab	33.65 a	37.76 a	35.60 ab	36.68 a
Means (R)	29.41 a	25.91 b		31.47 a	28.19 b	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

7- Leaf mineral content:

a. Macro element (N, P and K). It is clear from Table (7a) that, the effect of GA_3 application on two citrus rootstock seedlings did not show any distinctive effect on leaf Nitrogen and Phosphorus contents during 2008 and 2009 seasons. It is also noticed that, leaves of Volkamer lemon with T5 had higher of (K) content (0.96 and 0.99 %) followed in descending order by Volkamer lemon with T2 (0.90 and 0.91%) and Sour orange with T5 (0.90, 0.90 %) while, Sour orange under control treatment gave the lowest values (0.64 and 0.63 %) in this regard.

Anyhow, the differences between the different rootstocks and treatments in this regard were so high to be significant. Table (7a)

b. Micro elements

Iron (Fe ppm). The concentration of iron (Fe) in leaf tissues of Volkamer lemon and Sour orange seedlings in response toGA_3 application were presented in Table (7b). It was cleared that, Fe content of leaves was decreased by increasing GA_3 concentrations. Also, it is noticed that leaves of Sour orange had higher concentrations of (Fe) (80.20 and 85.27 ppm) than Volkamer lemon (63.63 and 63.18 ppm). Regarding the interaction between rootstocks and treatments data also revealed that, Sour orange under control treatment gave the highest significant values (108.4 and 105.00 ppm). Meanwhile, Volkamer lemon with T6 produced the lowest significant values (40.66 and 43.54 ppm) in this respect and the differences between different rootstocks and treatments were so high to be significant in the first and second seasons, Table (7b).

Zinc (Zn ppm). Data in Table (7b) showed that, the higher values for leaf content were on Sour orange with T5 (82.30 and 80.20 ppm) and the lower values were on Volkamer with T6 (65.80 and 60.70 ppm), Besides, leaves of other treatments seedlings scored in between values of zinc content in two seasons under study.

Table (7a).Effect of foliar spray with gibberellic acid GA_3 on some macro element content in leaves of two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	N (%)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	2.38 a	2.35 a	2.37 a	2.59 a	2.40 a	2.50 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	2.45 a	2.40 a	2.43 a	2.53 a	2.50 a	2.52 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	2.50 a	2.48 a	2.49 a	2.50 a	2.45 a	2.48 a
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	2.55 a	2.51 a	2.53 a	2.53 a	2.48 a	2.51 a
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	2.60 a	2.57 a	2.59 a	2.56 a	2.54 a	2.55 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	2.64 a	2.60 a	2.62 a	2.67 a	2.36 a	2.52 a
Means (R)	2.52 a	2.49 a		2.56 a	2.46	
P (%)						
Control (untreated seeds and seedlings by GA_3) - (T_1)	0.125 a	0.128 a	0.127 a	0.126 a	0.129 a	0.128 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	0.150 a	0.145 a	0.147 a	0.148 a	0.145 a	0.147 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	0.144 a	0.133 a	0.139 a	0.142 a	0.134 a	0.138 a
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	0.130 a	0.140 a	0.135 a	0.132 a	0.140 a	0.136 a
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	0.155 a	0.150 a	0.135 a	0.154 a	0.149 a	0.152 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	0.139 a	0.123 a	0.131 a	0.138 a	0.122 a	0.130 a
Means (R)	0.141 a	0.137 a		0.140 a	0.137 a	
K (%)						
Control (untreated seeds and seedlings by GA_3) - (T_1)	0.640 f	0.740 def	0.69 d	0.63 e	0.740 de	0.71 c
Seedlings were treated by GA_3 at 200 ppm - (T_2)	0.854 b	0.903 ab	0.88 a	0.853 bc	0.913 ab	0.88 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	0.804 bcd	0.800 bcd	0.80 b	0.802 cd	0.800 cd	0.80 b
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	0.690 ef	0.844 bc	0.77 bc	0.703 e	0.863 bc	0.78 b
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	0.895 ab	0.955 a	0.93 a	0.901 ab	0.990 a	0.95 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	0.750 cde	0.690 ef	0.72 cd	0.741 de	0.680 e	0.71 c
Means (R)	0.772 b	0.822 a		0.778 b	0.831 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

Manganese (Mn ppm). Data presented in Table (7b) indicated that, leaves of Sour orange with T6 gave the highest significant values for leaf content (167.3 ppm) in 2008 season and with T4 (172.4 ppm) in 2009 season. Meanwhile, the lowest significant values were belonged for Volkamer lemon with T3 (102.7 ppm) in the first season and on T6 (103.7 ppm) in the second season. Anyhow, the differences between different rootstocks and treatments were so high to be significant in both seasons, respectively. Table (7b).

Generally, our results of in the present study indicated that there were no significant differences between leaf N and P contents. While, leaf K content was increasing as a result for spray of GA_3. These results are in harmony with those obtained by (Monge, *et al*., 1994); they studied effect of spray of GA_3 to adult peach trees and found that the concentrations of P, Mg and K were unaffected. For micronutrient our data revealed that leaf Fe content was decreased by increasing GA_3 concentrations, and there were positively correlation between leaf Fe concentrations and leaf chlorophyll content. Also, there were significant differences between all treatments for leaf Zn and Mn. Several researches have reported on antagonism between Fe and Mn, which could lead to Fe chlorosis (Bindra, 1980) and (Casero and Carpena, 1987) probably due to a substitution of Fe by Mn in the biosynthesis of chlorophyll (Clairmont, *et al.*, 1986). Anyhow, using standard values of citrus seedling leaves mineral nutrient concentration (Chapman, 1960) the nutritional status of our citrus seedlings was good except for Fe, which was slightly above normal levels and increasing GA_3 concentrations.

Also, our results indicated that leaves of Volkamer lemon scored the highest significant values for K content and leaves of Sour orange recorded the highest significant values for Fe content, while, there were no significant between rootstocks for other element contents. This is in agreement with (Abou-Rawash, *et al.*, 1995) and (Eid, *et al.*, 2000); they mentioned that citrus rootstocks varied in their uptake of nutrients, since some rootstocks such as Volkamer lemon can absorb more macronutrient.

Table (7b). Effect of foliar spray with gibberellic acid GA_3 on some micro element content in leaves of two citrus rootstock seedlings in 2008 and 2009 seasons

Treatments(T)	Season, 2008			Season, 2009		
	Fe (ppm)					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	108.4 a	95.48 a	102.0 a	105.5 a	89.52 bc	97.50 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	75.45 b	60.60 cde	68.03 bc	85.47 bc	58.98 ef	72.22 b
Seedlings were treated by GA_3 at 400 ppm – (T_3)	76.64 b	59.03 de	67.83 bc	80.50 bcd	55.65 fg	68.08 bc
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	80.74 b	70.62 bcd	75.68 b	93.74 ab	85.72 bc	89.73 a
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	73.32 bc	55.38 e	64.35 c	75.75 cd	45.66 fg	60.71 cd
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	66.60 bcde	40.66 f	53.63 d	70.68 de	43.54 g	57.11 d
Means (R)	80.20 a	63.63 b		85.27 a	63.18 b	
Zn (ppm)						
Control (untreated seeds and seedlings by GA_3) - (T_1)	64.99 b	68.70 ab	66.85 b	62.40 cd	66.73 abcd	64.57 b
Seedlings were treated by GA_3 at 200 ppm - (T_2)	73.53 ab	75.30 ab	74.42 ab	75.80 abc	75.33 abc	75.57 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	73.90 ab	70.90 ab	72.40 ab	72.20 abcd	69.80 abcd	71.00 ab
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	69.80 ab	73.33 ab	71.57 ab	69.30 abcd	73.40 abcd	71.35 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	82.30 a	80.50 a	81.40 a	80.20 a	78.80 ab	79.50 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	69.40 ab	65.80 b	67.60 b	64.80 bcd	60.70 d	62.75 b
Means (R)	72.32 a	72.42 a		70.78 a	70.79 a	
Mn (ppm)						
Control (untreated seeds and seedlings by GA_3) - (T_1)	156.40 ab	120.60 de	138.50 b	124.40 de	129.70 de	127.10 cd
Seedlings were treated by GA_3 at 200 ppm - (T_2)	110.50 ef	130.70 cd	120.60 c	140.60 cd	140.70 cd	140.60 b
Seedlings were treated by GA_3 at 400 ppm – (T_3)	140.40 bc	102.70 f	121.50 c	119.40 ef	160.60 ab	140.00 bc
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	152.70 ab	150.70 ab	151.70 a	172.40 a	153.60 bc	163.00 a
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	132.40 cd	140.60 bc	136.50 b	120.50 ef	125.60 de	123.00 d
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	167.30 a	144.60 bc	156.00 a	163.60 ab	103.70 f	133.70 bc
Means (R)	143.30 a	131.60 b		140.20 a	135.60 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

8- Percent of suitable seedlings amenable forbudding.

Data tabulated in Table (8) showed the average percent of suitable seedlings amenable for budding of Sour orange and Volkamer lemon which influenced by foliar spray of GA_3 and were taken at three time intervals (mid June, mid July and mid August) during 2008 and 2009 seasons.

At mid June. Data in Table (8) showed that, Volkamer lemon seedlings under T2, T3, T4 and T5 gave the highest significant values (62.65, 62.60, 63.61 and 64.58 %) with no significant between them, while the lowest percent was in Sour orange with control treatment (45.53 and 47.53 %) in two seasons under study.

It is noticed that, Sour orange with T3 (Seedlings were treated by GA_3 at 400 ppm) recorded the highest percent of suitable seedlings amenable for budding (62.46 and 60.62 %), while the lowest value was in Sour orange under control treatment (45.31 and 47.53 %) respectively in both seasons 2008 and 2009.

At mid July. Data of Table (8) indicated that increasing rate of suitable seedlings amenable for budding as compared with the obtained results from the previous time (mid June) because in this time, stem diameter of resulting seedlings reached of a pencil size or larger. Data also showed that, Volkamer lemon with T5 had the highest averages (97.25 and 98.17%) and Sour orange (90.65 and 93.38 %) followed by Volkamer lemon with T2 (94.68 and 95.30%) and Sour orange (86.60 and 87.72 %), while the lowest significant values were on Sour orange (71.63 and 74.47%) under control treatment for the first and second seasons, respectively. Table(8).

At mid August. Data tabulated in Table (8) showed that decreasing rate of percent of suitable seedlings amenable for budding compared with the previous time (mid-July). It is also clear that, Sour orange had the highest values (75.78 and 71.75 %) under T_3 in both seasons. But, Volkamer lemon gave the most vigorous values under T3 (76.96%) in the

first season, and (72.65%) under T5 in the second season. Meanwhile, Sour orange and Volkamer lemon under T6 produced the lowest values (65.47 and 59.58 %) and (60.78 and 58.52%) for two seasons, respectively. Anyhow, the differences between all treatments were so high to be significant in 2008 and 2009, seasons.

Table (8).Effect of foliar spray with gibberellic acid GA_3 on percent of suitable seedlings amenable for budding of two citrus rootstock seedlings in 2008 and 2009 seasons.

Treatments(T)	Season, 2008			Season, 2009		
	Mid June					
	Rootstocks(R)			Rootstocks(R)		
	SO	VO	Mean (T)	SO	VO	Mean (T)
Control (untreated seeds and seedlings by GA_3) - (T_1)	45.31 c	60.48 ab	52.90 b	47.53 c	58.40 abc	52.96 a
Seedlings were treated by GA_3 at 200 ppm - (T_2)	60.45 ab	62.65 a	61.55 a	58.55 abc	59.52 ab	59.03 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	62.46 ab	62.60 a	62.53 a	60.62 a	58.56 abc	59.59 a
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	50.56 bc	63.61 a	57.09 ab	48.50 bc	57.45 abc	52.98 a
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	60.59 ab	64.58 a	62.59 a	56.21 abc	58.37 abc	57.29 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	58.53 ab	55.65 abc	57.09 ab	54.51 abc	53.50 abc	54.01 a
Means (R)	56.32 b	61.60 a		54.32 a	57.63 a	
Mid July						
Control (untreated seeds and seedlings by GA_3) - (T_1)	71.63 f	82.61 cd	77.12 d	74.47 f	85.61 cde	80.04 c
Seedlings were treated by GA_3 at 200 ppm - (T_2)	86.60 bc	94.68 a	90.64 a	87.72 bcd	95.30 ab	91.51 ab
Seedlings were treated by GA_3 at 400 ppm – (T_3)	82.68 cd	87.48 bc	85.08 b	84.42 cde	88.34 bcd	86.38 bc
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	74.38 ef	90.61 ab	82.50 bc	77.82 ef	91.58 abc	84.70 c
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	90.65 ab	97.25 a	93.95 a	93.38 abc	98.17 a	95.78 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	78.58 de	78.33 de	78.96 cd	80.30 def	80.55 def	80.42 c
Means (R)	80.76 b	88.66 a		83.02 b	89.93 a	
Mid August						
Control (untreated seeds and seedlings by GA_3) - (T_1)	65.75 bc	70.54 abc	68.15 bc	63.57 abc	65.38 abc	64.47 ab
Seedlings were treated by GA_3 at 200 ppm - (T_2)	73.71 ab	75.56 ab	74.63 ab	69.61 abc	70.44 abc	70.03 a
Seedlings were treated by GA_3 at 400 ppm – (T_3)	75.78 ab	76.96 a	76.37 a	71.75 ab	70.55 abc	71.15 a
Seedlings were untreated and soaked seeds by gibberellins - (T_4).	70.84 abc	72.29 ab	71.57 ab	68.46 abc	64.13 abc	66.29 ab
Seedlings were treated by GA_3 at 200 ppm and soaked seeds by gibberellins - (T5).	75.36 ab	75.69 ab	75.52 ab	70.49 abc	72.65 a	71.57 a
Seedlings were treated by GA_3 at 400 ppm and soaked seeds by gibberellins – (T_6).	65.47 bc	60.78 c	63.13 c	59.58 bc	58.52 c	59.05 b
Means (R)	71.15 a	71.97 a		67.25 a	66.94 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

From the above results it could be concluded that, there is positively correlation between the percent of suitable seedlings amenable for budding and vigorous growth, stem diameter and leaf mineral content of the rootstocks. These results can be attributed to the vigorous growth of Volkamer lemon rootstock which possessed the highest values for stem diameter and leaf mineral content. These results are in line with those obtained with (Mohamed-Hoda, 2007) who studied the behavior of Valencia orange buddlings grafted on
some citrus rootstocks growing in various soils and found that the highest percent of suitable seedlings amenable for budding were obtained with Volkamer lemon followed by Sour orange, while Troyer Citrange had the lowest values in this respect.

Moreover, our results reported that, the highest success rate of suitable seedlings amenable for budding was in mid-July for two seasons. This time led to shortening the period for budding in citrus seedlings about 8 months, whereas, resulting seedlings could be budded because their stem diameter reached of a pencil size (5.4 mm or larger). Shortening this time would benefit nurserymen by reducing various production inputs and their costs.

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4. References

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6/1/2010