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IMPROVING SEEDLING EMERGENCE AND DEVELOPMENT OF SOUR ORANGE AND CARRIZO CITRANGE ROOTSTOCKS BY SOME PRE-SOWING TREATMENTS

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ABSTRACT

Seeds of Sour orange (SO) and Carrizo citrange (CC) rootstocks were treated by soaking for 24 h in tap water, $Ca^{++}NO_3$ at 0.2%, KNO_3 at 0.2%, Goëmar (bio-stimulant) BM86 at 0.3 and 0.5%, Goëmar MZ63 at 0.5%, GA_3 at 50 ppm or control (directly sowing) in a trial to improve the emergence and growth of seedlings aiming to produce good transplants. The seeds were sown under plastic house during February of 2006 and 2007 seasons. SO seeds had higher emergence percentage, emerged faster and gave lower number of seedlings/seed than those of C.C. Moreover, seedling of S.O was higher at 70 days after sowing, but after 6 months those of CC were the highest in stem length and diameter, and the lowest in fresh and dry weight. On the other hand, the leaves of CC had higher N content in both seasons and lower P content in the first season only, compared to SO.

Treatments with Goëmar BM860.3% increased the emergence % (90.8 & 92.8%) as compared with all other ones, followed by GA_3 (85.0 & 88.5%), tap water (86.5 & 88.0%) and KNO_3 (84.7 & 85.8%). No significant differences were found in the emergence % among $Ca^{++}NO_3$, Goëmar BM86 (0.5%), Goëmar MZ63 (0.5%) and the control treatments. The average number of days required to complete the seedling emergence was reduced by soaking the seeds in tap water before sowing (emergence rate were 34.9 & 36.3 days, in both seasons, respectively). After 6 months from sowing, Goëmar MZ63 (0.5%) treatment produced seedlings with stem length (31.2 & 36.5 cm) higher than those of control one (28.4 & 33.7 cm). Seedling fresh and dray weights increased with tap water treatment compared to the control and GA_3 ones. On the other hand, leaf N content increased with $Ca^{++}NO_3$ and Goëmar MZ63 (0.5%), while P leaf content was higher with all treatments, except KNO_3 and GA_3 compared to the control.

Keywords: Citrus, rootstocks, seeds, pre-sowing treatments, Sour orange, Carrizo citrange, emergence.

INTODUCTION

The economic significance of improving citrus seed emergence, seedling vigour and uniformity is increasing as new systems and techniques of nursery operations develop. Physical, physiological and chemical pre-sowing treatments were the subject of many investigators; however inconsistent results have been obtained in some cases (Castle, 1981). Flesh or juice of fruit as well as seed coverings can strongly inhibit seed germination. Some substances associated with inhibition are various phenols, coumarin and abscisic acid. Nevertheless, in some specific cases where inhibitors are present, germination can be improved by leaching with water (Norton, 1980). The energy supply of seeds decreases during germination and probability of seedling survival increases as the germination period decreases (Tokeshi

and Chagas, 1999). Increases in germination percentage of seeds of four citrus rootstocks were obtained by soaking in water for 24 h before sowing (Moustafa and Al-Zidgali, 1995). On the other hand, Misra *et al.* (1982) reported that the best seed germination, greatest seedling height and largest leaf area of Malta common seedlings (*C. sinensis* Osbeck) were obtained by soaking in GA_3 at 200 ppm for 12 h. Also immersing seeds of trifoliate orange in a solution of GA_3 at 250 ppm for 24 h tended to improve germination and gave seedlings large enough for grafting (Suzuki and Konakahara, 1985). In addition, El-Saida *et al.* (2001) mentioned that the best number of seedlings per seed was obtained from tap water soaking for 24 h.

This study was conducted to investigate the effects of different seed treatments on improving seedling emergence and growth of Sour orange and Carrizo citrange rootstocks, so that it could be budded easily and to produce good transplants as soon as possible.

MATERIALS AND METHODS

This study was carried out under a plastic-house during the two successive seasons 2006 and 2007. Seeds of Sour orange (*C. aurantium* L.) and Carrizo citrange (*C. sinensis* (L.) Osb. x *Poncirus trifoliata* (L.) Raf.) rootstocks were freshly extracted, shade dried, treated with fungicide and stored at 5±1°C for 8 days. Seeds were treated by soaking for 24 h pre-sowing in tap water, calcium nitrate at 0.2%, potassium nitrate at 0.2%, Goëmar BM86 at 0.3 and 0.5%, Goëmar MZ63 at 0.5%, 50 ppm GA_3 and control (directly sowing without any treatment).

Goëmar BM86 and Goëmar MZ63 are bio-stimulants formulations based on a seaweeds cream blended with selected trace elements (Table 1).

Table (1): The component of both Goëmar types

Goëmar BM 86		**Goëmar MZ63**	
Nitrogen	2.40 %	Nitrogen	3.25 %
Magnesium	4.86 %	Magnesium	3.16 %
Sulfur	9.56 %	Sulfur	12.0 %
Boron	2.04 %	Manganese	1.77 %
Molybdenum	0.02 %	Zinc	2.38 %
		Cupper	0.79 %

Each treatment included three replicates (100 seed/replicate for each rootstock). The seeds were sown in basins 1 x 2 m (for each replicate) formed by stone blocks with 40 cm above the soil surface. The basins were spread with one layer of 5 cm gravel then another layer of 15 cm sand and the final layer was of 20 cm mix of peat moss and sand (1:3 v/v). The seeds were sown at a spacing of 5 cm between rows and 3 cm within row on 27/2 in both seasons.

I- Emergence studies:

Number of emerged seedlings was recorded at three days intervals started from 25 until 59 days from sowing and the following data were calculated:

1- Emergence percentage (E %).
2- Emergence rate (ER) was calculated according to Hartmann and Kester (1983) as follows: ER (Mean days) = N_1T_1+ N_2T_2 + …. + N_xT_x / Total number of seeds germinated.
N values are the number of seeds emerged within consecutive intervals of time; *T* values indicate the times between the beginning of the test and the end of the particular interval of measurement.

II- seedlings growth studies:

At the end of emergence stage (70 days after sowing), seedling height and number of seedlings per seed (polyembryony) were recorded.

After 6 months from sowing, twenty seedlings for each replicate were pulled and the following parameters were estimated: seedling fresh weight, stem length and diameter at 5 cm from crown, root length, leaf number and seedling dry weight.

III- NPK seedling leaves content

Total nitrogen content was determined using semi-micro Kjeldahl method, and phosphorus was estimated colormetrically (AOAC, 1985)**.** Potassium was determined by flame-photometer (Jackson, 1965)**.**

Statistical analysis: The experimental design was randomized complete blocks with a split-block experiment (Steel *et al.,* 1997). Analysis of variance, with treatments as the main plot and cultivar as the subplot, and means comparison (LSD test, $P \leq 0.05$.) were performed using MSTAT-C statistical package (M-STAT, 1990).

RESULTS AND DISCUSSION

I-Emergence parameters

1- Emergence percentage: From Table 1 it is clear that Sour orange seeds gave significantly higher emergence percentage as compared with those of Carrizo citrange at all considered counting dates in both seasons. For instance, the last recorded emergence percentages were 87.4 & 89.1% for Sour orange against 79.4 & 81.6 % for Carrizo citrange in the first and second seasons, respectively. This difference was probably due to the genotype variation. In this trend, Moustafa and Al-Zidgali (1995) and Khalil (1999) found clear significant differences in the germination percentage among the different citrus rootstocks.

Pre-sowing treatments indicated significant differences in the emergence percentages at all of the considered dates in both seasons. However, after 59 days from sowing revealed higher emergence percentages (90.8 & 92.8%) with Goëmar BM86 at 0.3% in the two seasons, followed by GA_3 at 50 ppm (85.0 & 88.5%), tap water (86.5 & 88.0%) and KNO_3 at 0.2% (84.7 & 85.8%) treatments. The lowest emergence percentages was noticed with $Ca^{++}NO_3$, Goëmar BM86 at 0.5%, Goëmar MZ63 at 0.5% and the control treatments, without significant differences among them in both seasons.

In this respect, Yousif *et al.* (1989) mentioned that Sour orange seed germination after 15 days from sowing was highest with GA_3 soaking treatment at 200 ppm, but after 27 days it was highest with GA_3 at 50 ppm

and in the control. While, Gravina and Vidal (1989) stated that final germination percentage of Reina mandarin seeds was similar in the control and all treatments (GA_3 at 100 ppm and KNO_3 at 2 or 4%). Furthermore, Moustafa and Al-Zidgali (1995) noticed that the highest citrus rootstocks seed germination percentage was associated with soaking in tap water for 24 h before sowing; also a significant reduction in germination percentage was clear by soaking the seeds in GA_3 at 1000 ppm in the first season. On the other hand, Leonel and Rodrigues (1995) reported that at 30 days after sowing, the treatment of KNO_3 at 0.2% gave the highest germination percentage as compared with the control in Rangpur lime cv. Carvo. However, the same authors (1999) noticed that, GA_3 (50-250 ppm) treatments did not enhance the seed germination of Rangpur lime, while KNO_3 at 0.1% and 0.2% treatments inhibited the germination.

The interaction (cultivars x soaking treatments) was statistically significant in both seasons with emergence percentage in most of the considered dates. Generally, the best emergence (59 days from sowing) occurred when seeds of Sour orange were soaked in Goëmar BM86 at 0.3% (92.3 & 95%) or in tap water for 24 h (91.0 & 92.3%) in both seasons.

These results agree with those of Moustafa and Al-Zidgali (1995), who stated that the highest germination percentage was obtained when seeds of Rough lemon were soaked in tap water for 24 h before sowing.

2- Emergence rate (ER): The ER was significantly affected by rootstock cultivar in both seasons (Table 1), where, ER was faster in Sour orange (34.3 & 34.8 days) than in Carrizo citrange (38.9 & 39.5 days). This agrees with results of Moustafa and Al-Zidgali (1995) and Khalil (1999), who found clear significant differences among the different citrus rootstocks cultivar in ER.

The average number of days required for complete seedling emergence was significantly reduced by soaking the seeds in tap water for 24 h before sowing in both seasons. However, in the second one, no significant difference was found between this treatment and KNO_3, Goëmar BM86 at 0.3% and Goëmar MZ63 at 0.5% treatments.

Similar results were obtained by Moustafa and Al-Zidgali (1995) and Khalil (1999), who reported that soaking of Sour orange seeds in GA_3 at 1000 ppm before sowing did not affect the emergence rate. Moreover, Leonel and Rodrigues (1995) found that holding of Rangpur lime seeds in 0.2% KNO_3 gave the lowest average number of days to germination. In contrast, Ono *et al*. (1995) mentioned that immersion of Swengle citrumelo seeds in 50 ppm GA_3 significantly reduced the average time taken to germinate.

The interaction between cultivars and treatments was significant in both seasons. The slower emergence rate was clear with Carrizo citrange in the control treatment (41.5 & 41.3 days, in the first and second seasons, respectively). The faster emergence rate was found with Sour orange in the treatments with Tap water and control (32.5 days for both) in the first season, and $Ca^{++}NO_3$ at 0.2% and Goëmar BM86 at 0.3% (33.9 days for both) in the second one.

T1

In this respect, Leonel *et al.* (1994) noticed that GA treatments did not affect the germination rate of Sour orange seeds. On the other hand, Leonel and Rodrigues (1995) reported that the lowest average number of days to germination of Rangpur lime seeds was obtained with KNO_3 at 0.2% soaking treatment.

3- Number of seedlings per seed: Seeds of Carrizo citrange significantly emerged higher number of seedling per seed than those of Sour orange, in both seasons (Table 2). Number of seedlings per seed differs greatly according to the rootstock, and this may be due to the variation for responsibility the nuclear buds of rootstock seeds (El-Saida *et al*., 2001).

Soaking treatments significantly affected the number of seedlings which emerged per seed in both seasons. Where, soaking seeds in Goëmar MZ63 at 0.5% significantly increased number of seedling per seed as compared with the control and soaking in tap water in the first season only. On the other hand, no significant differences were found among the other treatments. In the second season, treatment with $Ca^{++}NO_3$ at 0.2% significantly increased the number of seedlings emerged per seed (1.56) compared to Goëmar BM86 at 0.3% (1.29), control (1.3), tap water (1.38) and Goëmar MZ63 at 0.5% (1.38) treatments. GA_3 soaking treatment significantly increased seedling number per seed (1.5) compared with Goëmar BM86 at 0.3% and the control ones.

The interaction effect between rootstock cultivars and seed soaking treatments was insignificant in both seasons.

In this respect, Khalil (1999) reported that soaking treatment of GA_3 at 1000 ppm had slight positive effect on the number of the emerged seedlings/seed in some citrus rootstocks. Furthermore, El-Saida *et al*. (2001) indicated that GA_3 at 250 and 1000 ppm and tap water soaking treatments seemed to be of negligible effect on number of seedlings which emerged from Sour orange seed, while GA_3 at 500 ppm treatment produced a high number of seedlings. On the contrary, tap water treatment gave the best number of seedlings/seed in Cleopatra mandarin.

II- seedling growth parameters

1- Seedling height: Seedling height of Sour orange after 70 days from sowing was significantly higher than that of Carrizo citrange in both seasons (Table 2), while after 6 months from sowing the seedling stem length of Carrizo citrange (30.9 cm) was significantly higher than that of Sour orange (27.7 cm), in the first season only.

Seed soaking treatments significantly affected the seedling height at 70 days after sowing in both seasons. The treatment of Goëmar BM86 at 0.5% significantly increased the seedling height as compared to other treatments in both seasons, except the treatment of Goëmar BM86 at 0.3% in the first season only, which was statistically similar. This result may be due to the effect of the bio-stimulant that contain the seaweeds extraction, and some changes of organic components in seed.

After 6 months from sowing, seeds soaked in Goëmar MZ63 at 0.5% produced seedlings with stem length (31.2 & 36.5 cm) significantly higher than those of control (28.4 & 33.7 cm) in the two seasons.

T3

On the other hand, other treatments show no significant differences as compared with the control one.

The interaction (rootstocks x treatments) was significant in both seasons for seedling height at 70 days after sowing. The tallest seedling at 70 days was found with Sour orange treated with Goëmar BM86 at 0.5% (9.3 cm) in the first season, and Goëmar BM86 at 0.5% (10.3 cm), KNO_3 (10.3 cm) and Goëmar MZ63 at 0.5% (10.2 cm) in the second one. While, the interaction for the stem length after 6 months from sowing was significant in the second season only.

According to Misra *et al*. (1982), the greatest seedling height was obtained when seeds were treated with GA_3 at 200 ppm for 12 h., while Moustafa and Al-Zidgali (1995) reported that GA_3 at 1000 ppm significantly increased the seedling length of four citrus rootstocks after three months from germination, but this effect was significant in one season only. In addition, El-Saida *et al.* (2001) stated that soaking of Sour orange and Cleopatra mandarin seeds in tap water for 48 h or Zea maize extract for 48 h stimulated the stem length (100 days after germination) as compared to control, GA_3 at 250 ppm and tap water for 24 h.

2- Seedling root length: It is obvious from Table 3 that the seedling of both rootstocks had similar root length in both seasons of this study. On the other hand, soaking treatments show no clear effect on the seedling root length. In the first season, tap water soaking treatment significantly increased the root length compared to $Ca^{++}NO_3$ and Goëmar BM86 at 0.5%, while no significant differences were found among other treatments. In the second season, GA_3 and Goëmar BM86 at 0.5% produced seedlings with lower root length as compared with Goëmar BM86 at 0.3%, Goëmar MZ63 at 0.5% and control treatments. The interaction (rootstocks x treatments) was insignificant in both seasons.

In this line, El-Saida *et al.* (2001) found a significant effect of GA_3 at 500 ppm and tap water for 24 h treatments on Sour orange seedling's root length.

3- Stem diameter: Seedlings of Carrizo citrange had significantly higher stem diameter than those of Sour orange in both seasons (Table 2).

Soaking treatments showed no significant effect on the stem diameter in the first season, despite of Goëmar MZ63 at 0.5% treatment had higher value (28.3 mm) and tap water treatment had the lowest one (26.1mm). In the second season, Goëmar MZ63 at 0.5% treatment gave a significant higher stem diameter when compared with $Ca^{++}NO_3$ treatment.

The interaction effect was significant in the first season only, whereas the highest stem diameter was clear in Carrizo citrange with Goëmar MZ63 at 0.5% treatment and the lowest one was found in Sour orange with the control one.

4- Leaf number per seedling: From Table 2, it is clear that no definite trend was found in both seasons regarding the leaf number per seedling. In the first season, no significant differences were found between both rootstocks, or among treatments. In the second season, Sour orange seedlings had a significant higher leaf number/seedling than those of Carrizo citrange. KNO_3 at 0.2% treatment gave the lowest leaf number/seedling as compared with Goëmar BM86 at 0.5%, Goëmar MZ63 at 0.5% and control treatments.

T3

The other treatments were statistically similar in this respect. The interaction (rootstocks x treatments) was insignificant in both seasons.

5- Seedling fresh weight (FW): The average fresh weight of Sour orange seedling was significantly higher than that of Carrizo citrange one in both seasons of this study (Table 3).

Soaking treatments significantly affected the seedling fresh weight after 6 months from sowing in the two seasons. The lowest FW was noticed in the control and GA_3 treatments as compared with tap water and Goëmar MZ63 at 0.5% ones in the first season, while no significant differences were found among the other treatments. In the second season, almost the same trend was evident, whereas the seedling fresh weight in the control and GA_3 treatments was significantly lower than that in tap water one. On the other hand, the other treatments show no significant differences among them.

The interaction (rootstocks x treatments) was significant in both seasons. It seemed that seedling fresh weight of Carrizo citrange were not affected by treatments in the first season, but in the second one, treatment with Goëmar BM86 at 0.5%, showed significant higher seedling fresh weight when compared to tap water and GA_3 treatments, only. In contrary, with Sour orange seedling, the highest fresh weight was found with tap water soaking treatment (9.9 & 11.5 g, in both seasons, respectively), despite of no significant differences were found between this treatment and all Goëmar treatments in the first season, only.

6- Seedling dry weight (DW): Sour orange seedling had significant higher dry weight (DW) than those of Carrizo citrange; this result was true in both seasons.

Regarding the effect of soaking treatments on the seedling DW, which was significant in the two seasons, no definite trend was found in both seasons. This difference was probably due to the seasonal variations or to variation in seed viability. In the first season, tap water treatment produced seedlings with DW (2.013 g) significantly higher than those in $Ca^{++}NO_3$ (1.82 g), control (1.93 g) and GA_3 (1.95 g) treatments. No significant differences were found among tap water and KNO_3 or Goëmar treatments, in this respect. In the second season, all treatments significantly increased the seedling DW as compared with control one, except KNO_3 and Goëmar BM86 at 0.5% treatments, which were statistically similar in this respect. The highest seedling DW (2.27 g) was achieved by Goëmar BM86 at 0.3%, and $Ca^{++}NO_3$ (2.12 g) soaking treatments, without significant difference between both.

The interaction effect was significant in the first season only. The highest Carrizo citrange seedling DW was noticed with GA_3 (1.9 g), Goëmar BM86 at 0.3% (1.8 g) and $Ca^{++}NO_3$ (1.89 g) treatments, while with Sour orange, the highest seedling DW was clear in Goëmar BM86 at 0.3% (2.7 g), tap water (2.6 g) and Goëmar MZ63 at 0.5% (2.5 g), without significant differences among them.

In this respect, Khalil (1999) mentioned that soaking seeds of some citrus rootstocks in GA_3 at 1000 ppm for 24 h had slight positive effect on the seedling vigour as dry weight.

III- NPK leaf content

Regarding to rootstocks, data in Table 3 indicate that Carrizo citrange seedlings had significantly higher N leaf content in both seasons, and significantly lower P leaf content in the first season only, than those of Sour orange. No significant difference was found between both rootstocks in the K leaf content in the two seasons.

Seed treatments significantly affected NPK leaf content in both seasons, except K content in the second season.

Leaf N content was significantly higher with Goëmar MZ63 at 0.5%, tap water and $Ca^{++}NO_3$ treatments in the first season, and with Goëmar BM86 at 0.5%, $Ca^{++}NO_3$ and Goëmar MZ63 at 0.5% in the second one, as compared with control treatment.

Leaf content of P was higher with tap water, Goëmar BM86 at 0.3%, $Ca^{++}NO_3$ and Goëmar BM86 at 0.5% in the first season and with all treatments, except KNO_3 and GA_3 compared to control treatment in the second season.

All treatments increased the leaf K content as compared with control, except GA_3 treatment in the first season only.

It is also noticed that the interaction between rootstocks cultivars and seed soaking treatments was significant in both seasons for N and P leaf content, while was non-significant for K leaf content.

It is concluded that soaking seeds of Sour orange and Carrizo citrange in bio-stimulants (such as Goëmar BM86 & Goëmar MZ63), GA_3 solutions or tap water for 24 h before sowing, generally enhanced emergence percentage and vegetative growth; and in turn, the uptake of nutrient elements was improved, specially the NPK.

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تحسين إنبات ونمو شتلات أصول النارنج و الكاريزو سترانج ببعض المعاملات قبل الزراعة

مجدي على بصل
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خلال موسمي ٢٠٠٦ & ٢٠٠٧ تم معاملة بذور أصلى النارنج و الكاريزو سترانج بالنقع لمدة ٢٤ ساعة في الماء العادي ؛ نترات كالسيوم بتركيز ٠,٢% ؛ نترات بوتاسيوم بتركيز ٠,٢% ؛ جومار (مستخلص طحالب) بى إم ٨٦ بتركيزات ٠,٣ و ٠,٥% ؛ جومار إم زد ٦٣ بتركيز ٠,٥% ؛ الجبريلين بتركيز ٥٠ جزء في المليون ؛ إلى جانب المقارنة (الزراعة المباشرة). وقد تم زراعة البذور في أحواض تحت صوبة بلاستيكية أواخر شهر فبراير من كل عام، وذلك بغرض تحسين الإنبات ونمو الشتلات لإنتاج شتلات أصول جيدة.

أوضحت النتائج أن بذور النارنج كانت أفضل من بذور الكاريزو سترانج في نسبة وسرعة الإنبات ، وتعدد الأجنة. أيضا كانت شتلات النارنج أطول من الكاريزو سترانج بعد ٧٥ يوم من الزراعة ، أما بعد ٦ أشهر كانت شتلات الكاريزو سترانج هي الأطول والأكبر في القطر ولكن الأقل في كل من الوزن الطازج والجاف. من ناحية أخرى، فقد احتوت أورق الكاريزو سترانج على نسبة أعلى من النيتروجين في كلا الموسمين ونسبة أقل من الفسفور في الموسم الأول فقط.

معاملة الجومار بى إم ٨٦ بتركيز ٠,٣% أدت إلى زيادة نسبة الإنبات (٩٠,٨ و ٩٢,٨%) مقارنة بالمعاملات الأخرى بما فيها الكنترول ؛ تلاها في ذلك معاملة الجبريلين (٨٥ و ٨٨,٥%) ، النقع في الماء (٨٦,٥ و ٨٨%) ثم معاملة نترات البوتاسيوم (٨٤,٧ و ٨٥,٨%). ولم يكن هناك فروق معنوية في نسبة الإنبات بين كل من نترات الكالسيوم و الجومار بى إم ٨٦ بتركيز ٠,٥% و الجومار إم زد ٦٣ بتركيز ٠,٥% و الكنترول.

لوحظ أن معاملة الجومار إم زد ٦٣ بتركيز ٠,٥% أدت إلى زيادة طول ساق الشتلات (٣١,٢ و ٣٦,٥سم) مقارنة بالكنترول (٢٨,٤ و ٣٣,٧ سم)، وذلك بعد ٦ أشهر من الزراعة. أما معاملة النقع في الماء فقد أظهرت زيادة في كل من الوزن الطازج والجاف للشتلات مقارنة بكل من الكنترول و الجبريلين.

لوحظ زيادة محتوى الأوراق من النيتروجين في كل من معاملة نترات الكالسيوم و الجومار إم زد ٦٣ بتركيز ٠,٥% ؛ و من الفسفور في جميع المعاملات مقارنة بعاملة الكنترول، فيا عدا معاملة نترات البوتاسيوم و الجبريلين.

على ضوء النتائج المتحصل عليها يمكن القول، بصفة عامة بأن نقع بذور كل من النارنج و الكاريزو سترانج قبل الزراعة في أحد النشطات الحيوية (مثل مستخلص الطحالب جومار بى إم ٨٦ أو إم زد ٦٣) أو الجبريلين أو في الماء العادي لمدة ٢٤ ساعة يحسن من الإنبات و امتصاص العناصر الغذائية وبالتالي نمو الشتلات.

Table (1): Effect of pre-sowing treatments on seedling emergence % and rate, and seedling numbers per seed of Sour orange and Carrizo citrange rootstocks during 2006 and 2007 seasons

Treatments	Seedling emergence %												Emergence rate			Seedlings number/Seed		
	After 25 days			After 36 days			After 47 days			After 59 days								
	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean
1st season																		
Control	16.0	1.0	**8.5**	75.3	56.7	**66.0**	81.0	67.0	**74.0**	84.0	78.3	**81.2**	32.5	41.5	**37.0**	1.09	1.31	**1.20**
Tap water	26.0	9.7	**17.8**	85.0	66.3	**75.7**	90.3	75.7	**83.0**	91.0	82.0	**86.5**	32.6	37.3	**34.9**	1.02	1.34	**1.18**
$Ca^{++}No_3$ 0.2%	24.0	3.3	**13.7**	78.0	54.3	**66.2**	81.0	66.3	**73.7**	86.0	74.0	**80.0**	34.7	39.7	**37.2**	1.06	1.50	**1.28**
KNo_3 0.2%	23.0	10.3	**16.6**	78.0	63.7	**70.8**	83.7	74.3	**79.0**	88.0	81.3	**84.7**	34.9	38.0	**36.5**	1.08	1.41	**1.24**
Goëmar BM86 0.3%	29.0	8.7	**18.8**	83.7	69.7	**76.7**	88.0	80.3	**84.2**	92.3	89.3	**90.8**	34.1	38.6	**36.4**	1.03	1.56	**1.28**
Goëmar BM86 0.5%	18.0	4.7	**11.3**	71.0	60.7	**65.8**	79.3	69.3	**74.3**	84.0	75.0	**79.5**	36.0	38.3	**37.2**	1.11	1.44	**1.27**
Goëmar MZ63 0.5%	24.0	3.0	**13.5**	79.0	59.0	**69.0**	84.3	66.7	**75.5**	86.0	73.0	**79.5**	34.1	38.7	**36.4**	1.13	1.51	**1.32**
GA3 50 ppm	19.3	8.0	**13.7**	81.3	63.3	**72.3**	83.3	72.0	**77.7**	88.0	82.0	**85.0**	35.1	38.9	**36.9**	1.07	1.48	**1.28**
Mean	**22.4a**	**6.1**		**78.9**	**61.7**		**83.9**	**71.5**		**87.4**	**79.4**		**34.3**	**38.9**		**1.07**	**1.45**	
LSD 5% for rootstock	2.02			1.56			2.20			5.57			1.68			0.11		
LSD 5% for treatments	2.18			3.38			2.28			2.09			1.31			0.12		
LSD 5% for interaction	2.72			3.79			NS			3.29			1.75			NS		
2na season																		
Control	17.3	1.0	**9.2**	76.0	54.3	**65.2**	80.7	68.0	**74.3**	83.0	80.3	**81.7**	35.0	41.3	**38.1**	1.24	1.36	**1.30**
Tap water	26.3	9.0	**17.6**	86.0	65.7	**75.8**	91.0	75.0	**83.0**	92.3	83.7	**88.0**	34.4	38.4	**36.3**	1.21	1.54	**1.38**
$Ca^{++}No_3$ 0.2%	23.7	3.0	**13.3**	80.3	52.0	**66.2**	82.0	65.3	**73.7**	88.0	76.3	**82.2**	33.9	40.8	**37.4**	1.32	1.79	**1.56**
KNo_3 0.2%	23.7	9.3	**16.5**	78.7	61.7	**70.2**	84.7	73.7	**79.2**	89.0	82.7	**85.8**	35.0	37.9	**36.4**	1.38	1.60	**1.49**
Goëmar BM86 0.3%	29.7	9.0	**19.3**	84.3	69.0	**76.7**	88.7	81.0	**84.8**	95.0	90.7	**92.8**	33.9	39.7	**36.8**	1.15	1.43	**1.29**
Goëmar BM86 0.5%	19.0	5.3	**12.2**	72.7	61.7	**67.2**	79.0	70.7	**74.8**	87.0	78.0	**82.5**	36.5	38.7	**37.6**	1.38	1.50	**1.44**
Goëmar MZ63 0.5%	24.3	2.0	**13.2**	81.0	58.3	**69.7**	83.7	65.3	**74.5**	87.3	75.0	**81.2**	34.2	39.7	**37.0**	1.23	1.52	**1.38**
GA3 50 ppm	20.0	8.3	**14.2**	82.3	62.7	**72.5**	84.7	74.0	**79.3**	91.0	86.0	**88.5**	35.4	39.6	**37.5**	1.37	1.63	**1.50**
Mean	**23.0**	**5.9**		**80.2**	**60.7**		**84.3**	**71.6**		**89.1**	**81.6**		**34.8**	**39.5**		**1.29**	**1.55**	
LSD 5% for rootstock	1.89			3.53			2.64			4.04			0.78			0.14		
LSD 5% for treatments	1.89			2.93			2.33			3.04			0.96			0.16		
LSD 5% for interaction	2.69			3.21			4.66			3.40			1.04			NS		

S.O: Sour orange; C.C: Carrizo citrange.

Table (2): Effect of pre-sowing treatments on seedling growth of Sour orange and Carrizo citrange rootstocks during 2006 and 2007 seasons

Treatments	70 days after sowing			Seedling growth parameters; 6 months after sowing											
	Seedling height (cm)			Stem length (cm)			Root length (cm)			Stem diameter (mm)			Leaf Number/seedling		
	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean
1st season															
Control	8.5	7.7	**8.1**	25.6	31.2	**28.4**	20.6	20.4	**20.5**	24.3	29.6	**26.9**	22	22.3	**22.2**
Tap water	9.2	7.2	**8.2**	29.4	31.9	**30.7**	21.2	21.2	**21.2**	25.0	27.1	**26.1**	21.9	22.8	**22.4**
$Ca^{++}No_3$ 0.2%	8.9	7.4	**8.2**	26.8	28.6	**27.7**	20.4	18.0	**19.2**	26.1	27.7	**26.9**	22.6	22	**22.3**
KNo_3 0.2%	8.7	7.3	**8.0**	26.7	27.5	**27.1**	20.5	19.4	**19.9**	24.5	28.5	**26.5**	23.2	21.9	**22.6**
Goëmar BM86 0.3%	9.0	7.6	**8.3**	29.3	30.2	**29.8**	20.2	20.1	**20.2**	27.0	28.5	**27.7**	21.9	22.8	**22.4**
Goëmar BM86 0.5%	9.3	7.6	**8.5**	28.0	31.1	**29.6**	18.4	20.0	**19.2**	27.0	27.0	**27.0**	21.1	20.9	**21.0**
Goëmar MZ63 0.5%	9.0	7.2	**8.1**	28.5	33.9	**31.2**	19.5	20.3	**20.3**	25.5	31.1	**28.3**	21.3	23.7	**22.5**
GA3 50 ppm	8.7	7.2	**8.0**	27.0	33.1	**30.0**	18.7	20.8	**19.7**	24.3	30.1	**27.2**	21.5	22.8	**22.2**
Mean	**8.9**	**7.4**		**27.7**	**30.9**		**20.0**	**20.0**		**25.5**	**28.7**		**21.9**	**22.4**	
LSD 5% for rootstock	0.28			1.91			NS			2.11			NS		
LSD 5% for treatments	0.24			2.76			1.78			NS			NS		
LSD 5% for interaction	0.28			NS			NS			1.90			NS		
2nd season															
Control	9.4	8.3	**8.8**	30.9	36.5	**33.7**	24.7	22.7	**23.7**	29.5	31.9	**30.7**	27.6	26.3	**27.0**
Tap water	9.8	8.2	**9.0**	35.4	35.1	**35.3**	22.1	22.9	**22.7**	31.8	31.1	**31.5**	27	25.5	**26.2**
$Ca^{++}No_3$ 0.2%	9.6	8.0	**8.8**	31.8	36.3	**34.0**	22.0	21.5	**21.8**	28.9	31.1	**30.0**	26.8	25.1	**25.9**
KNo_3 0.2%	10.3	7.9	**9.1**	33.5	34.2	**33.9**	22.4	20.7	**21.6**	30.9	32.9	**31.9**	23.3	24.9	**24.1**
Goëmar BM86 0.3%	9.8	8.2	**9.0**	34.7	36.8	**35.8**	22.7	24.7	**23.7**	30.5	32.6	**31.5**	25.9	24.4	**25.2**
Goëmar BM86 0.5%	10.3	8.5	**9.4**	34.6	34.6	**34.6**	21.3	21.5	**21.4**	30.3	33.5	**31.9**	28.2	24.8	**26.5**
Goëmar MZ63 0.5%	10.2	8.0	**9.1**	35.4	37.7	**36.5**	23.8	23.3	**23.6**	32.9	32.1	**32.5**	22.6	25.4	**26.6**
GA3 50 ppm	9.8	7.8	**8.7**	30.4	36.4	**33.4**	20.3	21.1	**20.7**	29.5	32.6	**31.0**	27.6	23.7	**25.6**
Mean	**9.9**	**8.1**		**33.3**	**36.0**		**22.4**	**22.4**		**30.5**	**32.2**		**26.8**	**25.0**	
LSD 5% for rootstock	0.06			NS			NS			1.34			1.07		
LSD 5% for treatments	0.31			2.80			2.21			2.16			2.31		
LSD 5% for interaction	0.39			2.78			NS			NS			NS		

S.O: Sour orange; C.C: Carrizo citrange.

Table (3): Effect of pre-sowing treatments on seedling fresh and dray weight; and NPK leaf content (%) of Sour orange and Carrizo citrange citrus rootstocks during 2006 and 2007 seasons

Treatments	Seedling fresh weight (g)			Seedling dray weight (g)			N leaf content (%)			P leaf content (%)			K leaf content (%)		
	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean	S.O	C.C	Mean
1st season															
Control	8.1	4.8	**6.5**	2.4	1.5	**1.93**	2.50	2.73	**2.62**	0.256	0.282	**0.269**	2.87	2.95	**2.91**
Tap water	9.9	5.1	**7.5**	2.7	1.6	**2.13**	2.79	2.86	**2.83**	0.320	0.291	**0.306**	3.05	3.16	**3.11**
$Ca^{++}No_3$ 0.2%	8.6	5.2	**6.9**	2.2	1.4	**1.82**	2.88	2.74	**2.81**	0.305	0.286	**0.295**	3.04	3.04	**3.04**
KNo_3 0.2%	8.7	5.4	**7.1**	2.4	1.6	**2.02**	2.68	2.56	**2.62**	0.268	0.245	**0.256**	3.11	3.14	**3.13**
Goëmar BM86 0.3%	9.3	5.2	**7.2**	2.6	1.4	**2.00**	2.12	2.59	**2.36**	0.274	0.318	**0.296**	3.05	3.07	**3.06**
Goëmar BM86 0.5%	9.7	4.8	**7.2**	2.6	1.6	**2.07**	2.32	2.94	**2.63**	0.319	0.268	**0.294**	2.98	3.13	**3.05**
Goëmar MZ63 0.5%	9.4	5.3	**7.4**	2.6	1.6	**2.08**	2.71	3.03	**2.87**	0.313	0.222	**0.268**	3.17	3.18	**3.18**
GA3 50 ppm	7.6	5.5	**6.5**	2.4	1.5	**1.95**	2.40	2.56	**2.48**	0.235	0.254	**0.245**	2.98	2.97	**2.98**
Mean	**8.9**	**5.2**		**2.48**	**1.52**		**2.55**	**2.75**		**0.286**	**0.271**		**3.03**	**3.08**	
LSD 5% for rootstock	0.59			0.24			0.08			0.01			NS		
LSD 5% for treatments	0.77			0.15			0.07			0.02			0.14		
LSD 5% for interaction	0.98			NS			0.11			0.02			NS		
2nd season															
Control	9.8	6.3	**8.0**	2.0	1.6	**1.77**	2.72	2.94	**2.83**	0.288	0.319	**0.304**	3.17	3.18	**3.18**
Tap water	11.5	5.8	**8.7**	2.6	1.5	**2.05**	2.89	2.95	**2.92**	0.323	0.343	**0.333**	3.23	3.21	**3.22**
$Ca^{++}No_3$ 0.2%	9.6	6.7	**8.2**	2.4	1.8	**2.12**	3.11	2.99	**3.05**	0.323	0.326	**0.325**	3.21	3.20	**3.20**
KNo_3 0.2%	9.4	7.1	**8.3**	2.2	1.5	**1.83**	2.87	2.83	**2.85**	0.293	0.306	**0.299**	3.21	3.22	**3.21**
Goëmar BM86 0.3%	10.2	6.6	**8.4**	2.7	1.8	**2.27**	2.55	2.81	**2.68**	0.332	0.349	**0.341**	3.19	3.22	**3.20**
Goëmar BM86 0.5%	9.8	7.2	**8.5**	2.4	1.4	**1.90**	2.81	3.45	**3.13**	0.365	0.288	**0.327**	3.12	3.19	**3.16**
Goëmar MZ63 0.5%	10	6.7	**8.3**	2.5	1.4	**1.98**	2.86	3.09	**2.98**	0.333	0.303	**0.318**	3.22	3.20	**3.21**
GA3 50 ppm	8.9	6.2	**7.6**	2.3	1.9	**2.08**	2.81	2.73	**2.77**	0.268	0.293	**0.281**	3.19	3.21	**3.20**
Mean	**9.9**	**6.6**		**2.39**	**1.61**		**2.83**	**2.97**		**0.316**	**0.316**		**3.19**	**3.20**	
LSD 5% for rootstock	0.62			0.11			0.030			NS			NS		
LSD 5% for treatments	0.61			0.17			0.093			0.014			NS		
LSD 5% for interaction	1.00			0.30			0.132			0.031			NS		

S.O: Sour orange; C.C: Carrizo citrange.