

Effect of foliar application of GA₃ and Some Nutrients on Yield and Fruit Quality of Valencia Orange Trees

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Abstract: This work was done to study the effect of foliar application of GA₃, some macro and micro-nutrients either individually or in combinations on fruit set %, yield and fruit quality of Valencia orange trees during two successive seasons (2010-2011 and 2011-2012). The results indicated that foliar spraying of Valencia orange trees with GA₃ at either 15 or 25 ppm increased fruit set %, yield and some fruit quality such as fruit juice, TSS, V.C and TSS/Acid ratio than in comparison to those of control. Chelated calcium, Chelated zinc and boron significantly increased fruit set %, fruit quality, fruit weight (g), number of fruits/tree and the estimated yield (kg/tree) at harvest in comparison to control and other treatments. In this respect, applying any of combined treatments might be considered as a promising treatment specially chelated calcium +boric acid.

[Baghdady, G.A., Abdelrazik, A. M., Abdrabboh, G. A. and Aboelghit, A. A. **Effect of foliar application of GA₃ and Some Nutrients on Yield And Fruit Quality of Valencia Orange Trees.** *Nat Sci* 2014;12(4):93-100]. (ISSN: 1545-0740). <http://www.sciencepub.net/nature>. 12

Key words: GA₃, nutrients, foliar spraying, yield and fruit quality, Valencia orange.

1.Introduction

Citrus fruits are the backbone of fruit crop yield and could be regulated as cash crop in Egypt. Valencia orange [*Citrus sinensis* L. (Osbeck.)] is the most export cultivar among other citrus species in Egypt. The total cultivated area of citrus in Egypt reached 395731 Feddan in the season 2011, which produced about 3.730685 tons/year (FAO, 2012). Sandy soils are poor in low macro and micro – nutrients. Plant nutrient management could influence flowering, fruit set, fruit size, the amount of vegetative growth and other plant characteristics in most citrus fruit species. Plant foliar spraying has been used as means of supplying the plant with the minor and major nutrients, plant hormones, stimulants and other beneficial substances. The observed effects of plant fertilization has included yield increases and enhanced the fruit quality (Hafez and El-Metwally 2007; Tariq *et al.* 2007). The beneficial effects of spraying GA₃ and nutrient elements to achieve high yield production with high fruit quality, the matter, that was realized by many investigators such as (Abd-allah, 2006) on navel oranges. Elsese *et al.*, 2005 on mandarin who found that, GA₃ with zinc, applied at full bloom of small fruit stage, has significantly increased the number of harvested fruits. Calcium promotes early root formation and growth, improves general plant vigor, stiffness of stalks and improves fruit integrity. Calcium influences the uptake of other nutrients such as manganese, iron, zinc and boron (Polevoig, 1989). The micro-nutrient Boron plays as important role in growth behavior and productivity of trees. It increases pollen grains germination and pollen tube elongation, consequently fruit set percentage and finally the yield (Garcia-Papi and Martinez, 2003). The role of Zn in plant that it

affects the synthesis of tryptophan which is a precursor of Indole acetic acid and the formation of the growth substance is directly influenced by Zn. It has also an important role in starch metabolism in plant. It is well known that zinc acts a co-factor of many enzymes and affects many biological processes such as photosynthesis reactions, nucleic acids metabolism, protein and carbohydrate biosynthesis (Marschner, 1996). Therefore, this experiment was to test the effect of foliar spraying of GA₃, some macro and micro-elements either individually or additively to Valencia orange trees during full bloom on the fruit set, final yield and fruit quality.

2. Material and methods

This study was carried out during two successive seasons (2010-2011 and 2011-2012) on seven years old Valencia orange trees, budded on Volkamer lemon rootstock and planted apart 4X6 meters in sandy soil under drip irrigation system in a private orchard at El-Bostan – Behera Governorate. The spring foliar sprayed treatments were done at full bloom stage of Valencia orange as follows:

- T1- Control (sprayed with water only).
- T2- GA₃ at 15 ppm.
- T3- GA₃ at 25 ppm.
- T4- Chelated Zn at 0.4 %.
- T5- Chelated Zn at 0.4 % + GA₃ at 15 ppm.
- T6- Chelated Zn at 0.4 % + GA₃ at 25 ppm.
- T7- Boric acid at 300 ppm.
- T8- Chelated Ca 0.5%.
- T9- Chelated Ca 0.5% + Boric acid at 300 ppm.

The other culture practices were the same for all trees. Each treatment was replicated three times on one

tree plots and the complete randomized block design was arranged.

Measurements.

Fruit set number and percentage: Four branches (two years old) similar in growth, such that one branch in each original direction were chosen and twelve shoots per each main branch were tagged at balloon stage of the flowering. At blooming, all open flowers/shoot were counted. After the end of initial fruit set, the number of fruit set was recorded and initial fruit set percentage was calculated according to the following equation:

Total No. of set fruits /shoot

Initial fruit set % = ----- × 100

Total No. of opened flowers/shoot

Retained fruits percentage: Number of retained fruits/tree was counted at harvest.

Yield: Harvesting was achieved on (22nd April in 2010/2011 and in 2011/2012 seasons) and yield (Kg/tree) was estimated. Fruit yield increment or reduction percentage compared with the control was calculated by the following equation:

Fruit yield (kg)/treatment - Fruit yield (kg)/control

Fruit yield increment or reduction (%) = ----×100

Fruit yield (kg)/ control

Fruit physical characteristics: At harvest, samples of twenty fruits each tree replicated three times were devoted to determine both fruit weight (g) and fruit juice (%).

Fruit biochemical characteristics: At harvest, samples of twenty fruit of each tree replicated three times and the following biochemical characteristics were recorded.

Titrateable acidity %, TSS %, TSS/acid ratio and Ascorbic acid (vitamin C.) (mg/100 ml juice).

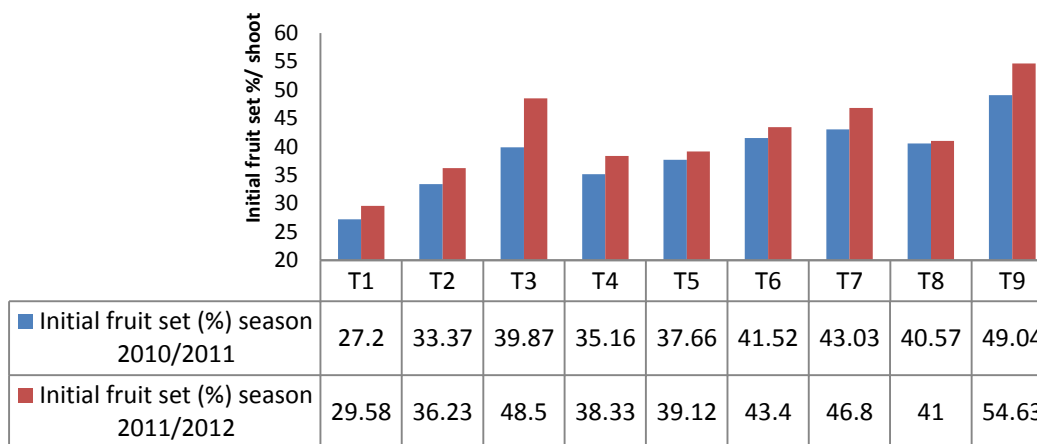
Statistical Analysis:

A complete randomized block design was followed and the analysis of variance (ANOVA) was performed using two ways ANOVA Co-stat software according to Stern (1991).

3. Results and Discussion

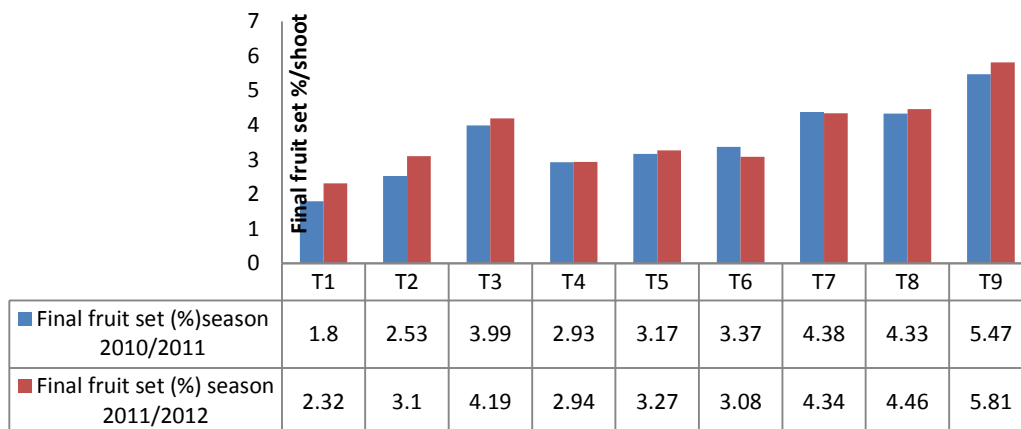
Effect of GA₃ and some nutrients on fruit set and fruit drop percentage.

Data in Figs. 1 and 2 clearly showed that all treatments significantly increased the initial fruit set percentage more than that of control during the two seasons of the study. The data also indicated that spraying the trees by Chelated calcium at 0.5% + boric acid at 300 ppm (T9) has showed more pronounced increase in fruit set percentage than did the other treatments including control followed descendingly by boric acid at 300 ppm (T7) or GA₃ at 25 ppm (T3). In respect to the previous results, Garcia and Martinez (2003) reported that the improvement in fruit set % of Clementine could be interpreted that as a result to increase pollen grain tube might vigorously elongated and grew due to boron treatments.



LSD at 5% for 2010/2011 season 12.48 and for 2011/2012 season 15.92

Fig. 1. Effect of foliar application of GA₃ and some nutrients on initial fruit set (%) of Valencia orange trees in seasons 2010/2011 and 2011/2012.

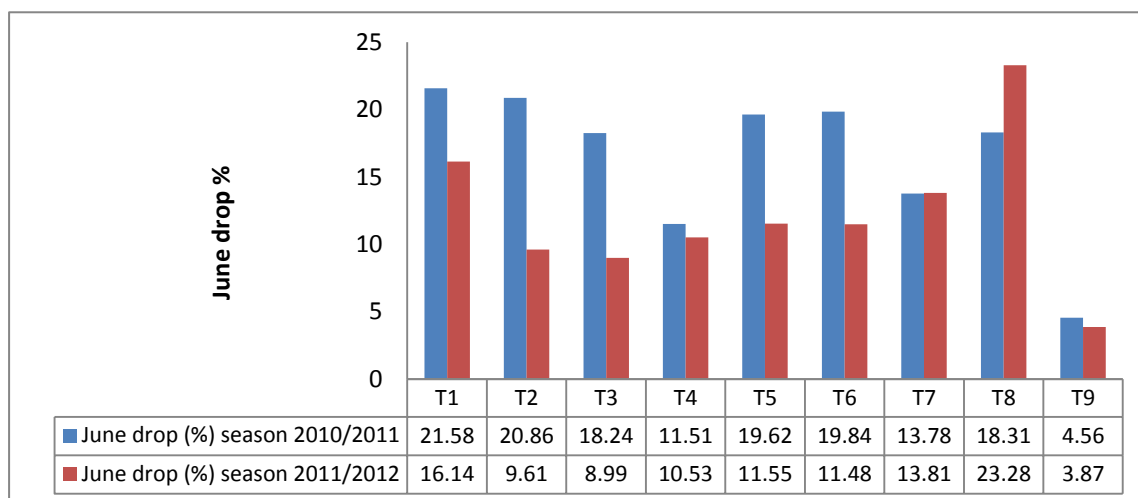


LSD at 5% for 2010/2011 season: 0.23 and for 2011/2012 season : 0.61

Fig. 2. Effect of foliar application of GA₃ and some nutrients on final fruit set (%) of Valencia orange trees in seasons 2010/2011 and 2011/2012.

Concerning fruit drop percentage, Fig. 3 showed that similar trend was observed regarding the effect of treatments on initial fruit drop %, since the trees were treated with combination of Chelated Ca 0.5% + boric acid at 300 ppm (T9) which markedly significantly decreased fruit drop % in the two seasons. Generally, fruit drop was higher in the first season than in the second season. However, at the second season GA₃ at 25 ppm (T3) had also significantly decreased fruit drop % when compared with control. The reduction in fruit

drop % as a response of GA₃ treatment might be due to the fast increase of ovaries growth and reduction magnitude of abscission the peak (Agusti *et al.*, 1982a). In addition, B played an important role in biosynthesis and translocation of the hetero auxin (IAA) into the fruits pedicels (Nijjar, 1985). These results are in harmony with those found by (Abd-Allah, 2006 and Abd El-Moniem *et al.*, 2007) working on Navel orange, who found that Chelated Ca plus boric acid or GA₃ induced high fruit set %.



LSD at 5% for 2010/2011 season: 1.01 and for 2011/2012 season : 0.78

Fig. 3. Effect of foliar application of GA₃ and some nutrients on June drop (%) of Valencia orange trees in seasons 2010/2011 and 2011/2012.

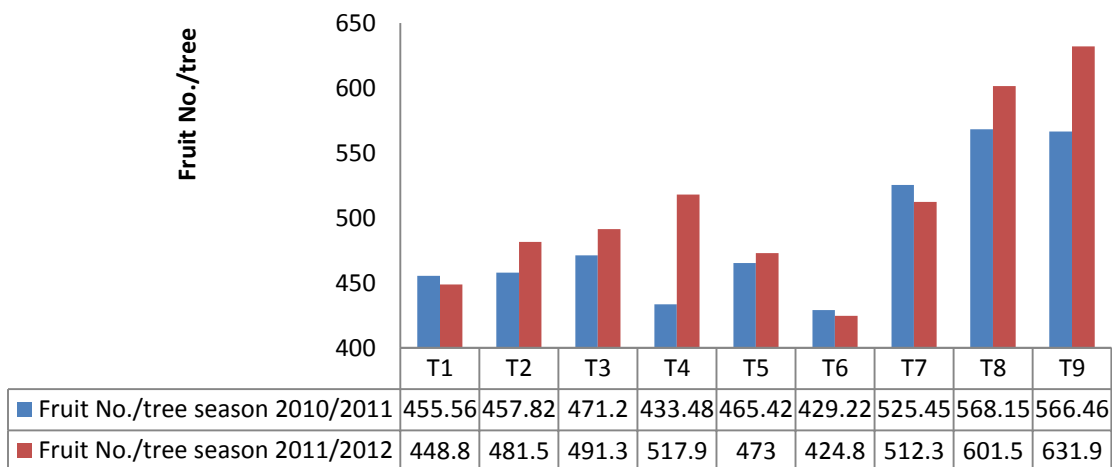
Effect of GA₃ and some nutrients on number of retained fruits/tree at harvest.

Data in Fig. 4 showed that all treatments had increased the number of retained fruits per tree compared with that of control expect that of (T6),

which give less number of retained fruit than that of control at the two studied seasons. However Chelated Ca at 0.5 % (T8) individually or additively with boric acid at 300 ppm (T9) resulted in the maximum increase in retained fruit/tree compared with other treatments

including the control in both studied seasons. The results in this study agreed with those reported by Room and Ranjit (2003) working on mandarin and Singh *et al.* (2007) who stated that the deficiency of

boron is a physiological barrier to fertilization, since boron stimulates pollen germination and pollen tube growth, as well as the formation of auxins that lead to encouragement of sucrose translocation to fruits.



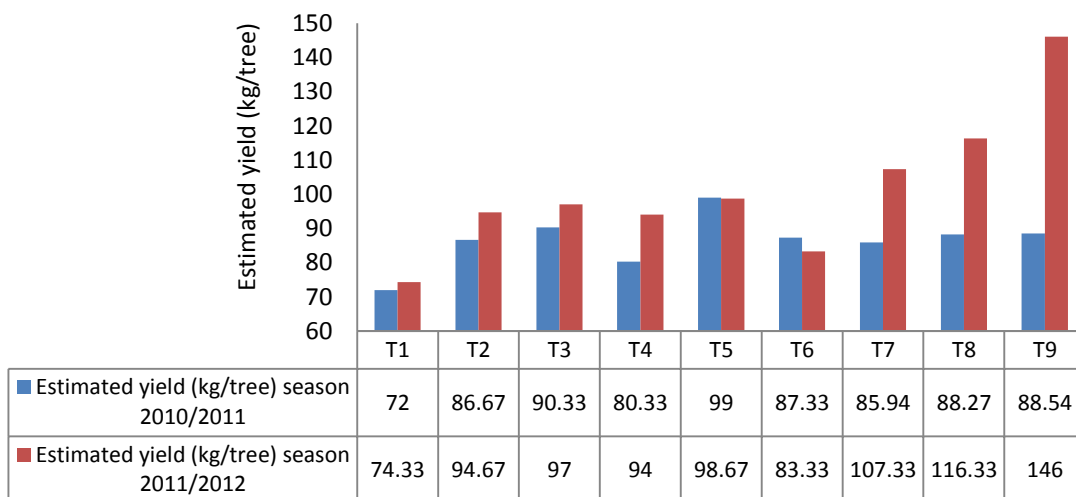
LSD at 5% for 2010/2011: 45.89 and 2011/2012 : 66.15

Fig. 4. Effect of foliar application of GA₃ and some nutrients on Fruit No. /tree of Valencia orange trees in seasons 2010/2011 and 2011/2012.

Effect of GA₃ and some nutrients on the estimated yield/tree.

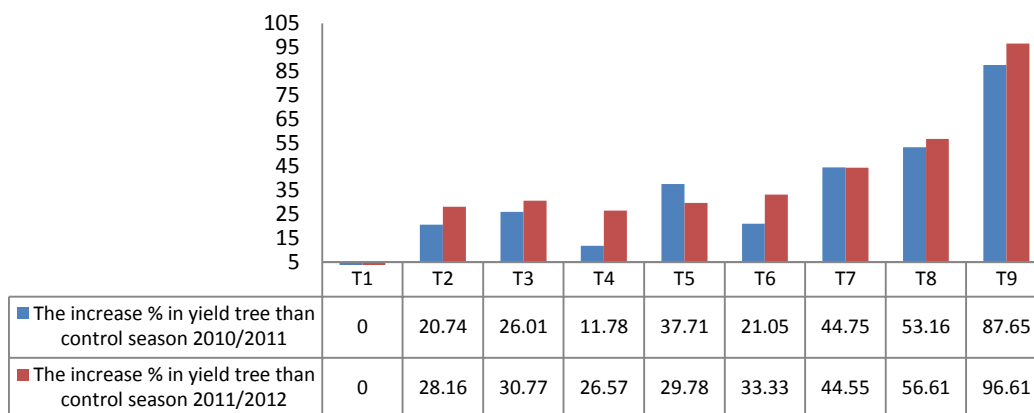
Figs. 6 and 7 showed that estimated yield (kg/tree) significantly increased by all treatments than the control. The increase in yield/tree may be due to the positive effect of the spraying that trace nutrient at individually or additively with GA₃ on fruit set consequently number of fruits per tree which induced

the improving of fruit weight. After spraying the Chelated Ca 0.5% alone (T8) or in combination with boric acid at 300 ppm (T9) and boric acid alone (T7) the maximum significant values of estimated fruit/tree were obtained. The previous results are in line with those obtained by Abd-El-Migeed *et al.* (2002) working on olive, that yield of olive was increased by boron foliar application.



LSD at 5% for 2010/2011 season: 11.78 and for season 2011/2012 : 10.01

Fig. 6. Effect of foliar application of GA₃ and some nutrients on estimated yield (kg/tree) of Valencia orange trees in seasons 2010/2011 and 2011/2012.



LSD at 5% for 2010/2011: 16.02 and 2011/2012 : 18.11

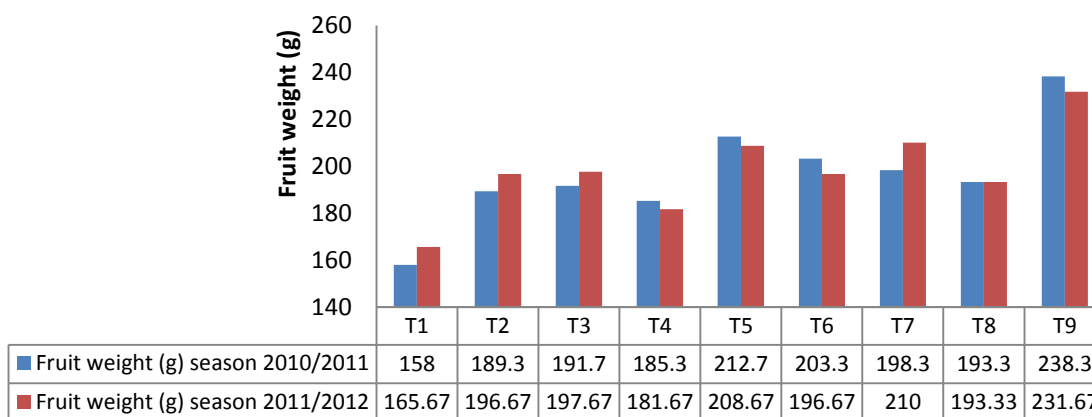
Fig. 7. Effect of foliar application of GA₃ and some nutrients on the increase % in yield/ tree more than control of Valencia orange trees in seasons 2010/2011 and 2011/2012.

Effect of GA₃ and some nutrients on some physical characteristics.

Fruit weight:

Data in Fig.5. showed that fruit weight of Valencia orange was significantly increased due to application of all experimented treatments compared with that of control in both studied seasons. Boric acid at 300 ppm (T7) sprayed individually or additively with Chelated Ca at 0.5 % (T9), which contained Chelated Ca at 0.5 % + B at 300 ppm gave the maximum values

of fruit weight (per g) of Valencia orange when compared with other treatments including control in the two studied seasons. The significant increase of Valencia orange fruits might be due the role of GA₃ in increasing the fruit cell elongation and expansion (Abd El-Moneim *et al.* 2007). These results were in agreement with those obtained by Abdel-Razik and Abdrabboh (2008) worked on Clementine, who found that spraying boric acid and GA₃ induced that largest number of fruits.



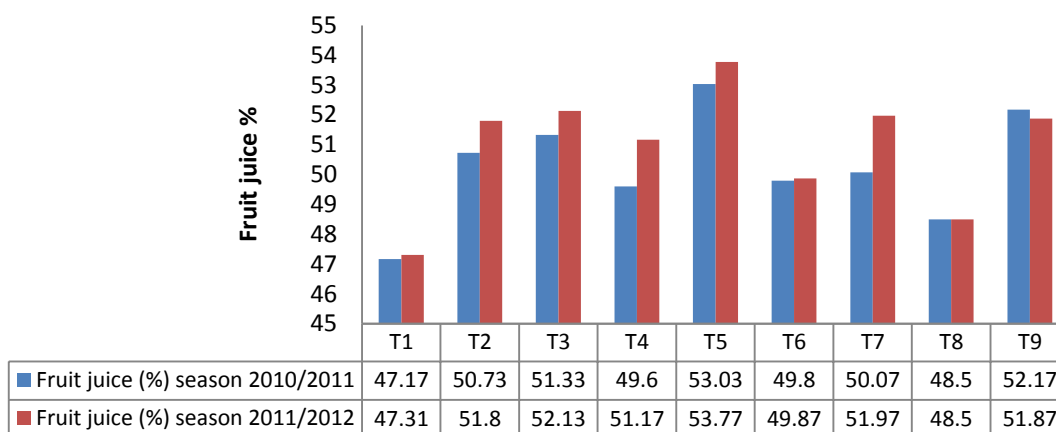
LSD at 5% for 2010/2011 season: 8.88 and for 2011/2012 season : 11.83

Fig. 5. Effect of foliar application of GA₃ and some nutrients on fruit weight (g) of Valencia orange trees in seasons 2010/2011 and 2011/2012.

Fruit juice (%):

It was clear from Fig.8 that the fruit juice percentage was significantly increased by all treatments compared with control in the two studied seasons. Chelated Zn at 0.4+ GA₃ at 15% ppm (T5) resulted in a

maximum fruit juice percentage among all treatments. The pervious mentioned increase in volume of fruit juice % might be due to the positive role of GA₃ in enlarging the fruit cells.



LSD at 5% for 2010/2011: 1.09 and 2011/2012 : 1.35

Fig. 8. Effect of foliar application of GA₃ and some nutrients on fruit Juice (%) of Valencia orange trees in seasons 2010/2011 and 2011/2012.

Effect of GA₃ and some nutrients on some biochemical fruit characteristics:

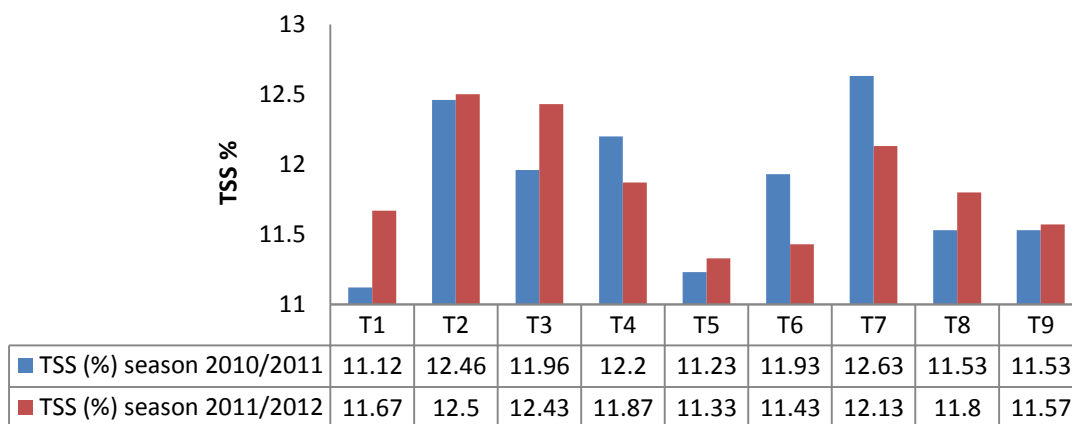
TSS percentage.

As for the total soluble solids, the data in Figs. (9 and 10) revealed that, boric acid at 300 ppm (T7), GA₃ at 15 ppm (T2) and Chelated Zn at 0.4% (T4) recorded the highest significant values of TSS % in the fruit juice of Valencia orange in the first season while in the second season GA₃ 15 ppm (T2) or 25 ppm (T3) and boric acid at 300 ppm (T7) recorded the higher significant values of TSS%. Hegab *et al.* (2003) reported that boron promotes starch transformation into

saccharides in plant cell. Zn also plays an important role in starch metabolism in plant (Hafez *et al.*, 2007).

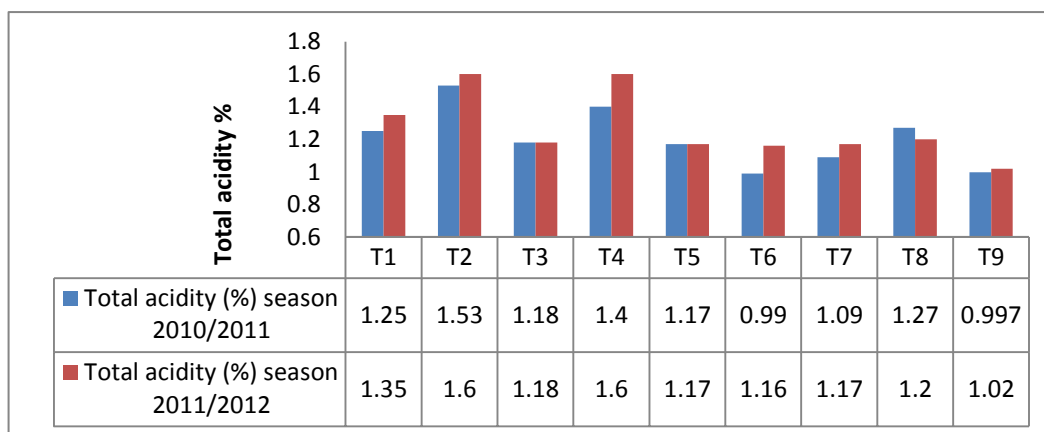
Total acidity.

Concerning the total acidity equivalent (citric acid) in fruit juice was significantly decreased than that of control except that spraying by GA₃ 15 ppm (T2) and Zn at 0.4% which significantly increased juice acidity compared with control. This means that the presents of GA₃ 15 ppm (T2) and Zn at 0.4 % tended to increase juice acidity. This may be due to the effect of GA₃ on delaying maturity (Ju *et al.*, 1999).



LSD at 5% for 2010/2011 season: 0.39 and for season 2011/2012 : 0.46

Fig. 9. Effect of foliar application of GA₃ and some nutrients on fruit TSS (%) of Valencia orange trees in seasons 2010/2011 and 2011/2012.



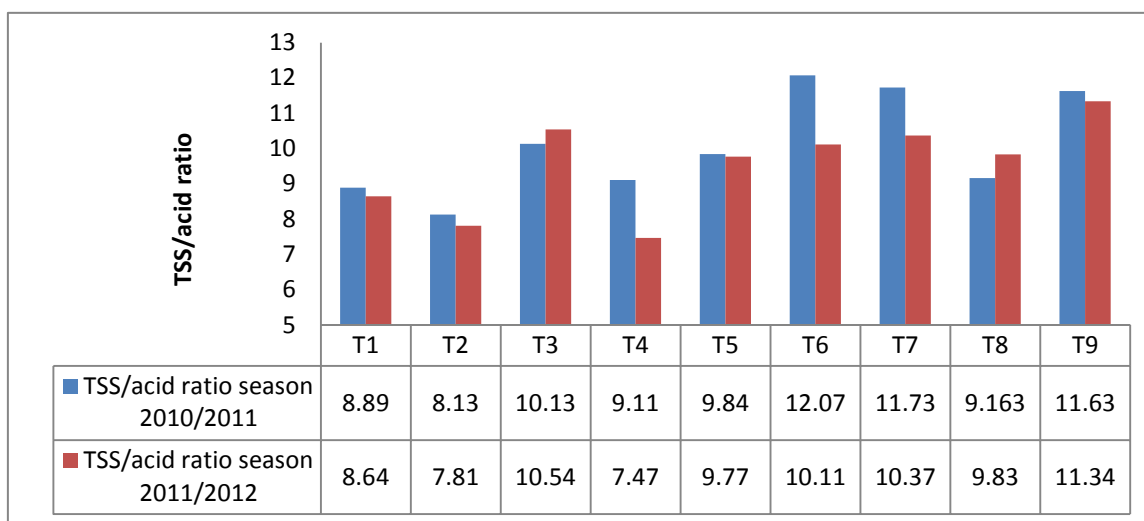
LSD at 5% for 2010/2011 season: 0.18 and for 2011/2012 season : 0.19

Fig. 10. Effect of foliar application of GA₃ and some nutrients on fruit total acidity (%) of Valencia orange trees in seasons 2010/2011 and 2011/2012.

TSS/acid ratio.

TSS/acid ratio (Fig. 11) was significantly higher in response to spraying Chelated Zn at 0.4% + GA₃ at 25 ppm (T6) and boric acid at 300 ppm alone (T7) or in combination with chelated Ca at 300 ppm (T9) in the

first season, while in the second season, Chelated Ca at 0.5% + boric acid at 300 ppm (T9) had significantly increased TSS/acid ratio when compared with that of control and other treatments.



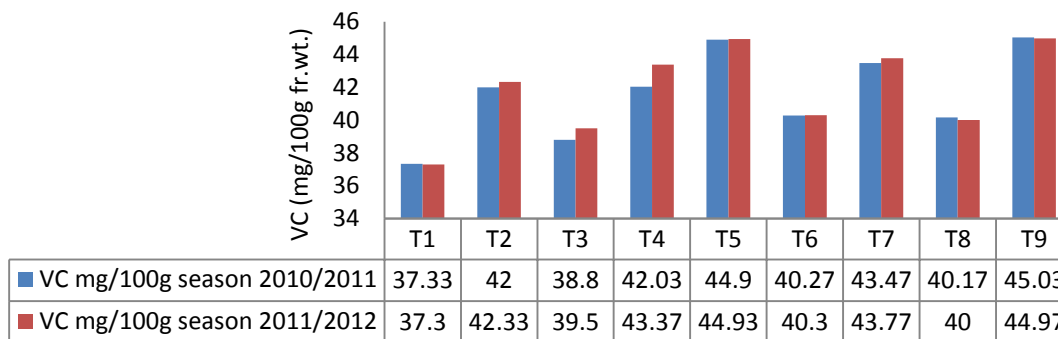
LSD at 5% for 2010/2011 season: 2.21 and for 2011/2012 season : 1.48

Fig. 11. Effect of foliar application of GA₃ and some nutrients on TSS/acid ratio of Valencia orange trees in seasons 2010/2011 and 2011/2012.

Ascorbic acid (V.C.).

Data in Fig. 12. showed that maximum values of Ascorbic acid (V.C mg/100g fr.wt.) were recorded when trees sprayed with Chelated Ca at 0.5% + B at 300 ppm (T9) or Chelated Zn at 0.4+ GA₃ at 15 ppm (T5) in comparison to other treatments including control in both seasons. The present results are in line with Sajida and Hafeez (2000) on sweet orange and Abdel-Razik and Abdrabboh (2008) on Clementine

who reported that fruit juice %, TSS % and V.C. were improved by boron and Zn treatments. From the above mentioned results, it could be concluded that, spraying Valencia orange trees with calcium, boron and Zn have a positive effect on fruit set, yield and fruit quality. In this respect, it seems that, all combined treatments are promising specially the additively treatment with Chelated calcium +boric acid.



LSD at 5% for 2010/2011: 0.8 and 2011/2012 : 1.13

Fig. (12). Effect of foliar application of GA₃ and some nutrients on VC contents (mg/100g f. wt) of Valencia orange trees in seasons 2010/2011 and 2011/2012.

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