V- SUMMARY AND CONCLUSIONS

This study was carried out during two successive 1987-1988 and 1988-1989 seasons on 20 years old trees of Washington navel orange and Valencia orange grown at a farm located 20 km. from Benha i.e. El-Shoukhr, Kafr Shokr region-Kaliobia Governorate. Forty five trees of each cultivar were carefully selected and devoted for this study. Trees were budded on sour orange root-stock, nearly uniform in vigour as being representative of orchard and received regularly the same cultural practices. As for chemical fertilizers, the following program was adopted in the whole region by the local growers:

1- N-fertilizer was annually applied as urea (46% N) at the rate of 300 kg./feddan.

2- Phosphorus fertilizer, was applied yearly as 250 kg. superphosphate/feddan.

Neither organic manure nor other mineral fertilizers were applied.

The purpose of this work aimed to increase productivity of both Washington navel and Valencia orange trees by investigating the response to foliar sprays with some fertilizer elements i.e. N,P,K either alone or combined with other macro (Mg) or micro
(Zn, Mn, Fe) nutrient elements. Thus, foliar spray treatments used were as follow:

1- Water spray (control).
2- Urea solution at 0.5%
3- Urea-0.5%+NaH2PO4-1%
4- Urea-0.5%+K2SO4-1%
5- Urea+ (NaH2PO4+K2SO4) at 0.5, 1% respectively.
6- Mixture of fifth treatment + 1% MgSO4.
7- Mixture of fifth treatment + 1200 ppm Nervanaid Zn-14.
9- Mixture of fifth treatment + 1200 ppm Chelated Fe (Aziplex).

Treatments were arranged in a complete randomized design and replicated five times each on a single tree.

Spraying was done twice in early March and Mid June during each season by covering the whole foliage of each tree and Tween-20 at 0.1% was added to all spray solutions as a surfactant. Vegetative growth, nutritional status, fruit set, fruit drop, yield and fruit quality of both cultivars as affected by the different treatments were studied.
Thus, the obtained results could be summarized as follows:

A- **Vegetative growth:**

A.1- **Shoot length:**

Foliar sprays with any of the different nutrient solutions used increased shoot length over those of control (water spray) either with spring or autumn cycles for both Washington navel orange and Valencia orange cvs. during two seasons of study. Since, the shortest shoots were those of check trees. On the contrary, the highest value of shoot length was that of (urea+P+K+Zn) sprayed trees. Moreover, (urea+P+K+Fe), (urea+P+K+Mn), (urea+P+K+Mg), (urea+P+K) and finally the other three nutrient solutions, ranked next to the (urea+P+K+Zn) treatment in a descending order, respectively as their effectiveness regarding shoot length was concerned.

A.2- **Average number of leaves per shoot:**

The same trend previously mentioned with shoot length was detected for the number of leaves/shoot. However, the differences were more pronounced with shoot length during both seasons for two flushes regardless of orange cultivar.
A.3- Leaf dry weight:

Concerning the response of leaf dry weight to the different foliar spray treatments, it could be noticed that no general trend could be detected as being representative of both cultivars together on one hand or the two seasons for each cultivar on the other. However, in this concern it is quite evident that:

1- Tap water foliar spray (control) showed two opposite status, since it was the superior in the first season but the reverse was true during the second season for both orange cultivars.

2- As an average of two seasons was concerned, both (urea+P+K+Mn) and (urea+P+K+Fe) treatments produced the heaviest leaf dry weight of Washington navel orange. Meanwhile, the (urea+P+K+Mn) was the superior for Valencia orange, in this concern.

3- Variations in leaf dry weight due to the different foliar spray treatments were more pronounced with Washington navel orange than Valencia Orange.
Conclusively, from data concerning the influence of different treatments on Vegetative growth measurements, it could be notice that trend of leaf dry weight is partially conflicting with that found for both shoot length and number of leaves/shoot. Since, the check trees were the inferior as both shoot length and number of leaves per shoot were concerned for both orange cvs. during both seasons. While control trees showed the highest value of leaf dry weight in the first season, but the trend took the other way around in the second season with both orange cultivars. However, no suitable explanation could be given for such case, but it may be attributed to some extent to the fact that trees of both orange cultivars were in the on-year state in the first season. Since, consumption and depletion of carbohydrates takes place acutely in trees of heavier crop, consequently this will be reflected positively/negatively on growth and dry weight of leaves developed on trees of lighter or heavier crop, respectively.
B- **Leaf mineral content:**

B.1- **Leaf nitrogen content:**

Leaf nitrogen content of Washington navel orange and Valencia orange trees were increased obviously by all nutrient solutions over the control where (urea+P+K+Mn) and (urea+P+K+Fe) treatments showed the highest value, while all other treatments fell in between for both two orange cultivars.

B.2- **Leaf phosphorus content:**

Leaf P content was affected obviously by all treatments in both two orange cultivars. In addition; (urea+P+K+Mn) and (urea+P+K+Fe) treatments resulted in the highest value while urea and (urea+K) treatments resulted in the lowest value in both two orange cvs.

B.3- **Leaf potassium content:**

Leaf K content in both orange cvs. were affected obviously by all nutrient solutions, where (urea+P+K+Mn) and (urea+P+K+Fe) treatments in Washington navel orange, as well as (urea) or (urea+P+K+Fe) treatments in Valencia orange resulted in the highest leaf K value. Since (urea+P+K+Mg) and (urea+P+K+Mn) treatments resulted in the lowest value in Washington navel orange and Valencia orange, respectively.
B.4- **Leaf calcium content:**

From the obtained data it could be concluded that all nutrient solutions increased leaf Ca % significantly while the foliar sprays with (urea+P+K+Fe) and (urea+P+K+Zn) were the superior in this concern.

B.5- **Leaf magnesium content:**

The same trend previously mentioned with calcium content was detected for leaf Mg %, regardless of orange cultivar.

B.6- **Leaf zinc content:**

It is obvious, that all nutrient solutions increased the zinc content over control. However, those trees received any of the (Zn, Mn, Fe) in combination with the mixture of (urea+P+K) were the superior in this respect.

B.7- **Leaf Mn content:**

The obtained data revealed that all nutrient solutions increased it significantly over control, especially those included any of the (Zn, Mn, Fe). However, those trees received Fe and Mn were the superior with Washington navel and valencia orange, respectively.
B.8- Leaf Fe content:

All nutrient solutions affected the leaf Fe content positively, while the (urea+P+K+Fe) treatment showed the highest value of leaf iron content.

C- Cropping aspects:

C.1- Fruit set percentage:

The obtained data showed that all nutrient solutions resulted in a highly significant increase in fruit set % over the check trees "control" in both seasons of study for the two orange cvs. In addition all nutrient solutions could be arranged into a descending order as their enhancing effect on fruit set percentage of each orange cultivar was concerned as follows:

1- The highest value of fruit set % in Washington navel orange was detected as any of (urea+P+K+Mg), (urea+P+K+Zn), (urea+P+K+Mn) and (urea+P+K+Fe) treatments was applied.

2- Washington navel orange trees sprayed with any of the (urea+P+K), (urea+P) and (urea+K) solutions showed statistically the same fruit set % on one side and came next to those of the previous group on the other, in this respect.
3- Urea sprayed Washington navel orange ranked last and just before the check trees, in this concern.

4- As for Valencia orange, it is quite clear that trees sprayed either with MgSO₄ or chelated zinc combined with (urea+P+K) solution were the superior as the fruit set % was concerned.

5- Foliar spray with solution of (urea+P+K) solely or combined either with chelated manganese or chelated iron were of the same effectiveness and statistically came next to the aforesaid two solutions with Valencia orange cvs.

6- Finally, (urea+P), (urea+K) solutions followed those of the previous group and statistically exceeded the urea spray treatment, whereas later representing the inferior nutrient solution and ranked last just before control.

It is easy to conclud that, Mg, Zn, Mn, Fe application were more effective when each combined with a (urea+P+K) solution with both orange cultivars.

C.2- Sesonal changes in remaining fruit percentage:

From data obtained, it is clear that the remainder fruits of both cultivars were continuously decreased as the season progressed. The decrease
was acute till early June, moderate through June, then became very smooth from August until the end of season, whereas the difference between the last dates of counting were negligible.

Nevertheless, lowest value of the remaining fruit % was that of control, where the differences were highly significant as compared to those of the other treatments at the corresponding dates during both seasons, regardless of orange cultivar. On the other hand adding of any of Mg, Zn, Mn or Fe to the mixture of (urea+P+K) solution showed promising effect, since the highest value of remaining fruits % was detected over all treatments used with both Washington navel and Valencia orange cvs. during the two seasons of study.

C.3—Yield:

Regarding, yield expressed either as kg. or number of fruits per tree in response to foliar sprays with the different nutrient solutions used on both Washington navel and Valencia orange cvs. obtained data revealed that the check trees "control" produced statistically the lightest crop during both seasons of study. On the other hand, (urea+P+K+Zn) foliar spray solution was the most effective treatment,
followed by those containing (either Mg or micro element Mn/Fe) added to the mixture of (urea+P+K) solution with both orange cultivars. Thereafter, (urea+P+K), then either (urea+K) or (urea+P) and finally (urea solely) solutions are arranged in a descending order in this respect. Meanwhile, Variation in yield due to the different treatments was more pronounced when it was expressed as kg./tree than as number of fruits per tree in most cases.

D- Fruit quality:

D.1- Fruit physical properties:

D.1.1- Fruit weight:

Obtained data disclosed clearly that check trees of both orange cultivars produced fruits were statistically of the lightest weight during both seasons of study. On the contrary, (urea+P+K+Zn) and (urea+P+K+Fe) sprayed trees produced fruits having the heaviest weight over all treatments used for both Washington navel and Valencia orange cultivars during both seasons of study. Moreover, the other nutrient solutions were in between.
D.1.2—Fruit size:

Generally, a similar trend to that previously mentioned with fruit weight was detected for fruit size of both orange cvs. in response to different treatments during two seasons of study. However, variations in fruit size of Washington navel orange were more pronounced than those of Valencia cv.

D.1.3—Fruit dimensions:

Regarding fruit dimensions i.e. (height and diameter) of both Washington navel and Valencia orange cvs. in response to foliar sprays, obtained data showed that all nutrient solutions generally increased both dimensions significantly over control, except with both (urea) and (urea+P) solutions where the increase was not significant, especially Valencia orange. Moreover, trees of both orange cultivars sprayed either with (urea+P+K+Zn) or (urea+P+K+Fe) produced fruits statistically having the longest dimensions for both cultivars with few exceptions in both seasons of study, i.e. when compared with those of (urea+P+K+Mg) sprayed trees.
D.1.4- Fruit shape index:

Concerning fruit shape index "fruit height/fruit diameter ratio", obtained data revealed that no definite trend could be detected for both cultivars during the two seasons of study. However, fruits of Washington navel orange tended to be of a compressed shape when trees were sprayed either with tap water "control" or 0.5% urea solution, but difference was insignificant. As for Valencia orange, it is clear that fruits of trees received any of (Mg, Zn, Mn or Fe) after adding to (urea+P+K) solution became of oblonged shape, especially those received zinc. These results could be attributed to the unparlleled responses of both fruit dimensions to the different nutrient solutions.

D.1.5- Fruit peel thickness:

Referring to fruit peel thickness, obtained data revealed that all nutrient solutions increased it for both orange cultivars. Difference was highly significant with Washington navel orange, except (urea) spray in the first season which induced fruits with the same rind thickness of control. Beside, with Valencia orange the check trees produced fruit with thinner rind, while those sprayed with any of
(Zn, Mn or Fe) plus (urea+P+K) showed the thickest fruit peel. Meanwhile, (urea+P+K+Mg) sprayed trees of Valencia orange produced fruits with moderate peel thickness.

**D.1.6 Fruit juice content:**

Fruit juice as affected by the different treatments used was determined with Valencia orange only "juicy cultivar". The obtained results showed a similar trend to that previously mentioned with both weight and size of fruit.

Generally, it could be concluded that all nutrient solutions increased significantly both fruit juice weight and fruit juice volume over the control. However, both (urea+P+K+Mg) and (urea+P+K+Zn) treatments were the superior, in this concern.

**D.2- Fruit chemical properties:**

**D.2.1 Fruit juice total soluble solids (T.S.S.%):**

Concerning fruit juice total soluble solids percentage in relation to the different foliar spray treatments, obtained data revealed that foliar sprayed trees with urea solely were the inferior, since they produced fruits with the lowest T.S.S.% during two season, regardless of orange cultivar. On the contrary,
control trees, (urea+P+K+Mg) and (urea+P+K+Zn) sprayed trees of both Washington navel and Valencia orange cvs. as well as (urea+P+K+Mn) sprayed trees of Washington navel orange were the superior. Since, they produced fruits with the highest value of fruit juice T.S.S.%.

Nevertheless, differences in Washington navel orange were more pronounced. This may be due to the prolonged season that needed for maturation and ripening processes in Valencia fruits.

D.2.2- Fruit juice titratable acidity:

Regarding fruit juice acid % in response to the differential treatments used, data obtained disclosed that both (urea 0.5%) and (urea 0.5% + NaH₂PO₄ 1% + K₂SO₄ 1% + 1200 ppm chelated iron "Aziplex") resulted in producing fruits with the highest level of juice acidity for both orange cultivars, as an average of the two seasons was concerned. Beside, control trees showed the lowest value of fruit juice acidity for both orange cultivars.
D.2.3- **Total soluble solids/acid ratio:**

Concerning, fruit juice T.S.S./acid ratio as influenced by different treatments present data cleared that both (urea) and (urea+P+K+Fe) treatments resulted in significant decrease in fruits of both cultivars than control either data of each season or an average of both seasons were concerned. Such effect of these treatments will be reflected on delaying maturation and ripening of both orange cultivars.

D.2.4- **Fruit juice ascorbic acid content:**

The obtained data showed that no specific trend could be detected concerning fruit juice vitamin C content "ascorbic acid" in response to the different treatments for both orange cultivars during the two seasons of study. However, it could be concluded that fruits of both control and (urea+P+K+Fe) sprayed trees Contained the lowest value of vitamin "C" as an average of two seasons was concerned, regardless of orange cultivar. The reverse was true with both (urea+P) and (urea+K) treatments where the highest level was observed for Washington navel and Valencia orange, respectively. Moreover, the other treatments were in between.
Concluding remarks:

Finally, we can conclude that growth and nutritional status of both Washington navel and Valencia orange trees as well as their productivity could be improved by application with nutrient foliar sprays as an additional treatment to the fertilizer program adopted in many citrus orchards at Kaliobeia Governorate. Specifically, (urea+P+K) combined with Mg, Zn, Mn & Fe, since the highest yield with the proper quality could be achieved. Moreover, the responses to the different treatments indicated also the following:

1- The necessity to reevaluate method of application phosphorus fertilizer used in Egypt.

2- The importance of potassium, magnesium and micro nutrient elements (Zn, Mn and Fe) applications which are needed under condition of such region.

3- Further investigations are required to determine the desired nutrient combinations by which we can realize better results for every citrus crop.