SUMMARY AND CONCLUSION

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The present dissertation was conducted during two successive experimental seasons throw three 2001; 2002 and 2003 years with the main purpose to investigate the effect of irrigation with Cairo sewage effluent (primary reclaimed) on fruitful trees and young nursery trees (transplant)of some Citrus species /cultivars budded on some citrus rootstocks and grown in sandy soils.

So two factorial experiments were conducted as follows:

V. I. Experiment, I "Fruitful trees" :

It was carried out during two seasons of 2001- 02 & 2002 - 03 on 25 year old fruitful trees of two orange cvs. (Valencia & Washington navel orange budded on sour orange rootstock) and seedy Balady lime cv. grown in sandy soil at two locations i.e., El-Gabal Al-Asfar & Quesna regions irrigated with primary reclaimed Cairo sewage effluent and well water, respectively. In this factorial experiment the six investigated treatments were representative of the differential six combinations between two studied factors (3 Citrus species /cultivars X 2 irrigation water resources), where it was dealing with investigating the specific effect of water resource and citrus spp / cvs, as well as interaction effect of their combinations. The complete randomized block design with five replications was employed, where each replicate was represented by a single tree. The specific & interaction effects were evaluated through the response of the following measurements:

V. I. I. Vegetative growth:

In this respect average length; diameter; number of leaves and average leaf area per each mature spring flushed shoot (on late September), as well as tree canopy volume were the five included growth measurements.

V. I. II. Leaf chemical analysis:

In this regard some leaf biochemical constituents (chlorophyll A&B; indoles; phenoles; total free amino acids; catalase & peroxidase enzymes activities and some endogenous growth substances (phytohormones) i.e., IAA; GA_3 and ABA) and mineral composition (leaf N; P; K; Mg; Fe; Mn; Zn; Cu; Na; Pb and Ni contents) were chemically determined.

V. I. III. Flowering measurements:

In this regard inflorescence type (leafy & woody); flower nature (normal & aborted) and pollen grain viability were investigated in 2nd experimental season only.

V. I. IV. Productivity:

Productivity measurements included the periodical fruit retention %; the preharvest drop % and yield expressed as weight and number of harvested fruits per either an individual tree or one cubic meter of its canopy were evaluated regarding their response to the specific and interaction effects of two investigated factors and their combinations during two seasons. Moreover, fruit quality i.e., physical properties (average fruit weight; fruit shape index; peel thickness and fruit juice % by weight); chemical properties (TSS %; acidity %; TSS: acid

ratio and V.C. content) and N; P; K; Mg; Fe; Mn; Zn; Cu; Na; Pb and Ni contents in both peel and pulp were also determined.

V. II. Experiment, II "Potted transplants":

It was conducted during two 2000 - 02 and 2001- 03 experimental seasons on two year old potted Valencia orange transplants budded on three citrus rootstocks (Volkameriana; rough lemon and Cleopatra mandarin) grown in virgin sandy soil from two sites (El-Gabal Al-Asfar & Dahshour regions) at the Experimental Station of Horticulture Research Institute Giza, Governorate. Transplants were irrigated with either primary treated Cairo sewage effluent or fresh water. This experiment aimed to investigate the specific and interaction effects of three investigated factors (2 water resources; 3 citrus rootstocks and 2 soil sites) and their combinations. The complete randomized block design with three replications (each represented by five transplants) was employed. The response was evaluated through the following measurements as the experiment was terminated in February 2002 and 2003 during 1st and 2nd seasons, respectively.

V. II. I. Vegetative growth measurements:

Transplant height; scion diameter; number of leaves / transplant; average leaf area; dry weight of different transplant organs (leaves; shoots and roots) and total plant -weight, besides top: root ratio were the different evaluated growth measurements.

V. II. II. Leaf chemical analysis:

Leaf photosynthetic pigments (chlorophyll A & B) and N; P; K; Mg; Fe; Mn; Zn; Cu; Na; Pb and Ni were determined in response to the different investigated treatments.

V. II. III. Residual effect of irrigation water resource on some soil physical and chemical properties:

The changes in soil texture; EC; SAR; available N; P; K; Mg; Cu; Fe; Mn; Zn; Ni; Pb elements (as mg/L) and some anions / cations levels (Co_3; HCO_3; Cl; SO_4; Ca; Mg; Na; K as meq. /L.) of two soil sites as influenced by irrigation water resource during second experimental season was investigated.

The obtained results during both experimental seasons for two conducted experiments could be summarized as follows:

V. I. Experiment, I "Fruitful trees":

V. I. I. Vegetative growth measurements:

Data obtained during both seasons revealed obviously that the five investigated growth measurements didn't completely coincide in their response to either specific or interaction effects of two studied factors (water resource & Citrus spp/cv) and their combinations. Whereas each followed its own trend as follows:

A. Specific effect:

With regard to specific effect of water resource, the obtained data displayed that irrigated trees with sewage effluent had significantly the tallest shoots with greatest leaf area and tree canopy volume as compared to those of well water irrigated trees, especially with two later measurements

where differences reached about one fold or more. On the contrary, the reverse was true with shoot diameter; however the variance was relatively slight. Meanwhile, with the number of leaves per shoot differences were completely absent between two irrigation water resources from statistical point of view during two seasons.

As for the specific effect of Citrus spp / cv data obtained displayed that Balady lime cv. surpassed statistically two orange cultivars as the average shoot length; its diameter and tree canopy volume were concerned, however differences were more pronounced with later measurement about two folds and former one while it was less pronounced with diameter. On the contrary the reverse was true with leaf area where Balady lime ranked statistically last in this concern.

B. Interaction effect:

Regarding the interaction effect, data obtained revealed that irrigated Balady lime trees with sewage exhibited statistically the longest shoots with greatest number of leaves per each and the largest canopy volume. However, the greatest leaf area and thickest shoots were always in significant concomitant to the sewage irrigated Washington navel orange and well water irrigated Balady lime trees, respectively. On the contrary, the least values of shoot length; its diameter; number of leaves per each; leaf area and tree canopy volume were generally in closed relationship to well water irrigated trees of two orange cultivars, especially Washington navel orange for three former measurements and Valencia orange cv. for two later growth measurements. In addition, other combinations

were in between the aforesaid two extremes with a considerable tendency of variance observed from a given measurement to another.

V. I. II. Leaf chemical analysis:

V. I. II. 1. Leaf photosynthetic pigments content:

In this regard leaf chlorophyll "A"; "B"; "A+B" and "A:B ratio" in response to specific and interaction effects of water resource ; Citrus spp/cv and their combinations were investigated.

A. Specific effect:

Regarding the specific effect of irrigation water resource, data obtained displayed that sewage effluent increased significantly leaf chlorophyll A content; chlorophyll A:B ratio and to some extent the total (A+B) content. The reverse was true with leaf chlorophyll "B" content where leaves of well water irrigated trees were obviously the richest.

As for the specific effect of citrus spp/cv it was quite clear that each parameter followed its own trend. Anyhow, Balady lime had significantly the richest leaves chlorophyll "A" content, while the reverse was true regarding its leaves chlorophyll "B" content. Such conflicted trends of both two chlorophyll kinds were reflected on their ratio, where Balady lime ranked 1st .On the other hand, Washington navel orange was the richest in its leaf "B" content associated with a considerable higher chlorophyll "A" and consequently the richest total chlorophyll (A+B) with the lowest A:B ratio. Meanwhile, Valencia was the poorest in chlorophyll (A) but

intermediate in chorophyll (B), consequently of a considerable (A+B) and lower A:B ratio.

B. Interaction effect:

Sewage irrigated trees of both Balady lime and Valencia orange had the richest leaves chlorophyll "A"; " A+B" and A:B ratio but the poorest in their chl B content, especially Balady lime. Washington navel orange irrigated with well water had the richest leaf chlorophyll "B" content and to great extent a higher (A+B). The least leaf chlorophyll A:B ratio was generally coupled with well water irrigated trees of two orange cultivars.

V. I. II. 2. Leaf total phenols; indoles and free amino acids content:

Regarding the response of specific and interaction effects of two studied factors, data obtained displayed that each component followed its own trend as follows:

A. Specific effect:

With regard to specific effect of water resource, two conflicted trends were detected. Herein, total phenols were increased significantly by sewage, while the reverse was detected with both indoles and free amino acids, where well water-irrigated trees were significantly the richest.

As for the specific effect of Citrus spp/cv, Washington navel orange had significantly the richest leaves in their phenols content, but the reverse was true with both indoles and total free amino acids. On the contrary, Valencia orange leaves

had the highest levels of both total indoles and free amino acids, but the least phenols content.

B. Interaction effect:

Leaves of both Balady lime and Washington navel orange trees irrigated with sewage were significantly the richest in their phenols content from one hand, but the poorest as their indoles and total free amino acids contents were concerned from the other side. On the contrary, Valencia orange trees irrigated with well water induced leaves with the highest indoles and free amino acids levels but of lower phenols content. Other combinations were in between.

V. I. II. 3. Leaf catalase and peroxidase enzymes activities:

Catalse activity:

Data obtained displayed that catalase activity respond specifically to water resource. However, two trends were detected, where sewage effluent depressed its activity in Balady lime but the reverse was true with both orange cultivars. On the other hand, catalase activity was gradually increased as time of determination process was advanced, however the increase was more pronounced with Balady lime and Washington navel orange cvs.

Generally it could be concluded that leaves of well water irrigated Balady lime trees and sewage irrigated ones of both orange cultivars showed statistically the highest catalse activity after 90 seconds. On the contrary, the least activity was markedly coupled with leaves of irrigated trees with other water resource just at start or after 15 seconds.

Peroxidase activity:

It was quite clear that the response to irrigation water resource was statistically absent. However, the activity was significantly in positive relationship with advancement of determination time up to 300 seconds. So, leaves exhibited the highest peroxidase activity after 240 and 300 seconds were spent through determination process, irrespective of irrigation water resource for three Citrus spp / cvs.

IV. I. II. 4. Some endogenous growth substances (phytohormones) contents in leaves of fruitful citrus trees:

In this respect leaf GA_3; IAA; ABA contents and their ratios i.e (GA_3:IAA; GA_3: ABA and IAA: ABA) in response to irrigation water resource were investigated. Data obtained revealed that two conflicted trends were detected. Herein, the first exhibited that GA_3 and two its different ratios (GA_3: IAA & GA_3: ABA) were obviously increased in leaves of sewage irrigated trees of three Citrus spp. / cvs. The increase was more pronounced with Balady lime. However, second trend took the other way around, where both IAA and ABA contents, as well as their ratio (IAA:ABA) were decreased in leaves of sewage irrigated trees. The reduction was relatively more pronounced in Washington navel orange.

V. I. II. II. 5. Leaf mineral composition:

Leaf N; P: K; Mg: Fe; Mn; Zn; Cu: Na; Pb and Ni contents of fruitful citrus trees (Balady lime; Valencia and Washington navel orange cultivars) in response to specific

effect of irrigation water resource (sewage and well water) and Citrus spp/cv , as well as their combinations were investigated.

A. Specific effect:

Data obtained during both seasons displayed that all the aforesaid eleven elements respond markedly to water resource, where they increased significantly by sewage effluent. Meanwhile, the response to specific effect of citrus spp/cv varied from one element to another. Anyhow, Balady lime leaves were significantly the richest in their N; P; Mg; Zn; Cu, Na and Pb contents, but the poorest for Fe; Mn and Ni associated with moderated K level. On the other hand Valencia orange leaves exhibited statistically the highest K and Fe level, while the reverse was true with N; Zn; Cu and Pb associated with moderate P; Mg; Mn; Na and Ni contents. In addition, the highest (Mn and Ni) content associated with the least (P; K : Mg and Na) level with a moderate (N; Fe; Zn; Cu and Pb)level were always in concomitant to Washington navel orange cv.

B. Interaction effect:

Data obtained during both seasons displayed obviously that specific effect of each investigated factor was directly reflected significantly on their possible combinations. Hence, leaves of Balady lime trees irrigated with sewage effluent had significantly the highest N; P; Mg; Zn; Cu; Na and Pb levels, besides they were characterized also by their relative higher K; Fe; Mn and Ni contents. On the other hand, sewage effluent irrigated trees of both sweet orange cultivars i.e., Valencia and Washington navel exhibited statistically the highest (K & Fe) and (Mn & Ni) levels for former and later cultivars,

respectively. On the contrary, well irrigated trees of two orange cultivars had statistically the poorest leaves in their mineral composition except Mn; Zn and Ni which were the least in Balady lime trees irrigated with the same resource (well water).

In addition, other combinations were generally in between with a noticeable tendency pointed out that combinations of sewage irrigation included in such intermediate category tended to be richer.

IV. I. III. Flowering measurements:

1. Number of inflorescences and their types:

Data obtained revealed that sewage effluent increased significantly total number of inflorescence; especially Balady lime and Valencia Orange (2 folds) more than well water. As for the effect of water resource on inflorescences type, well water increased leafy type % significantly (about 2 folds) more than sewage effluent for both Valencia and Washington navel orange cvs. While with Balady lime no effect was detected, where woody (leafless) inflorescences were the unique type.

2. Flower nature / normality (normal flowers %)

Sewage effluent increased significantly normal flowers %, of Balady lime (Egyptian lime) especially in its flowers of both either large or intermediate size of flowering waves (March 10th & April 3rd) however with its small flowers they were completely upnormal.

As for the response of flower nature (normality) of both Valencia and Washington navel orange cvs. to water resource, the trend varied from one cultivar to another, besides

inflorescence type and flowers size both reflected their own influence. Herein, large flowers of both orange cultivars were 100 % normal, regardless of irrigation water resource cultivar and inflorescence type. Meanwhile, both orange irrigation water resource followed the same trend regarding the response of their medium flowers to water resource, where sewage effluent resulted in 100% normal flowers, but well water induced 100 % upnormal flowers, regardless of inflorescence type. The small flowers of both orange cultivars varied in their response. to water resource, where with Valencia orange its small flowers were 100 % upnormal, while with Washington navel orange the trend of response was typically coincident with that previously detected with its intermediate size flowers.

3. Pollen grains viability:

Pollen grains viability of both Balady lime and Valencia orange (germination%) respond significantly to water resource, where sewage effluent decreased it. Meanwhile, differences between two Citrus spp. didn't follow firm trend.

V. I. IV. Productivity measurements:

V. I. IV. 1. Fruit retention and preharvest drop:

Changes in fruit retention at three dates (June; August and October) and preharvest drop as influenced by irrigation water resource; Citrus spp. / cvs. and their combinations were concerned.

A. Specific effect:

Data obtained during two seasons revealed that two conflicted trends were detected for two measurements (fruit

retention & preharvest drop) as their response to specific effect of irrigation water resource was concerned. Herein, sewage effluent reduced fruit retention % especially at two earlier dates (June and August), however at October variations between two water resources was so slight to be taken into consideration. Meanwhile, the trend took the other way around with preharvest drop %, where sewage effluent increased it significantly, especially during 2nd season.

As for the specific effect of Citrus spp. / cvs., it could be generally concluded that Valencia orange exhibited the least values of both fruit retention and preharvest drop %, but the reverse was true with Balady lime. Such trend was true, especially as an average of two seasons was concerned.

B. Interaction effect:

Data obtained during both seasons declared generally that well water irrigated Balady lime trees exhibited the highest %of both fruit retention and preharvest drop. The reverse was true with Valencia orange trees (irrespective of water resource). In addition, other combinations were in between.

V. I. IV. 2. Yield.

Data obtained during both seasons displayed that the yield estimated as Kg and number of harvested fruits per either an individual tree or one cubic meter of its canopy volume in response to irrigation water resource followed generally the same trend where well water irrigated trees surpassed statistically the analogous ones supplied with sewage effluent. Such trend was true except with Balady lime when its yield

was estimated per the whole individual tree (expressed as weight or number), where the trend took the other way around.

V. I. IV. 3. Fruit quality:

V. I. IV. 3. 1. Fruit physical properties:

Average fruit weight; peel thickness; fruit shape index and fruit juice % in response to water resource; Citrus spp/cvs and their combinations were the investigated physical properties.

A. Specific effect:

With regard to specific effect of water resource, data obtained displayed that well water slightly increased fruit weight and peel thickness. However, the reverse was true with fruit juice %, while fruit shape index didn't respond.

As for the specific effect of Citrus spp/cvs data obtained pointed out that heaviest fruits with the thickest peel were significantly coupled with Washington navel orange, while the reverse (lightest fruits & thinnest peel were statistically related to Balady lime, while Valencia orange was in between. Meanwhile, the highest fruit juice % was markedly coupled with Valencia orange, discendingly followed by Balady lime and Washington navel orange, which ranked statistically the inferior.

B. Interaction effect:

Washington navel orange fruits of well irrigated trees were significantly the heaviest and had the thickest rinds with the least juice %. Meanwhile, Balady lime had the lightest fruits with the thinnest peel and oblonged shape, regardless of

water resource. In addition, Valencia orange fruits of sewage irrigated trees were statistically the juiciest ones.

V. I. IV. 3. 1. Fruit chemical properties:

In this respect fruit juice TSS %; acidity %; TSS / acid ratio and vitamin C (ascorbic acid) contents were the four investigated fruit chemical properties in response to specific and interaction effects of water resource; Citrus spp. / cvs. and their combinations.

A. Specific effect:

With regard to specific effect of irrigation water resource, data obtained during both seasons revealed that well water increased significantly TSS %, total acidity % and vitamin C contents, while the reverse was true with TSS / acid ratio.

As for the specific effect of Citrus spp /cv., the response varied from one constituent to another. Anyhow, Balady lime showed the least values of TSS %; TSS / acid ratio and vitamin C, but the reverse was true with fruit juice total acidity where its fruits were statistically the richest. Meanwhile, Valencia and Washington navel orange were statistically the richest as their fruit juice TSS % and TSS / acid ratio were concerned, respectively, but both orange cultivars showed the highest and similar vitamin C level.

B. Interaction effect:

Well water irrigated Valencia orange trees showed the highest TSS % and vitamin C contents. However, Washington navel orange trees irrigated with sewage effluent and well

water had the highest juice TSS / acid ratio and vitamin C, respectively. Balady lime trees, especially when irrigated with well water showed statistically the highest juice acidity %. On the contrary, sewage irrigated trees of Balady lime exhibited statistically the least TSS %; TSS / acid ratio and vitamin C contents, while Washington navel orange fruits of sewage irrigated trees had the poorest juice acidity content.

V. I. V. 4. Fruit mineral composition:

A. Specific effect:

With regard to specific effect of irrigation water resource و data obtained during both seasons displayed that sewage effluent irrigated trees induced fruits significantly higher in their peel and pulp N; P; K; Mg (especially pulp); Fe; Zn; Cu; Na; Pb and Ni contents than those of well water irrigated ones. However, with Mn content the same trend was detected especially in fruit peel, but differences were relatively slight.

As for the specific effect of Citrus spp. / cvs., data obtained revealed that the response varied from one element to another. Anyhow, Balady lime fruits were the richest in their peel and pulp N; P; K; Mg; Mn; (especially pulp); Zn; Cu; Na and Pb (especially peel) contents, while the reverse was true with Fe and Ni. Meanwhile, Valencia orange fruits were the richest in their P; K; Fe and Ni, but the poorest in N (especially peel); Mn; Zn and Cu. Moreover, Washington navel orange fruits had richer peel and pulp Mn; Ni and pulp Pb content associated with the least values of N (especially pulp); P; K; Mg; Fe; Zn; and Na.

B. Interaction effect:

Data obtained during both seasons displayed that Balady lime trees irrigated with sewage effluent induced fruits with the highest peel and pulp N; P; K; Mg; Mn (especially pulp) Zn; Cu; Na; Pb (especially peel) contents. Meanwhile, sewage irrigated trees of Valencia orange exhibited the highest Fe and Na (especially peel) and P (especially pulp). Moreover, Washington navel orange trees subjected to sewage effluent had fruits with highest Mn (especially peel); Pb (especially pulp) and Ni contents.

On the contrary, well water irrigated trees of Washington navel orange induced fruits with the least N; P; K; Mg; Fe; Zn; and Na. However, the least Mn; Zn; Cu and Pb contents were closely related to well water irrigated trees of Valencia orange. While the least Ni content was coupled with Balady lime trees irrigated with well water. In addition, other combinations were in between with noticeable tendency of variance as they compared each other.

V.II. Experiment, II "Valencia nursery trees (transplant)"

The response of Valencia orange nursery trees (transplants) to specific and interaction effects of 3 investigated factors (irrigation water resource; citrus rootstock and soil site) and their combinations was evaluated through the following measurements:

V. II. I. Vegetative growth measurements:

Nursery trees (transplant) height; scion diameter; Nº of leaves / transplant; average leaf area; dry weight of transplant organs (shoots, leaves, roots and total plant) and top / root ratio were the ten investigated growth measurements.

Data obtained during both seasons displayed that the trends of response for all investigated vegetative growth measurements to specific effect of every investigated factor and interaction effect of their combinations were not completely coincident. Herein, each followed its own trend.

A. Specific effect:

As for the specific effect of irrigation water resource, it was quite evident that sewage effluent increased significantly all growth measurements over fresh water except both root length and its dry weight, where the reverse was true.

Referring the specific effect of citrus rootstock, data obtained during both seasons displayed that budded Valencia orange nursery trees (transplant) on Volkameriana surpassed statistically the analogous ones on two other rootstocks as all investigated growth measurements were concerned. However, those on Cleopatra mandarin were in most cases the inferior.

Nevertheless the specific effect of soil site was completely absent from the statistical standpoint for all vegetative growth measurements.

B. Interaction effect:

Valencia orange nursery trees (transplant) budded on Volkameriana and irrigated with sewage effluent especially

when grown in El-Gabal Al-Asfar soil and to great extent in Dahshour soil exhibited statistically the greatest values of investigated growth measurements except root length and its dry weight, where the fresh water irrigated nursery trees (transplant) budded on either volkameriana or rough lemon rootstocks in El-Gabal Al-Asfar soil showed the greatest values of two root system parameters. On the contrary, the least values of investigated growth measurements were significantly coupled with the fresh water irrigated transplants budded on either Cleopatra mandarin or rough lemon rootstocks and grown in two soil sites or Dahshour, respectively. Such trend was true during both seasons for all studied growth measurements, except root length and its dry weight, where the sewage irrigated nursery trees (transplant) budded on either Cleopatra mandarin or rough lemon (regardless of soil site) in most cases exhibited significantly the least values.

In addition, other combinations were in between the aforesaid two extremes.

V. II. II. Leaf chemical analysis:

V. II. II. 1. Leaf photosynthetic pigments content:

In this respect leaf chlorophyll A; B; A+B and A: B ratio of Valencia orange nursery trees (transplant) in response to specific and interaction effects of irrigation water resource; citrus rootstock; soil site and their combinations were investigated.

A. Specific effect:

Data obtained during both seasons revealed that leaf chlorophyll content respond specifically to water resource, where chlorophyll (A) ; (A+B) and (A:B ratio) increased significantly by sewage effluent. However, chlorophyll B didn't significantly respond to water resource. Nevertheless, Cleopatra mandarin rootstock decreased significantly leaf chlorophyll (A); (B); (A+B) and (A:B ratio) than two other rootstocks, where both showed in most cases the same effect in this regard. In addition, specific effect of soil site on four measurements of leaf chlorophyll A and B was significantly absent.

B. Interaction effect:

Data obtained during both seasons displayed that leaf chlorophyll contents (A; B; and A+B) reached significantly their peak in Valencia orange nursery trees (transplant) irrigated with sewage effluent either budded on Volkameriana or rough lemon rootstocks, especially when grown in El-Gabal Al-Asfar soil. While the reverse was generally found in fresh water irrigated nursery trees (transplant) budded on either rough lemon or Cleopatra mandarin grown in El-Gabal AL-Asfar soil, beside those on Volkameriana and grown in Dahshour soil. On the other hand, leaf chlorophyll (A: B ratio) didn't follow firm trend in their response to various combinations between three investigated factors. However, all combinations of sewage effluent had higher chlorophyll (A: B ratio) as compared to the corresponded ones (on same

rootstock and soil site) but irrigation with fresh water during both seasons.

V. II. II. 2. Leaf mineral composition:

In this regard leaf N; P; K; Mg; Fe; Mn; Zn; Cu; Na; Pb and Ni contents of Valencia orange nursery trees (transplants) as influenced by specific effect of three investigated factors i.e, irrigation water resource; citrus rootstock used and soil site, as well as interaction effect of their combinations were investigated.

A. Specific effect:

With regard to specific effect of irrigation water resource, data obtained during both seasons displayed that all the investigated eleven elements were increased by using sewage effluent for irrigation as compared to the fresh water irrigated nursery trees (transplant).

Meanwhile, all determined mineral elements (nutrient and heavy metals) respond significantly to citrus rootstock used except Mg which didn't change. The response varied from one element to another. Herein, leaves of budded nursery trees (transplants) on Volkameriana rootstock were statistically the richest in their N; Zn; Cu; Pb and Ni content but the poorest in Fe and P contents. However, the highest leaf P; K; Fe; Mn; and Na contents were always in concomitant to the budded nursery trees (transplant)on rough lemon rootstock. In addition, budded Valencia orange nursery trees (transplant)on Cleopatra mandarin seemed generally to be intermediate in this concern.

Referring the specific effect of soil site, data obtained revealed that each element followed its own trend. Hence, Mg; Mn; Na; and Pb contents didn't significantly influenced by soil

site (both El-Gabal Al-Asfar and Dahshour soil were nearly similar). However, leaves of grown nursery trees (transplant)in El-Gabal Al-Asfar soil had higher N; K; Fe; Zn; Cu and Ni levels (the increase in two former elements i.e, N and K was slight). On the other hand, leaf P content was slightly increased in Dahshour soil.

B. Interaction effect:

However the response of leaf mineral composition to interaction effect of different combinations varied from one element to another, where each followed its own trend, but it could be generally concluded from the obtained results during two seasons the following topics:

1. Sewage irrigated Valencia orange nursery trees (transplant) budded on Volkameriana rootstock had the highest leaf N; Zn; Cu; Pb and Ni contents especially when grown in El-Gabal Al-Asfar soil or even in Dahshour soil also for both heavy metals (Pb and Ni).
2. Sewage irrigated nursery trees (transplant) budded on rough lemon showed the highest K; Mg; Fe and Mn grown in El-Gabal Al-Asfar soil.
3. Budded nursery trees (transplant) on Cleopatra mandarin rootstock had higher leaf P and Mg contents when irrigated with fresh water and grown either in Dahshour or two soils, respectively.
4. Fresh water irrigated nursery trees (transplant) budded on Cleopatra mandarin rootstock showed the least leaf N; K; Fe; Mn; Na; Pb; and Ni content when grown in

Dahshour soil, while the least P % in El-Gabal Al-Asfar soil.

5. Fresh water irrigated Valencia orange nursery trees (transplant) budded on rough lemon rootstock characterized by their poorest leaves N; Fe; Mn; Zn; Cu; Pb and Ni when grown in Dahshour soil, besides the least Mg level in El-Gabal Al-Asfar soil.
6. Budded nursery trees (transplant) on Volkameriana rootstock in Dahshour soil had also lower K; Fe; Mn; Zn; Cu Pb and Ni when irrigated with fresh water.

Most soil physical and chemical properties of virgin sandy soils of two cites were slightly influenced. Such light influence may be reflect further changes could be achieved with the advancement of irrigation practices .

CONCLUSION

According to the obtained results regarding the influence of irrigation water resource on nutritional status and fruit mineral composition i.e., increase in some constituents especially heavy metals (Pb & Ni) which throw doubtful shadows about the availability of using sewage effluent for irrigation purpose particularly fruits, vegetable and edible fruit crops. Consequently it could be concluded that primary treated Cairo sewage effluent must be used as an alternative water resource for irrigating woody trees, which must be carefully selected for being used as a green belt surrounding grand towns like Cairo city.