

V. SUMMARY AND CONCLUSION

The present investigation was carried out in a private nursery at El-Katameia region, Cairo Governorate, Egypt. This study was conducted during both 2008 and 2009 seasons. One-year-old "Ne plus ultra" almond seedlings grafted on both Nemagurd and Bitter almond rootstock grown in a soil collected from new valley governorate (El-Farafra Oasis).

Eight treatments represented the different possible combinations between the following two investigated factors.

- Two rootstocks (Nemagurd peach and Bitter almond) grafted with Ne plus ultra almond as a scion.
- Four irrigation regimes, taking in consideration that irrigation with 100 % field capacity is the control.

Thus the investigated irrigation regimes which were investigated by two rootstock were as follows:

- 1) Ne plus ultra almond on Nemagurd peach and irrigation with 100 % from field capacity (common irrigation) as the control.
- 2) Ne plus ultra almond on Nemagurd peach and irrigation with 75 % from field capacity.
- 3) Ne plus ultra almond on Nemagurd peach and irrigation with 50 % from field capacity.
- 4) Ne plus ultra almond on Nemagurd peach and irrigation with 25 % from field capacity.
- 5) Ne plus ultra almond on Bitter almond and irrigation with 100 % from field capacity (common irrigation) as the control.
- 6) Ne plus ultra almond on Bitter almond peach and irrigation with 75 % from field capacity.
- 7) Ne plus ultra almond on Bitter almond and irrigation with 50 % from field capacity.

8) Ne plus ultra almond on Bitter almond and irrigation with 25 % from field capacity.

Obtained data could be summarized as follows:

V.I. Vegetative growth measurements.

V.I.1- Average shoot length.

A. Specific effect:

Regarding the specific effect of rootstock type on shoot length data revealed that, Nemagurd peach rootstock was better than the other investigated rootstock, concerning the specific effect of the different irrigation regime (100 % 75 %, 50 % and 25 % of field capacity) on Ne plus ultra almond shoot length, data revealed that, water addition through irrigation with full field capacity (control) was superior in this respect where it was able to increase significantly shoot length as compared with the different investigated irrigation regime (100 %, 75 %, 50 % and 25 % of field capacity) during both seasons of study. Irrigation with 75 % of field capacity came in the second rank, we can concluded that, there was positive relation between shoot length of increment Ne plus ultra almond and amount of water through irrigation.

B. Interaction effect:

Regarding the interaction effect of the two investigated factors i.e., rootstock type and different irrigation regime (100 %, 75 %, 50 % and 25 % of field capacity) on Ne plus ultra almond shoot length, data show a considerable and statistically effect in both seasons of the study, where the highest shoot length was obtained with the combination between Nemagurd peach rootstock irrigated with 100 % of field capacity (control), however the lowest decrease in shoot length was noticed by Ne plus ultra almond grafted on Bitter almond rootstocks and

irrigated with 25 % of field capacity as compared with the other two irrigation regime and control during the two seasons of study.

V.I.2- Total number of shoot/transplant, shoot diameter and total number of leaves/transplant.

A. Specific effect:

Data show that, Bitter almond rootstock was better than Nemagurd peach rootstock in this respect, where it improved statistically the three investigated parameter for both seasons of study. With respect to the different irrigation regime on shoot number/transplant, shoot diameter and number of leaves/transplant, data revealed that shoot number/transplant , shoot diameter and number of leaves/transplants were statistically increased when the transplants were irrigated with the highest rate irrigation (100 %) of field capacity as compared with the other irrigation regime during both seasons of study.

B. Interaction effect:

Data cleared that, the maximum improvement in both shoot number/ transplant, shoot diameter and number of leaves/transplant parameters were noticed with such combined of Bitter almond rootstock irrigated with 100% of field capacity. On the other hand, the lowest decrease in and of Ne plus ultra almond was obtained when Nemaguard peach used as rootstock and the transplants were irrigated with 25 % of field capacity in both seasons of study.

V.I.3- Average leaf area (cm²)

A. Specific effect:

Regarding the specific effect of the rootstock type (Bitter almond and Nemaguard peach) and different irrigation regime (100 %, 75 %, 50 % and 25 %) beside the control (100 % of field

capacity) on the average leaf area (cm^2) Ne plus ultra almond, data revealed that Nemaguard peach rootstock had a greater value of leaf area than the other investigated rootstock (Bitter almond) during both seasons of study.

Regarding the specific effect of different irrigation regime on average leaf area (cm^2), data indicated that, all the investigated irrigation regime significantly decreased average leaf area (cm^2) of Ne plus ultra almond as compared with control which was irrigated with 100 % of field capacity. Control irrigation treatment gave the highest value of the average leaf area (cm^2).

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock type and different irrigation regime on average leaf area (cm^2), data showed that, the most increment of leaf area per transplant was that combination between Nemaguard peach rootstock and the highest irrigation rate (100 % of field capacity, control). On the other hand, the most depressive in the average of leaf area value per transplant was detected by Ne plus ultra almond grafted on Bitter almond rootstock and irrigated with 25 % of field capacity during both seasons of study. The other combinations were in between.

V.I.4- Top fresh weight, root fresh weight and top/root ratio.

A. Specific effect:

Concerning the specific effect of the two investigated factors i.e., rootstock type and the different irrigation regime on top fresh weight , root fresh weight and top/root ratio, data indicated that Bitter almond rootstock gave the highest values of three investigated parameters as compared with the other investigated rootstock (Nemaguard peach).

Regarding the specific effect of different irrigation regime, data revealed that three investigated parameters (top fresh weight of Ne plus ultra almond, root fresh weight and top/root ratio) took the same trend where their values were significantly increased when the transplants were irrigated with 100 % of field capacity during to 2008 and 2009 seasons.

B. Interaction effect:

Concerning the interaction between rootstock type (Bitter almond and Nemagurd peach) and different irrigation regime (100 %, 75 %, 50 % and 25 %) on top fresh weight (Ne plus ultra almond), root fresh weight of the two investigated rootstocks (Bitter almond and Nemagurd peach) and top/root ratio, data cleared that, the best result regarding top fresh weight, root fresh weight and top/root ratio parameters were obtained with Bitter almond rootstock combined with irrigation rate at 100% of field capacity during both seasons of study.

V.II. Effect of rootstock type and different irrigation regime on some chemical constituents:

V.II.1- Effect on leaf chlorophyll a and b contents.

A. Specific effect:

Regarding the specific effect of the two investigated factors on leaf chlorophyll a and b contents, data reflected that, Nemaguard peach rootstock had a higher value of chlorophyll a than the other investigated rootstock (Bitter almond) during 2008 and 2009 seasons. Such trend was true for leaf chlorophyll b and total chlorophyll a and b contents, whereas the difference between the two investigated rootstocks were more pronounced.

Concerning the specific effect of the different irrigation regime on leaf chlorophyll a, b and total chlorophyll contents of

Ne plus ultra almond, data indicated that, the three investigated irrigation regime (75 %, 50 % and 25 % of field capacity) lead to decrease chlorophyll a, b and total chlorophyll contents in the leaves of Ne plus ultra almond which were grafted on the two investigated rootstocks during both seasons of study. This decrement was significant as compared with those irrigated with 100 % of field capacity (control). There was statistically differences between the three investigated irrigation regime when leaf chlorophyll a, b and total chlorophyll contents were concerned.

B. Interaction effect:

Dealing with the interaction effect between rootstock type and the different irrigation regime on leaf chlorophyll a, b and total chlorophyll of Ne plus ultra almond, data showed that the combination between Ne plus ultra almond grafted on Nemaguard peach rootstock and irrigated with 100 % of field capacity (control) greatly enhanced the investigated parameters, whereas this combination statistically maximized the values of leaf chlorophyll a, b and total chlorophyll content during 2008 and 2009 seasons.

On the other hand, the least values of leaf chlorophyll a, b and total chlorophyll contents were noticed in the leaves of Ne plus ultra almond grafted on Bitter almond rootstock and received 25 % of water field capacity during both seasons of study. It could be concluded that photosynthetic pigment (chlorophyll a and b) formation could be enhanced in the leaves of Ne plus ultra almond grafted on Nemagurad peach rootstock when the transplants irrigated with 100 % of field capacity.

V.II.2- Total carbohydrates.

A. Specific effect:

Regarding the specific effect of rootstock type on stem dry matter carbohydrates content, data displays that, total carbohydrates of Ne plus ultra almond grafted on Nemaguard peach rootstock were significantly higher than those grafted on Bitter almond rootstock during 2008 and 2009 seasons.

With regard to specific effect of different irrigation regime on carbohydrates content of Ne plus ultra almond stem dry matter, data display that, irrigation with 100 % of field capacity (control) the best irrigation treatment whereas it increased significantly stem total carbohydrates as compared with the other investigated irrigation regime during the first and second seasons of study.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., rootstock type and the different irrigation regime on stem total carbohydrates of Ne plus ultra almond, data showed obviously that the highest stem carbohydrates content was detected with that combination between Nemaguard rootstock and the irrigation at 100 % of field capacity (control) during both seasons of study.

V.II.3- Leaf proline content.

A. Specific effect:

Data show that, Bitter almond rootstock was more effective than the other investigated rootstock (Nemaguard peach rootstock) in this respect.

Referring the specific effect of different irrigation regime on leaf proline content, data reveals that the level of leaf proline

content was gradually increased by decreasing the amount of water irrigation. Anyhow, the highest level of leaf proline content regarding water regime (100 %, 75 %, 50 % and 25 % of field capacity) was associated with the addition of water at 25 % of field capacity during both seasons of study.

B. Interaction effect:

As for the interaction effect of the two investigated factors i.e., rootstock type and the different irrigation regime on leaf proline content of Ne plus ultra almond, data showed obviously that, the higher value increase in leaf proline content of Ne plus ultra almond transplants was detected by that combination between Bitter almond rootstock and the irrigation with 25 % of field capacity.

V.III. Effect of rootstock type and different irrigation regime on leaf and root mineral composition:

V.III.1- Leaf and root nitrogen content.

A. Specific effect:

Data displays that leaf and root N content did not response specifically to the investigated rootstock type. Hence, the statistically differences were in between the two investigated rootstocks (Bitter almond and Nemaguard peach) when leaf and root N contents were concerned.

With respect to the specific effect of the different irrigation regime on leaf and root N content, data revealed that both leaf and root nitrogen content decreased significantly with decreasing the level of water irrigation during both seasons of study. On the contrary, the control treatment (irrigation with 100 % of field capacity) increased significantly N % in both leaves and roots.

B. Interaction effect:

Regarding the interaction effect of the two investigated factors i.e., rootstock type and the different rates of irrigation on leaf and root N content, data clear obviously that the most stimulative combination enhanced both leaf and root N contents was that combination between Bitter almond rootstock and the irrigation with 100 % of field capacity during the two seasons of study. Moreover, the lowest decrease in both leaf and root N content was detected by Bitter almond rootstock irrigated with 25 % of field capacity during 2008 and 2009 seasons. On the other hand, other combinations treatments were in between in this respect.

V.III.2- Leaf and root phosphorus content.

A. Specific effect:

Regarding the specific effect of the two investigated factors involved in this study i.e., rootstock type and the different irrigation regime on leaf and root phosphorus contents. The results clearly show that the leaves of Ne plus ultra almond grafted on Nemaguard peach rootstock were richer in their phosphorus content as compared with those grafted on Bitter almond rootstock. In this respect, root phosphorus content of Nemaguard peach rootstock was highly significant than those detected in the roots of Bitter almond rootstock during both seasons of study. It could be concluded from the abovementioned result that phosphorus content was highly enhanced in both the leaves of Ne plus ultra almond as a scion and in the roots of Nemaguard peach as a rootstock.

With respect to the specific effect of the different irrigation regime on leaf and root phosphorus content, data revealed that as

the rate of irrigation decreased, both leaf and root phosphorus content decreased during both seasons of study.

B. Interaction effect:

Results show the effect of the interaction between rootstock type and the different irrigation regime on leaf and root phosphorus contents. These results revealed that leaf and root phosphorus was significantly affected by the interaction between the two investigated factors involved in this study. On the other hand, the highest value of leaf and root phosphorus content was that combination between Nemaguard peach rootstock and irrigation with 100 % of field capacity, whereas the most depressive effect on leaf and root phosphorus content was detected with Bitter almond rootstock combined with irrigation with 25 % of field capacity. Moreover, other combinations were in between in this respect.

V.III.3- Leaf and root potassium content.

A. Specific effect:

It is obvious from the data that, neither leaf potassium content of Ne plus ultra almond nor root potassium content affected by both investigated rootstocks (Nemaguard peach and Bitter almond) involved in this study during both seasons of study. In another word, there was no significantly difference between the two investigated rootstocks on either leaf or root potassium content.

Concerning the specific effect of the different irrigation regime on leaf and root potassium contents, data revealed that irrigation with 100 % or 75 % of field capacity were the best in this respect, whereas they were able to achieve the maximum level of both leaf and root potassium content, followed in a

descending order by irrigation with 50 % and 25 % of field capacity during both seasons of study.

B. Interaction effect:

As for the interaction effect between the two investigated factors involved in this study i.e., rootstock type (Nemaguard peach and Bitter almond) and the different irrigation regime (100 %, 75 %, 50 and 25 % of field capacity) on leaf and root potassium contents, data showed that interaction had significant effect on potassium content in the leaves of Ne plus ultra and in the roots of both investigated rootstocks during 2008 and 2009 seasons. On the other hand, the combination between Bitter almond rootstock and the irrigation with 100 % of field capacity as well as the combination between Nemaguard peach rootstock and irrigation with 100 % of field capacity had the same trend and the highest value of potassium content in the leaves of Ne plus ultra almond during 2008 and 2009 seasons. The same trend was true when root potassium content was concerned. In contrast, the combination between Bitter almond rootstock and the irrigation with 25 % of field capacity had the least value of potassium content in both the leaves of Ne plus ultra almond as a scion and the root of Bitter almond rootstock during both seasons of study. The other combinations were in between in this respect.

V.III.4- Leaf and root calcium content.

A. Specific effect:

Regarding the specific effect of rootstock type and irrigation regime (100 %, 75 %, 50 % and 25 % of field capacity) on leaf calcium content of Ne plus ultra almond and root calcium content of both investigated rootstocks, data clearly show that there was no significant differences in leaf calcium content of Ne plus ultra either grafted on Bitter almond or Nemaguard peach rootstocks. The opposite was true regarding root calcium content

whereas the roots of Nemaguard peach rootstock was richer in their calcium as compared with Bitter almond rootstock during both seasons of study.

Regarding the specific effect of the irrigation regime on leaf and root calcium content, data revealed that as the irrigation rate decrease both leaf and root calcium significantly increased during the two seasons of study.

B. Interaction effect:

As for the interaction effect of the two investigated factors i.e., rootstock type and the irrigation regime on leaf calcium content of Ne plus ultra as a scion and root calcium content of Bitter almond and Nemaguard peach rootstocks. Data obviously clear that the highest leaf and root calcium content was coupled with Nemaguard peach rootstock irrigated with 75 % of field capacity. On the contrary the lowest value of both leaf and root calcium content was detected by using Nemaguard peach as a rootstock watered with 100 % of field capacity during both seasons of study.

V.III.5- Leaf and root magnesium content.

A. Specific effect:

Referring the specific effect of rootstock type on leaf and root Mg content of Ne plus ultra almond as a scion and the two investigated rootstocks respectively, data clearly show that leaf Mg content was not affected by any of the two investigated rootstocks during both seasons of study. Whereas root Mg content was greatly affected by rootstock type. Root Mg content of Bitter almond rootstock was statistically higher than that recorded with Nemaguard peach rootstock.

As for the specific effect of the irrigation regime on leaf and root Mg content, data revealed that both leaf and root Mg

content took the same trend, whereas the highest leaf and root Mg content was remarked with the transplants irrigated with 100 % of field capacity. Meanwhile, the lowest value of Mg content in both leaves and roots was associated with the irrigation with 75 % of field capacity during 2008 and 2009 seasons.

B. Interaction effect:

As for the interaction effect of the two investigated factors i.e., rootstock types and the irrigation regime on leaf and root Mg content, data showed obviously the variable response to the different combinations during 2008 and 2009 seasons. Bitter almond rootstock combined with control treatment (irrigation with 100 % of field capacity) was the best combination where it raised leaf and root Mg content to the maximum level as compared with the other tested combinations during both seasons of study. On the other hand, leaf and root Mg content reached the minimum value when Nemaguard peach watering as rootstock and with 75 % of field capacity. The other combinations were in between during both seasons of study.

V.III.6- Leaf and root chloride content.

A. Specific effect:

Regarding the specific effect of rootstock type and the irrigation regime on leaf and root Cl content, data clearly show that, leaves of Nemaguard peach rootstock surpassed the leaves of the other investigated rootstock (Bitter almond in their Cl content. Meanwhile, root Cl content was equal in both investigated rootstocks during both seasons of study.

As for the specific effect of irrigation regime on leaf and root Cl content, data revealed that, as the field capacity increase from 25 % to 75 % of field capacity leaf and root Cl contents increase during 2008 and 2009 seasons.

B. Interaction effect:

Regarding the interaction effect of the two investigated factors i.e., rootstock type and the irrigation regime on leaf and root Cl content, data revealed that the highest leaf content was detected by the combination between Nemaguard peach rootstock and the irrigation with 75 % of field capacity, while the lowest leaf Cl content was obtained by Bitter almond rootstock irrigated with 100 % of field capacity.

The following two combinations:

- a. Nemaguard peach rootstock x 75 % of field capacity and
- b. Bitter almond rootstock x 75 % of field capacity gave the highest root Cl content. On the other hand, the lowest value of root Cl content was detected with Nemaguard peach rootstock irrigated with 100 % of field capacity during both seasons of study. The other combinations were in between.

V.III.7- Leaf and root iron, zinc and manganese contents.

A. Specific effect:

Concerning the specific effect of rootstock type and irrigation regime on both leaf and root Fe, Zn and Mn contents, data revealed that Bitter almond rootstock surpassed the other investigated rootstock (Nemaguard peach).

As for the specific effect of irrigation regime on leaf and root Fe, Zn and Mn contents, data shows that leaf and root contents of the three nutrient elements took the same trend when irrigation regime is concerned. It was remarkable clear that both leaf and root Fe, Zn and Mn contents significantly decreased gradually by increasing the irrigation regime from 25 % of field capacity passing through 50 % and finally terminated by 75 % of field capacity. The maximum level of leaf and root Fe, Zn and

Mn content was achieved when the transplants were irrigated with 100 % of field capacity during both seasons of study.

B. Interaction effect:

Dealing with the interaction effect of the investigated factors i.e., rootstock type and the irrigation regime on both leaf and root Fe, Zn and Mn contents, data showed that the combination between Bitter almond rootstock and the irrigation with 100 % of field capacity maximized both leaf and root Fe, Zn and Mn contents. On the other hand the combination between Nemaguard peach rootstock and the irrigation with 75 % of field capacity minimized leaf and root Fe, Zn and Mn contents during both seasons of study. The other combinations were in between.

- Anatomical study

Anatomical structure of root for both Nemaguard peach or Bitter almond rootstock indicated that, root diameter, thickness of bark xylem thickness, number of xylem rows / vascular, number of vessels / row and thickness of phloem were decreased and reached to the minimum values at 25 % F.C.

Anatomical study showed that the cuticle layer of stem of Ne plus ultra almond was increased by increasing the level of water stress of both Nemaguard peach and Bitter almond rootstocks when grafted on compared with the control (field capacity 100 %).

Water stress increased thickness of both cuticle and epidermis layers of two leaf surfaces as well as palisade tissue thickness.