



PHYSIOGENETICAL STUDIES ON SOME CITRUS HYBRIDS AND THEIR PARENTS

BY

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A Thesis Submitted in Partial Fulfillment of the Requirement

for Degree of

Doctor of Philosophy

In

Agricultural Science

(Pomology)

DEPARTMENT OF HORTICULTURE

FACULTY OF AGRICULTURE

BENHA UNIVERSITY

2022

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SUMMARY AND CONCLUSIONS

Five parents and their four crosses were collected in the form of flower buds. The samples used in the present study are authenticated and are being maintained at the Cytogenetic lab, At Moshtohor Scientific Station; the trees were marked and appropriately labeled before flowers were collected from them, which formed the basic material for detailed male meiotic studies. The present investigation was carried out during the two experimental 2019 and 2020 seasons on potted young seedling of four citrus rootstocks species grown in nursery of Faculty of Agriculture, Banha, Qaliubiya gove-rnorate – Egypt.

The treatments as follows:

<i>Citrus aurantifolia</i> (L.) Burmf.	Limes
<i>Citrus reticulata</i> Blanco	Cleopatra mandarin
<i>Citrus paradisi</i> Macf.	Grapefruit
<i>Citrus sinensis</i> (L.) Osbeck	Succari
<i>Citrus mites</i> L.	Clementine
<i>Citrus species</i>	Limes x Clementine
<i>Citrus species</i>	Cleopatra mandarin x Clementine
<i>Citrus species</i>	Grapefruit X Clementine
<i>Citrus species</i>	Succari X Clementine

The obtained results for each could be summarized as follows:

Part 1. Evaluation of vegetative growth and fruit quality for hybrid and parental plants:

- The values of shoot length significantly differed according to citrus genotypes and parental cultivars during two studied seasons. Citrus parental (P1- Limes) recorded the highest values of shoot length than other genotypes and superior on parental cultivars. On the other side, the shortest shoot length was observed by citrus parental P4- (Succari orange) and H1- (Limes x Clementine) comparing with other genotypes and parental cultivars. Such trend was true during both 2019 and 2020 seasons of study.
- The maximum thickness of shoots is concomitant to citrus genotype H2- (Cleopatra mandarin x Clementine) following with other genotypes with non-significant between them in the first season, as well as the parent “P2” (Cleopatra mandarin) was the superior parent in all other in the first season. While the genotype H1- (Limes x Clementine) and P4- (Succari) in the second season; also the parent “P4” the best values in all parents during 2020 season. On the other side, there were an intermediate records represented between

genotypes and their parental cultivars, the minimal thinnest values were recorded by genotype (H3- Grape fruit x Clementine) and H2- (Cleopatra mandarin x Clementine) during two studied seasons. So, the parents P5- (Clementine) and P2- (Cleopatra mandarin) the lowest values in this concern. Such trend was true during both 2019 and 2020 seasons of study.

- It is genotype H3- (Grape fruit x Clementine) followed by genotype H2- (Cleopatra mandarin x Clementine) “11.00”; H1- (Limes x Clementine) and the final H4- (Succari x Clementine) during the first season and second season, respectively. While best parent is the P1- (Limes) followed by P2- Cleopatra mandarin in the second rank in the first and second season, respectively. But the lowest values in the parent were the P4- (Succari orange) in the two seasons of study, respectively.
- Regarding to the genotype H2- (Cleopatra mandarin x Clementine) and genotype H3- (Grape fruit x Clementine) gave the highest values of the leaf length during the two studied seasons, respectively. On the contrary, the shortest leaf length was in concomitant to genotypes H4- (Succari x Clementine) and H1- (Limes x Clementine) citrus cultivars in two seasons, respectively. On the other hand, the best parent was P3- (Grape fruit) and P5- (Clementine) in the first and second season. On the contrary the lowest value of the parent was (P1- Limes) in the 2019 and 2020 seasons.
- Data show obviously considerable variations in this respect, herein, the greatest values of leaf width was cleared in citrus genotype H3- (Grape fruit x Clementine) in the studied 2019 and 2020 seasons, whereas the genotype H1- (Limes x Clementine) achieved the least width in the two studied seasons, respectively.
- The genotype H2- derived from (Cleopatra mandarin x Clementine) and the parent P3- (Grape fruit) gave the largest leaves than other parents; whereas the narrowest leaves were obtained in the genotype H1- (Limes x Clementine) and the parent (P2- Cleopatra mandarin) during the 2019 and 2020 seasons. The rest tested genotypes and parents gave intermediate values in this respect.
- The highest value of total biomass fresh weight was reported by genotype H2- (Cleopatra mandarin x Clementine); followed by the second rank H3- (Grape fruit x Clementine); then the third rank (H4- Succari x Clementine) and the final and Furth rank H1- (Limes x Clementine) in the first season. While, genotype H3- (Grape fruit x Clementine), the next H4- (Succari x Clementine) and H2- (Cleopatra mandarin x Clementine) then the final come H1- (Limes x

Clementine) in the second one. On the other side, parent H3- (Grape fruit x Clementine) was the best values in the two seasons of study. Conversely, the lowest values in this respect were obtained by parents P2- (Cleopatra mandarin) during 2019 and 2020 seasons.

- The genotype H3- (Grape fruit x Clementine) achieved the maximum records in total number of flowers/shoot and superior on the parental cultivars during the two seasons of the experimental. On the other side, the lowest value was attained by genotype H1- (Limes x Clementine) in the first 2019 and second 2020 season, respectively. However, the parent (P1- Limes) was the best values in this respect, but the lowest parent was P3- (Grape fruit) during the two seasons of study. Similarly other genotypes and parental cultivars were in between the aforesaid extremes.
- The highest values of No. of remaining setting fruits were in genotype H2- (Cleopatra mandarin x Clementine) and the parent P2- (Cleopatra mandarin) in the 1st and 2nd seasons, respectively in this study. On the contrary, the genotype H1- (Limes x Clementine) and the parent P3- (Grape fruit) scored the lowest values, and the rest genotypes and parents gave an intermediate values during two seasons.
- The highest values of No. of remaining fruits at harvest was in genotype H2- (Cleopatra mandarin x Clementine) and the parent P2- (Cleopatra mandarin) in the 2019 and 2020 seasons in this study, respectively. Conversely, the genotype H1- (Limes x Clementine) and the parent P3- (Grape fruit) recorded the lowest values, and the other genotypes and parents gave an intermediate values during 2019 and 2020 seasons.
- A genotype H2- (Cleopatra mandarin x Clementine) was the superior for fruit weight and volume in this concern, in two seasons of study, respectively. Whereas the genotype H2- (Cleopatra mandarin x Clementine) scored the lowest values, during the two seasons, respectively. The rest genotype gave the intermediate values in this concern. But the best parent for fruit weight and volume attained by P3- (Grape fruit) through the two seasons of study. On the reverse, the lower values for parent it was from P1- (Limes) for fruit weight and volume in the 2019 and 2020 seasons.
- The highest values of fruit length were reported by genotype H1- (Limes x Clementine); followed by the second rank H3- (Grape fruit x Clementine); then the third level H4- (Succari x Clementine) and the final and Furth rank H3- (Cleopatra mandarin x Clementine) in the first “2019” season. Whereas, the

genotype H3- (Grape fruit x Clementine), the next H4- (Succari x Clementine) and H1- (Limes x Clementine) then the final come H2- (Cleopatra mandarin x Clementine) in the second one. On the other side, parent P3- (Grape fruit) was the best recorded values in the two seasons of study, respectively. Conversely, the lowest values in this respect were obtained by parents P2- (Cleopatra mandarin) during the first “2019” and second “2020” seasons, respectively.

- Concerning the genotype H3- (Grape fruit x Clementine) gave the highest values of the fruit thickness during the 2019 and 2020 seasons of study, respectively. On the contrary, the lowest values of fruit thickness was in concomitant to genotypes H2- (Cleopatra mandarin x Clementine) in two seasons, respectively. On the other hand, the best parent was P3- (Grape fruit) in the first and second seasons. On the contrary the lowest value of the parent was P2- (Cleopatra mandarin) during the 2019 and 2020 seasons.
- The genotypes H1- (Limes x Clementine) in the first season and H3- (Grape fruit x Clementine) & H4- (Succari x Clementine) in the second one, respectively. Whereas the genotype H4- (Succari x Clementine) and H1- (Limes x Clementine) achieved the least width in the two studied seasons. On the other hand, the best parent was P1- (Limes) during the two seasons of study. On the contrary the lowest values in this concern it was from P2- (Cleopatra mandarin) during the two seasons of study, respectively. The rest genotypes and parents gave an intermediate values during two seasons.
- The genotype H4- (Succari x Clementine) and H3- (Grape fruit x Clementine) recorded the highest peel thickness in the first and second seasons, respectively. While genotype H1- (Limes x Clementine) gave the least values during two seasons, respectively. On the other hand, the parent P3- (Grape fruit) was the best values in the 2019 and 2020 seasons, respectively. Other genotypes and parents gave intermediate values during two seasons of study.
- The genotype demonstrates that genotype H3- (Grape fruit x Clementine) gave the highest value than other genotypes during two seasons of study, while genotype H2- (Cleopatra mandarin x Clementine) scored the lowest value, in this respect in 2019 and 2020 seasons, respectively.
- The genotype H1- (Limes x Clementine) recorded the highest number of seeds in 2019 and 2020 seasons, respectively. However, genotype H2- (Cleopatra mandarin x Clementine) gave the lowest values during two seasons, respectively. On the other hand, the parent P2- (Cleopatra mandarin) was the best values during the first and second seasons, respectively. On the contrary,

the parents P1- (Limes) and P3- (Grape fruit) scored the lowest values in this concern. Other genotypes and parents gave intermediate values during two seasons of study.

- The highest value of TSS (%) were reported by genotype H1- (Limes x Clementine) and (H4- Succari x Clementine) where recorded the same statistic values in the first season, while H1- (Limes x Clementine) give the best result in the second one. On the other side, genotype H2- (Cleopatra mandarin x Clementine) give the lowest values during 2019 and 2020 seasons, respectively. On the other hand, the parent P4- (Succari) and P5- (Clementine) was the best values in the two seasons of study. Conversely, the lowest values in this respect were obtained by parents P1- (Limes) and P2- (Cleopatra mandarin) during 2019 and 2020 seasons.
- Acidity (%) was recorded by genotype H1- (Limes x Clementine) in the first and second seasons. On the other side, genotype H4- (Succari x Clementine) give the lowest values during two studied seasons, respectively. On the other side, the parent P1- (Limes) was the best values in the two seasons of study. On the reverse, the lowest values in this respect were obtained by parents P4- (Succari) during 2019 and 2020 seasons. Other genotypes and parents gave intermediate values during two seasons of study.
- The genotype H4- (Succari x Clementine) had the highest values of TSS/acid ratio, so H1- (Limes x Clementine) give the lowest values during two studied seasons. On the other side, the parent P4- (Succari) was the highest values in the two seasons, respectively. On the contrary, genotype P1- (Limes) gives the lowest values in this concern during two seasons, respectively. The rest genotypes and parents gave intermediate values during two seasons of study.
- The genotype H3- (Grape fruit x Clementine) gave the give the utmost result during the first and second seasons, respectively, while the lowest values were genotype H2- (Cleopatra mandarin x Clementine) during the 2019 and 2020 seasons, respectively. On the other hand, the parent P1- (Limes) was the best values during the two studied seasons. Conversely, the lowest values in this respect were obtained by P2- (Cleopatra mandarin) during the first “2019” and second “2020” seasons.

Part 2. SRAP analysis:

Sequence-related amplified polymorphism (SRAP) markers were used to detect molecular marker polymorphisms among five parents and four crosses of citrus and their relatives in Aurantioidea. Four SRAP primer combinations

produced a total of 160 polymorphic fragments with an average of 40 per primer combination and the an-average polymorphism information content (PIC) of 0.86. The un-weighted pair group method arithmetic average (UPGMA) analysis demonstrated that the accessions had a similarity range from 0.35 in the cross between Limes and Clementine to 0.43 in the Grapefruit parent with a mean of 0.37. The dendrogram separated the parents and the resulted crosses of *Citrus* species into two main sub-clusters with a similarity value of 0.37. Only one member of the first sub-cluster which is Clementine or the parent of all the resulted crosses. In the second main sub-cluster, Only one member of the first sub-sub-cluster which is Grapefruit or the parent of one cross. The second sub-sub-cluster has consisted of one parent separated alone (Succari parent) and another sub-cluster. This sub-cluster is formed from the sub-sub-cluster including the parent Cleopatra mandarin and the resulting from cross Cleopatra mandarin x Clementine. The last sub-cluster has consisted of one group containing the parent Limes and the resulted cross Limes x Clementine. The other group consisted of two crosses; Grapefruit x Clementine and Succari x Clementine.

Part 3. Genetic diversity of some *Citrus* (L) genotypes as revealed by meiosis:

The Delta region especially in Qalubia governorate of Egypt is reported to be the new origin place and rich in diversity of *Citrus* (L.) species, where some species of *Citrus* appeared in their natural habitat. To have comprehensive information about the extent of genetic variability and the occurrence of cryptic genomic hybridity between and within various *Citrus* species, a combined approach involving cytogenetical approaches was adopted in the present study. Cytogenetic approaches are applied to five parents and their four crosses. Male meiotic studies showed a gametic chromosome number of $n = 9$, without any evidence of numerical variations. Bivalents outnumbered all other types of associations in pollen mother cells (PMCs) analyzed at diplotene, diakinesis and metaphase I. Univalents were frequently encountered in nine genotypes presently studied, though their presence appropriately did not influence the distributional pattern of the chromosomes at anaphases I and II.