The effect environmental conditions on shelf-life of washington navel orange fruits

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This study was conducted during the two seasons of 1993 and1994, on twenty years old Washington navel orange trees budded onsour orange rootstock grown at three locations i.e. Wady EI-Mollak(EI-Esmailia governorate); South EI-Tahreer and El-Qanater (El-Qaliobia governorate).Twenty trees, healthy and nearly similar in vigor received thecommon fertilization and irrigation programs used in each location,were chosen.The present study included two parts: The first part was fruitmaturity determination, while the second was fruit handling andstorage treatments.Anyhow, fruit maturity study covered the effect of orchardlocation (heat units) and irrigation system.In this respect, fruit samples were collected from labeled fruitsat the three locations starting from the age of 150 days from fruit set,and repeated every 10 days interval till the age of 200 days. Each fruitsample comprised 30 fruits for determining maturity indices, i.e. totalsoluble solids, acidity, and T.S.S/acid ratio. Meanwhile, available heatunits at each location for different fruit ages were calculated. At eachdate, 25 fruits per each sample were stored under room temperature(l8±40C) for studying the ability of harvested fruits to maintain theirfine conditions without shrinkage.Furthermore, fruit handling and storage study included theeffect of orchard location, irrigation system, storage method, package-- _.. _. - -- --- - ._-------136SIze, storage temperature, and fungicides and non-traditionaltreatments on fruit storage.Mature fruits were harvested from trees grown at Wady El-Mollak location under drip irrigation for studying the effect of storagetemperature and package size, while for studying the effect of locationand irrigation system on fruit storage, fruits were taken from thedifferent three locations as well as Wady EI-Mollak location,respectively.Fruits were soaked in water containing 1500ppm SOPP at 45°Cand pH 11.8 for four minutes, dried and sprayed with wax containing4000 ppm TBZ.The treated fruits were packed in export packages for studyingthe effect of storage temperatures, i.e. room (18±4°C), 4±l°C and7±l0C besides the effect of different locations under study anddifferent irrigation systems at Wady EI-Mollak on the shelflife offruits.Furthermore, for studying the effect of package size i.e.consumer and export package, fruits were taken from Wady El- .Mollak location under drip irrigation. Meanwhile, fruits were alsoharvested from El-Qanater location for studying the effect offungicides and non-traditional treatments on fruit storage. In thisrespect, fruits were washed with tap water, dried then treated asfollows:1-Control (untreated): Clean dry fruits were sprayed with wax.2- 1500 ppm SOPP (Sodium orthophenylphenate) dissolved in waterat 45°C for 4 minutes. Fruits left to dry then sprayed with wax.- - -- -- ----------1373- 2000 ppm IMZ (Imazolil): Clean dry fruits were sprayed with waxcontaining 2000 ppm IMZ.4- 4000 ppm TBZ (Thiobendazole): Clean dry fruits were sprayedwith wax containing 4000 ppm TBZ.5- Hot water treatment at 47°C for 6 minutes.6- 500 ppm Garlic oil: Clean dry fruits were sprayed with waxcontaining 150 ppm Pro-Gib plus.All treated fruits were packed in export package and storedunder both room temperature (18±4°C) and 7±1°C. Fruit sampleswere taken every 20 days till the end of storage period.Generally, in all previous experiments, fruits were subjected tothe following determinations of fruit quality during storage: fruitdecay, fruit weight loss and fruit analysis i.e. TSS, acidity, TSS: acidratio and ascorbic acid contents.The obtained results can be summarized as follow:Part I: Fruit Maturity:1- Fruits ofEl- Tahrir location attained maturity when they were 170-175 days old (20 - 30 September), received heat units 14945,total soluble solids 9.3%, total acidity 1.09”10 and total

solublesolids: acid ratio 8.52: 1. While, fruits from EI-Qanater locationreached maturity when they were 160 to 180 days old (10 - 20September) received heat units 1586.8 with total soluble solids(9.5 - 10.4%), total acidity (1.09 to 1.25%), TSS: acid ratio (8.51:1). On the other hand, at Wady El-Mollak location fruits becamemature at the age of 175-180 days (1- 10 October), heat units--- - - - - - - - -- - - -138(1534 - 1605), total soluble solids (9.2 - 9.5%), total acidity(0.98 - 1.26%), total soluble solids: acid ratio (7.50 - 9.39 : 1).Meanwhile, Wady El-Mollak location under drip irrigationsystem, fruits reached maturity when their age was 160 - 165days (10 - 20 September), heat units (1352.5 - 1489.0) with fruittotal soluble solids 10.5%, total acidity (1.15 - 1.31%), totalsoluble solids: acid ratio (8.10 - 9.13 : 1).2- Fruits harvested before or after the above indicated ages at each ofthe indicated locations or irrigation systems were not best suitedfor long shipment as they showed shrinkage when kept underroom temperature for different periods less than 25 days afterharvest.3- Total soluble solids percentage increased until the age of 190 daysfrom fruit set in all locations under study.4- Fruits from El-Qanater location, generally, showed higher fruit totalsoluble solids percentages as compared with the other twolocations used.5- Trees irrigated with surface irrigation at Wady El-Mollak location .gave fruits with lower values of juice TSS content until 180 daysfrom fruit set as compared with the corresponding ones underdrip irrigation system.6- Titmtable acidity of Navel fruit juice decreased towards the age of200 days in all locations.7- No significant differences were obtained between various locationsunder study in fruit juice acidity.1398- Under the two irrigation systems at Wady El-Mollak location,titratable juice acidity decreased as fruits approached maturity.However, irrigation systems had no effect on fruit juice acidity.9- TSS: acid ratio in fruit juice of Navel orange increased with theprogress in fruit age in all locations under study.10- Both El-Tahrir and Wady El-Mollak locations gave fruits withhigher values of TSS : acid ratio as compared with El-Qanaterlocation.11- TSS : acid ratio in fruit juice increased with increasing fruit ageunder both irrigation systems used.12- Fruits produced under drip irrigation system had higher TSS : acidratio as compared with the corresponding ones of those of surfaceirrigation system.Part 2: Post-harvest (Fruit storage):1- Storage method:1- Effect of orchard location and irrigation system:1- Fruit decay percentages were directly proportional and coincided .with the increase in storage duration under different storagemethods and different orchard locations. Room temperaturestorage induced higher rate of fruit decay than those of coldstorage. In this sphere, fruit decay percentage increased withprolonged storage period up to 120 days under cold storage, whilefruits stored at room temperature became unacceptable forconsumption after 60 days. Besides, El-Tahrir location showedlower fruit decay percentage followed by Wady El-Mollak ascompared with EI-Qanater location. In addition, fruit decaypercentage of trees under drip irrigation system gave lower valuesas compared with those for trees under surface irrigation.2- Fruit weight loss percentage increased with prolonging the storageperiod in all locations and storage methods. Fruits stored undercold temperature had the lowest weight loss percentage than thosestored at room temperature. Fruit weight loss percentage increasedwith the extension of storage period up to 120 days when fruitsstored under cold storage, while fruits at room temperature becameunacceptable to consumer after 60 days. Moreover, EI-Tahrirlocation caused the lowest fiuit weight loss percentage followedby EI-Qanater location as compared with Wady EI-Mollaklocation. Besides, fruit weight loss percentage from trees underdrip irrigation system gave the lowest values as compared withthose under surface irrigation system.3- During the storage period that was extended to 90 days, fiuits juiceTSS increased gradually whether fiuits were stored under cold orroom temperature. Room temperature gave lower rate of increase .in fiuit TSS than those under cold storage. In addition, juice TSS%was the highest in fiuits obtained from El-Qanater and Wady EIMollak,while fiuits of EI-Tahrir were the lowest in juice TSS%content. Also, TSS% of fiuits from trees under drip irrigationsystem gave higher values as compared with those fiuits fromtrees under surface irrigation.4- Fruit acidity decreased gradually by extending the period of storagewhether fiuits stored under room or cold storage. In this concern,cold storage induced higher rate of DROP in fruit acidity than thoseunder room temperature storage. Fruit juice acidity variedaccording to orchard location. Nevertheless, fruit acidity washighest in fruits obtained from EI-Qanater followed by Wady EIMollakas compared with EI-Tahrir location. At Wady EI-Mollaklocation fruits picked from trees under drip irrigation had highestjuice acidity content than those harvested from trees under surfaceirrigation.5- During storage period that extended up to

90 days TSS:acid ratioincreased gradually whether fruits were stored under cold or roomtemperature. TSS:acid ratio in fruit juice at maturity variedaccording to orchard location. However, fruits of EI-Tahrirlocation had the highest value of TSS:acid ratio, while both EIQanaterand Wady El-Mollak locations had nearly similar values.At Wady EI-Mollak location no significant difference wasobtained between fruits picked from trees under drip irrigation andthose under surface irrigation.6- Ascorbic acid content in fruit juice decreased by the advance in .storage period. The DROP in ascorbic acid content during storagewas at a higher rate in fruits under room storage than those undercold storage. At picking time, ascorbic acid content was higher infruits obtained from EI-Qanater followed by those from Wady EIMollakand EI-Tahrir locations. Fruits harvested from trees underdrip irrigation had higher juice ascorbic acid content than thosepicked from trees under surface irrigation.II-Package size:1- Decay percentage is directly proportional and coincided with theincrease in storage duration in all different packages used i.e.export package and consumer package. Moreover, consumerpackage, reduced fruit decay percentage in relation to exportpackage.2- Fruit weight loss percentage of export and consumer packagesincreased with increasing storage period. Consumer packagereduced weight loss percentage as compared with export sizepackage.3- Data clearly indicate that fruit juice TSS increased gradually duringthe storage period. Moreover, packages size had no significanteffect on fruit total soluble solids.4- Fruit juice acidity decreased gradually with prolonging storageperiod. No significant difference was obtained between export andconsumer packages in this respect.5- TSS : acid ratio in fruit juice increased with increasing storageperiod for either export or consumer packages used. No significant .difference was noticed between export and consumer packages.6- Fruit ascorbic acid content decreased with prolonged storage. Nosignificant difference was evident between the two package sizesused.111-Storage temperature:1- Fruit decay percentage increased with prolonging storage period.Decay percentage of fruits stored under room temperature143(l8±40C) had the highest percentage followed by fruits stored at7±1°C and 4±1°C in a descending order.2- Fruit weight loss is directly proportional and coincided with theincrease in storage duration in all storage temperatures used. Fruitsstored at 4±1°C had significantly the lowest weight loss followedby fruits stored at 7±lOC as compared with fruits stored underroom temperature. In the same time, fruit weight loss percentageincreased with the progress in storage period up to 90 days whenfruits stored at 4±1°C and 7±1”C. Fruit weight loss percentage wasmuch higher under room temperature and became unacceptable toconsumers after 60 days.3- Fruit juice TSS content increased with advancing storage period.The lowest temperature 4±1°C induced the highest increase in fruitTSS percentage during storage as compared with the other twotemperatures used. No significance was detected between 4±1°Cand 7± 1°C in this respect.4- Data indicate that in all storage temperatures used the percentage offruit juice acidity decreased with the increase in the storage period. .No significant differences were obtained between juice acidity offruits stored at 7±1°C and 4±1°C but, was significant betweenfruits stored at room temperature and fruits stored at 4±1”C.5- TSS: acid ratio increased by increasing storage period in all storagetemperatures. Fruits stored at 4±1°C produced the highest ratio ofTSS : acid followed by fruits stored at 7±1 as compared with fruitsstored under room temperature in a descending order.6- Fruit juice ascorbic acid content decreased gradually as storageperiod increased in all storage temperatures used. Storage underlow temperature (4±I°C) reduced the loss in fruit juice ascorbicacid content.IV- Fungicides and the non-traditional treatments:1- Fruit decay percentage increased with the extension of fruit storageperiod for all different temperatures of storage. Fruits kept at roomtemperature became unacceptable to consumers after 80 days forthe control treatment, while the decay percentages for othertreatments ranged between 15 and 39% after the same period. Allfruits kept at room temperature decayed after 100 days for alltreatments. Fruits stored at 7±1°C didn’t show any decay up to 80days of cold storage when treated with Garlic oil. Pro-Gib, IMZ,and TBZ treatments succeeded in maintaining all fruits withoutdecay for 40 days, while hot water and SOPP treatments had 3.0%fruit decay and control fruits had 36% fruit decay after the sameperiod of cold storage. Garlic oil as a non-traditional treatmentsucceeded in reducing fruit decay under cold storage up to 12% for160 days storage and between 18 to 39% for other fungicides andnon-traditional treatments. Untreated fruits (control) werecompletely unacceptable to consumers after 100 days of coldstorage. Anyhow, treating fruits

with Garlic oil then storage at7±I°C gave the least percentage offruit decay even after 160 daysof cold storage. SOPP fungicide was the second best, while hot145water and Pro-Gib-plus treatments had the highest percentages offruit decay. The TBZ and IMZ fungicide treatments were. inbetween.2- Prolonging the storage period resulted in increased fruit weightloss. After 80 days storage at room temperature, fruits treated withfungicides ranged between 15.9% for IMZ treatment to 17.9% forSOPP treatment. Fruits received non-traditional treatments lostbetween 21.0% for Garlic oil treatment and 24.9% for hot watertreatment for their weight after the same period of roomtemperature storage. After 80 days of room temperature storage allfruits became unacceptable to consumers, while fruits stored at7±loC and 85% RH remained acceptable to consumers for morethan 120 days. Weight loss for control fruits after 120 days of coldstorage was only 10.5%, for fungicide treatments ranged between7.0 for IMZ and 7.7% for SOPP and for the non-traditionaltreatments ranged between 7.1% for Garlic oil and 9.2% for hotwater treatments. Fruits treated with Garlic oil or with IMZremained acceptable to consumers up to 160 days of cold storagewith fruit weight loss of 9.4% for Garlic oil and 12.1% for IMZtreatments.3- TSS percentage, of all treatments used, increased with prolongingperiod of fruit storage. Fruits of the control became unacceptableto the consumers after 60 days of storage under room temperatureand 80 days under cold storage. Fruits treated with Garlic oil orchemical fungicides were acceptable to the consumers up to theend of cold storag , while Pro-Gib plus, and hot water as nontraditionaltreatmen failed in realizing such success.4- Fruit juice acidity un er different treatments decreased with storageeither under room r cold temperatures under the same storagemethod. The differ nee between either fungicide treatments ornon-traditional trean ents was not clearly noticed.5- TSS : acid ratio in fruit juice increased with increasing storageperiod. Fruits treat with Garlic oil had lowest values ofTSS :acid ratio in comparrson with fungicide treatments i.e. SOPP, IMZand TBZ which had nearly similar values at 160 days storage.6- Juice ascorbic acid content of different treatments decreased withincreasing the period of storage. At 100 days of cold storage, fruitstreated with hot water were inferior in ascorbic acid content ascompared with other treatments. At the end of cold storage (160days), fruits treated with Garlic oil surpassed fungicides in fruitascorbic acid content.