Researches regarding quality maintenance of nectarines during storage, depending on fertilzation system

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Abstract This paper presents the results obtained by storage of the nectarines in different conditions of temperature, humidity and gaseous composition of the air to determine the most suitable fertilization systems and methods for storage of nectarines, in order to maintain fruits quality longer period of time after harvest.
It was experienced two nectarines varieties from SCDP Constanta (Cora and Delta), which were fertilized with organic fertilizer and chemical fertilizer applied to soil and foliar.

The nectarines were stored at ICDIMPH-Bucharest in three variants: the ambient temperature (26-280C) in cold conditions (T = 2-4°C) and cold + modified atmosphere conditions. The determinations were made in the dynamic of the quantitative and qualitative losses during preservation nectarines. The results show that between variants of fertilization, the chemical fertilization variant – in soil + foliar feeding, induces the best storage capacity for both varieties of nectarines. In the second place regarding this aspect stands the variant of organic fertilization.
The results indicate the superiority of preserving fruits in modified atmosphere, which recorded the lowest losses during storage. Simple cold preservation gave also very good results and can be successfully used in case there is no possibility of changing the gaseous composition of the air in the storage space.

Key words

Cora, Delta, organic fertilizer, chemical fertilization in soil + foliar feeding, cold storage, modified atmosphere, quantitative and qualitative losses

Fruits are plant organs that continue their evolution after their separation from the plant. This development affects, in the same time, in a more or less rapidly manner, all characteristics of those organs. The changes that occur in fruits is firstly a degradation of quality, but on the other hand can be beneficial and necessary for these products to reach normal maturity of consumption.

The developed technologies of fresh fruits valorization propose mainly the maintaining of their quality by ensuring the normal development from the harvest to consumption and to minimize possible losses of any kind. For some horticultural products (peaches, nectarines), this technologies make possible to achieve specific consumer and commercial requirements (firmness, flavor, taste, color) after harvest, at desired time.

All this are based on knowledge of the principal biological processes and proper leading of factors according to the demands of each species or variety, every type of deposit or each method applied, commercial demands, product destinations, etc.

Because of the great taste attributes, aspect and specifically flavor, plus their importance in nutrition, nectarines, peaches as well, occupies an important place in consumption in both, fresh and processed condition. Their superior dietary attributes are determined by their content of vitamins, minerals, cellulose, acids and pectin.

The achieving and maintaining of the quality of fruits depend on complex factors involved in all links of culture and valorization technology: from the choice of variety, culture's maintenance, to harvest, conditioning and expedition.

The nectarines storage capacity is dependent on the quality of the material used to preserve and of the conditions of storage. The chemical composition of nectarines, which determine the biochemical processes during storage and therefore storage capacity is strongly influenced by the fertilization regime. Based on this research results proved that the doses of organic and mineral fertilizer affect the chemical composition of fruit, with effect on storage capacity [5, 7].

Through the way which technological factors are achieved during storage (temperature, humidity, air

composition, etc.) exert a great influence on the storage duration of the nectarines [3, 4].

In valorization technologies are recommended the application of the technological storage methods (low temperatures, changing the gaseous composition of the air, etc.) that determines the inhibition of the physiological and biochemical processes in fruits, leading to maintain their commercial value a longer period of time. [1, 2, 6].

To underline the influence of the culture fertilization and of the fruits storage conditions on providing quality nectarines, we organized appropriate tests at ICDIMPH - HORTING, in collaboration with SCPP Constanta.

Material and Method

The necessary fruits for researches were obtained from SCDP Constanta. Cora and Delta nectarine varieties was tested. Each variety has benefited, in culture, by 4 different types of fertilization:

V1 - control (unfertilized);

V2 - organic fertilization (with fermented manure);

V3 - chemical fertilization (NPK complex fertilizers 15:15:15.);

V4 - chemical + foliar feeding fertilization (NPK complex fertilizers in soil with 15:15:15 and to plant with Murtonik foliar fertilizer 20:20:20).

At Research and Development Institute for Processing and Marketing of the Horticultural Products "HORTING", fruits were stored in 3 storage variants:

- At ambient temperature (T = 26-28oC, RH = 65-70%) in 1kg packaging– warm storage;
- In refrigeration room (T = 2-4oC, RH = 83-87%), in packs of 1 kg covered with perforated polyethylene film - cold storage;
- In refrigeration room (T = 2-4oC, RH = 92-96%), in 1 kg hermetic packages, so that the composition of the atmosphere inside has modified, decreasingof the O_2 content and increasing of the CO_2 content and the relative air humidity - storage in modified atmosphere-AM.

The storage period (days) varied depending on the storage variant :

- warm storage: 7
- refrigeration storage: 28
- MA storage: 30

After removal the nectarines from storage space, we made observations on general aspect of the fruits and we determinate the mass (quantitative) and the depreciation (qualitative) losses suffered by fruits during storage.

All results were statistically analyzed by variant analyze, using ANOVA model, with equal number of observations in cell; the significations were set using Tukey test for limit differences for each analyzed variable.

Results and Discussions

The nectarine's losses occurred during the warm keeping (room temperature) for 7 days are presented in table1.

Table 1

Nectarine's losses occurred during the warm keeping

Variant	Losses [%]					
	totals		mass		depreciation	
	Cora	Delta	Cora	Delta	Cora	Delta
V1	47,93	43,13	14,88	13,63	33,05	29,50
V2	40,24	36,89	15,55	13,32	24,69	23,57
V3	42,13	45,71	15,52	14,97	26,61	30,74
V4	21,93	31,79	15,53	14,36	6,40	17,43
Variety average	38,06	39,38	15,37	14,07	22,69	25,31

It was found that total losses, for both varieties, are large in all 4 fertilization types, due to mass losses and especially those by depreciations .

Thus, total losses in Cora nectarines variety are very high at fertility variants V1 (47.93%), V3 (42.13%) and V2 (40.24%), firstly due to high percentage of losses by depreciation (33.05%, 26.61% and 24.69% respectively) and due significant quantitative losses (14.88%, 15.52%, 15.55%), while for the V4 variant they are acceptable (21,93%).

The average values of these indicators on Cora variety are : 38.06% - total losses, 15.37% - mass losses and 22.69% - depreciation losses.

Under similar conditions of storage, Delta nectarines variety presents a losses percentage greater than Cora variety.

Thus, by warm storage, there were recorded the following total losses : 43,13% for the V1 variant, 36,89% for the V2 variant, 45,71% for the V3 variant and 31,79% for the V4 variant.

It can be noted that, unlike the Cora variety, the differences regarding total losses are smaller between the fertilization variants. The V4 variant recorded, in this case, the lowest losses.

The causes of high rates of losses by depreciation of the nectarines are produced by late infections before harvest caused by fungi as Monilinia laxa and M. Fructigena, and the attack produced during harvest and manipulators by molds as Rhizopus stolonifer si Botrytis cinerea.

By using the refrigeration method (table 2) these fungi and molds development is slowed, so that total losses were greatly reduced in all fertilization

variants.Their values were at Cora variety nectarines : 11.74% for the V1 variant, 6.49% for the V3 variant, 5.54% for the V2 variant and 3.97% for the V4 variant, with a variety average 6.94%.

Table 2

Nectarine's losses occurred during the cold keeping

Variant	Losses [%]					
	totals		mass		depreciation	
	Cora	Delta	Cora	Delta	Cora	Delta
V1	11,74	34,28	1,51	1,50	10,23	32,78
V2	5,54	10,17	1,18	1,30	4,36	8,87
V3	6,49	22,06	1,01	1,43	5,48	20,63
V4	3,97	5,67	1,42	1,33	2,55	4,34
Variety average	6,94	18,04	1,28	1,39	5,66	16,65

Using low temperature led,also, to a major mass losses and depreciation losses of the Delta variety nectarines, leading to: 34.28% for the V1 variant, 22.06% for the V3 variant, 10,17% for the V2 variant and 5.67% for the V4 variant, with a total losses variety average of 18.04% (table 2).

Obviously, as in storage the fruits at high temperatures, the V4 variant has the lowest loss, followed by V2 variant.

Situation of losses in Cora nectarines variety during storage at ambient temperature, in cold storage and in modified atmosphere is shown in figure 1.

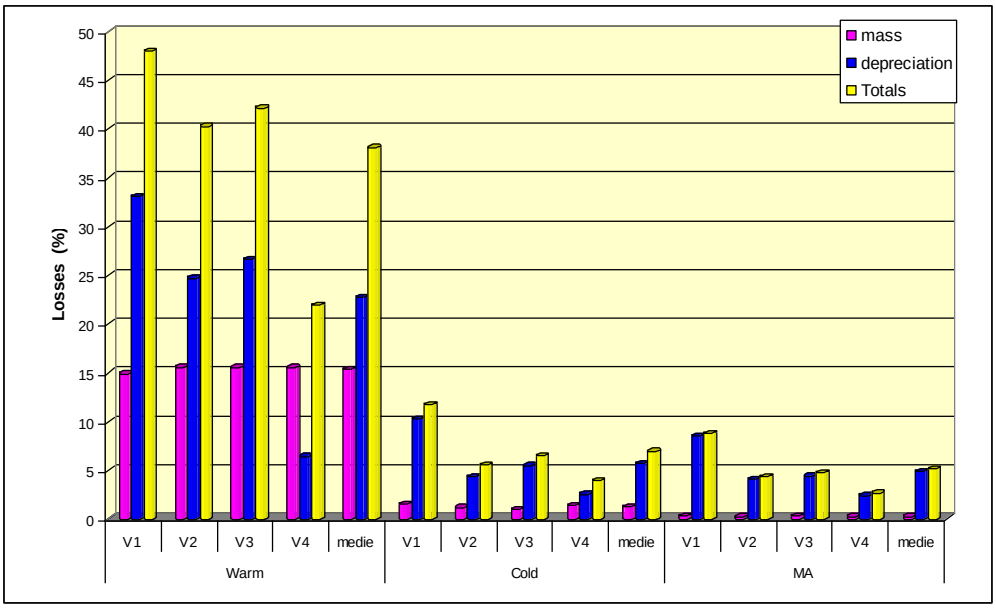

Figure 1 – Registered losses during storage in different conditions for Cora nectarines variety

By storage fruits in modified atmosphere the percentage of total losses is more reduced, leading, in Cora nectarines variety, at: 8.80% for the V1 variant, 4.73% for the V3 variant, 4.36 for the V2 variant and 2,68% for the V4 variant, with an variety average 5,14% (table3).

Table 3

Nectarine's losses occurred during storage in MA

Variant	Losses -%					
	totals		mass		depreciation	
	Cora	Delta	Cora	Delta	Cora	Delta
V1	8,80	12,17	0,29	0,31	8,51	11,86
V2	4,36	6,47	0,25	0,33	4,11	6,14
V3	4,73	6,99	0,33	0,31	4,40	6,68
V4	2,68	0,23	0,27	0,23	2,41	-
Variety average	5,14	6,46	0,28	0,29	4,86	6,17

In this case, quantitative losses represent a small percentage, 0,28%.It also noted the V4 variant, followed by the V2 and the V3 variants.

Keeping in modified atmosphere was very efficient for Delta nectarines variety, too; because the total losses were reduced to 6.46% for the variety, being 12.17% for the V1 variant, 6.99% for the V3 variant, 6.47% for the V2 variant and only 0.23% for the V4 variant.

For the V4 variant there were no depreciation losses and in fact the mass losses was very low, compared with other storage methods.

In figure 2 are presented the results obtained by keeping Delta nectarine variety in the three tested variants.

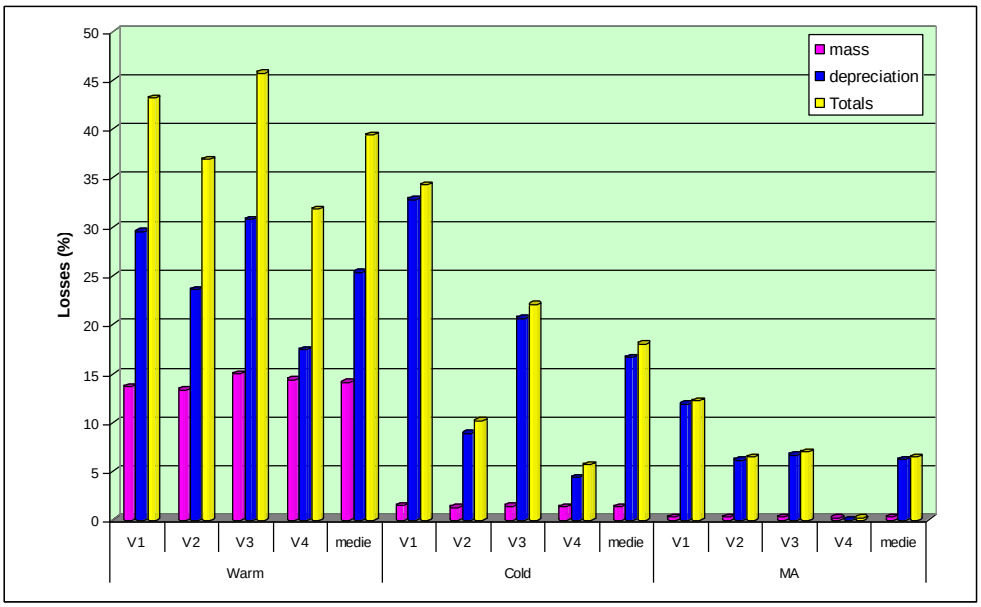

Figure 2 – Registered losses during storage in different conditions in Delta nectarines variety

Analyzing losses occurred during the storage of 2 nectarines varieties was found that the Cora variety have a better storage capacity, compared with the Delta variety, where quantitative losses but especially qualitative ones, were higher.

The significance of analytical results for each tested variety and for each experimental factor are presented in table 4.

Table 4

Statistical semnifications of obtained results in Cora and Delta nectarine varieties in different storage conditions

Variety	Storage method	Variant	Total losses %			Mass losses %			Depreciation losses %		
			values	defe-rences	semnifi-cations	values	defe-rences	semnifi-cations	values	defe-rences	semnifi-cations
CORA	warm	**V1**	47,93		Mt	14,88		Mt	33,05		Mt
		V2	40,24	- 7,69		15,55	0,67		24,69	- 8,36	
		V3	42,13	- 5,80		15,22	0,64		26,61	- 6,44	
		V4	21,93	- 26,00		15,53	0,65		6,40	- 26,65	
	cold	**V1**	11,74		Mt	1,51		Mt	10,23		Mt
		V2	5,54	- 6,20		1,19	- 0,32		4,36	- 5,87	
		V3	6,49	- 5,25		1,01	- 0,50		5,48	- 4,75	
		V4	3,97	- 7,77		1,42	- 0,09		2,55	- 7,68	
	MA	**V1**	8,80		Mt	8,51		Mt	8,51		Mt
		V2	5,06	- 3,74		4,11	0,66		4,11	- 4,40	
		V3	4,73	- 4,07		4,40	0,04		4,40	- 4,11	
		V4	2,68	- 6,12		2,41	-		2,41	- 6,10	
DELTA	warm	**V1**	43,13		Mt	13,64		Mt	29,49		Mt
		V2	36,89	- 6,24		13,32	- 0,32		23,56	- 5,93	
		V3	45,71	2,58		14,97	1,33		30,74	1,25	
		V4	31,79	- 11,34		14,36	0,72		17,43	- 12,06	
	cold	**V1**	34,28		Mt	1,49		Mt	32,79		Mt
		V2	10,18	- 24,10		1,30	- 0,19		8,87	- 23,92	
		V3	22,06	- 12,22		1,43	- 0,06		20,63	- 12,16	
		V4	5,57	- 28,71		1,33	- 0,16		4,34	- 28,45	
	MA	**V1**	12,17		Mt	0,31		Mt	11,86		Mt
		V2	6,47	- 5,70		0,33	0,02		6,14	- 5,72	
		V3	6,99	- 5,18		0,31	0		6,68	- 5,18	
		V4	0.23	- 11,94		0,23	- 0,08		0	- 11,86	

DL 5%	**16,644**	**1,398**	**16,068**
DL 1%	**23,036**	**1,850**	**21,273**
DL 0,1%	**28,467**	**2,390**	**27,481**

Conclusions

1. The quality maintenance capacity of the nectarine fruits varies depending of fertilization system, variety and storage conditions and especially by temperature and gaseous air composition.

2. Between fertilization variants, the V4 variant (chemical fertilization in soil + foliar feeding) induces the best storage capacity, at both studied nectarines varieties. Foliar fertilizers provides, besides the contribution of macro-and micronutrients and other organic substances which stimulate the metabolism of chlorophyll assimilation, energetically efficiency and finally the quality of the fruits. In the second place stands the V2 variant (organic fertilization), which has the advantage of ecological fruits obtaining. Organic fertilizers contribute by their presence in the plants supplies with all necessary minerals, ensuring the high quality fruits production and good storage capacity.

3. The variety is an important factor in maintaining the fruit quality after harvest. There are differences between varieties regarding storage capacity and their response to applied storage technology. Thus, Cora variety has better storage capacity and response very well to the cold application, while Delta variety, with lower storage capacity, responds very well to modified atmosphere applications. Cora nectarines variety have better storage capacity compared with those of the Delta variety, due the greater resistance to deposit diseases and therefore, the lower percentage of quality losses during storage.

4. In the conditions of the appropriate practicing methods of the fruits storage (optimal temperatures for storage or modified atmosphere characteristic for a species or a variety) biochemical processes are inhibited, maintaining products quality. Between the 3 methods of storage (ambient temperature, refrigeration room and refrigeration room + modified atmosphere) the best results were obtained in the case of the third method, where was registered the lowest losses during nectarines storage. Very good results were obtained also in simple refrigeration storage method, in which case losses during storage for 28 days were registered much lower values compared with storage to the room temperature for 7 days.

5. Refrigeration storage can be successfully used for nectarines in case there is no possibility of modifying the air gaseous composition from storage space. Low temperatures inhibits or slow down the growth of specific fungi and molds for fruits and species and decrease the biochemical processes during their storage, so the depreciation losses are greatly reduced.

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