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POST-HARVEST LOSSES OF PERISHABLE COMMODITIES CAUSED BY FUNGI IN MACEDONIA

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Abstract

Kiwifruit were stored after harvesting at O° C until soluble sugar content reached about 12% and flesh firmness about 5 kg. The bulk of fruits of each grower passed along rolling bars where fruits were selected and separated into two lots, either suitable for exportation or the local market. From both lots, those fruits unsuitable for the market for any reason, were separated and the *Botrytis*-rotted fruits were counted. From the results of this survey it is clearly shown that *Botrytis* rot is the predominant post-harvest cause of rotting, destroying approximately 1% of the fruits each year.

A survey of losses in market potatoes was made in vegetable stores of Thessaloniki on random samples of 100 tubers each (selected from several stores), while 25 such samples were taken totally originating from three potato areas of Greece. In each sample, rotted potatoes were counted and the cause of rotting was identified. *Fusarium* was the main cause of rot, damaging about 15% of tubers. *Verticillium tricorpus* and *Phialophora parasitica* were also among the causes of rotting identified for the first time in Greece.

Apple and pear samples collected randomly from several fruit stores were examined concerning the cause of rot only. Among the identified fungi *Colletotrichum* sp., *Stemphylium* sp. and *Penicillium glaucum* are reported for the first time as rot cause of apples and pears in Greece.

1. INTRODUCTION

Post-harvest rots from several fungi cause considerable losses, in almost all fruits, vegetables and cut flowers in many countries during storage or transportation (Hide, 1981; Sommer, 1982; Opgenorth, 198; Ceponis *et al*, 1987, 1988; Sive and Resnizky, 1987; Abdel-Rahim, 1988; Adicaram, 1988; Singh and Prashar, 1989; Snowdon, 1990; Agbor-Egbe and Richard, 1991; Böttcher and Pohle, 1991; Shaul *et al*, 1992; Niklis, 1994). In Greece there are very few studies concerning post-harvest diseases and only the control of the diseases was investigated in all cases (Economopoulos and Thanassoulopoulos, 1977, Chitzanides, 1985; 1989; Niklis *et al*, 1992; Niklis, 1994). There has been no research studying quantitative losses in

order to know the proportion lost and how much expensive would be the treatments to prevent these losses.

The present paper consists of three separate surveys attempting to study: 1. Loss assessment by *Botrytis* in stored kiwifruit, 2. Quantitative and qualitative loss assessment in market potato tubers and 3. Causes of rotting in market apple and pears.

2. MATERIAL AND METHODS

Kiwifruit are usually harvested during October, in the main area of cultivation, and stored at 0° C for 3-4 months until sugar soluble contents and flesh firmness reached about 12% and 5 kg respectively. The present work was carried out in a store-room located in Korinos Pierias of Central Macedonia. Sampling was made during processing of fruits for the market. The bulk of fruits of each grower was separated into two lots: 1. Fruits suitable for exportation and 2. Fruits suitable for the local market. In both lots fruits unsuitable for the market were manually separated. From these, *Botrytis*-rotted fruits and those suitable for the local market, found after the observation of external symptoms on kiwifruit, were separated and weighed. The examined samples were chosen randomly. Isolations from kiwis were also randomly made in order to confirm *Botrytis* presence.

Potato tuber losses were estimated surveying vegetable stores in Thessaloniki. Random samples of 100 tubers each were selected from several stores. 25 samples were taken totally, originating from three potato areas of Greece. In each sample, rotted tubers were counted and the cause of rotting in each tuber was identified by isolations made from the flesh area, including healthy and rotted tissues.

Rotted apple and pear samples were randomly collected from several fruit stores of Thessaloniki. The fruits were examined for the cause of rot only by isolations made from the procure in the pericarp including healthy and rotted tissues.

Isolations of fungi, in all three cases were made on PDA acidified with 0.25 lactic acid. The fungi grown in each colony were identified by traditional methods. If the identified fungus had not been reported in Greece then a pathogenicity test followed. Inoculations were made on injured and/or injured tubers and fruits. In either case, a rot of the tuber or the fruit followed the inoculation, then the fungus was considered to be at least a post-harvest pathogen.

3. RESULTS AND DISCUSSION

Loss assessment of kiwifruit by Botrytis cinerea in storage

The work was carried out the seasons 1993 and 1994. Samples of 64 467 kg the first year and 21 130 kg the second year were examined, in which a total of 982.1 kg and 135.1 kg were rotted by *B. cinerea* (Table 1). The quantity of *Botrytis*-rotted fruits was higher than the total unsuitable for the market fruits for the year 1994.

From our results it is clearly evident that *B. cinema* was the main cause of discarded fruits and that a proportion of *Botrytis*-infected fruits could escape workers inexperienced in disease symptoms, during fruit grading, especially in the early stages of disease development.

Table 1. Losses of kiwifruit by *Botrytis cinerea* during storage

	Total sampled	Total	Not marketable	
			Botrytis	rotted
Year	Kg	Kg	Kg	%
1993	64467	1452	982.1	1.52
1994	21130	98	135.1	0.64

Besides the direct losses because of fruit rotting, further rot development in a bulk of kiwifruit was strongly influenced by the presence of the fungus (Niklis *et al.*, 1992; Niklis, 1994) which could result in increased sensitivity and infection of the uninfected fruits because the ethylene mechanism production is triggered by the interaction of fruit and *Botrytis* causing faster ripening and an increase in sugars in the fruit, which is in turn a factor of increasing *Botrytis* infection.

Cause of rots and loss assessment in market potato tubers

Fusarium species were found to be the main pathogens causing post-harvest rots in market potato tubers, principally *F. roseum* according Snyder and Hansen (1940). A total of 15.21% rotted tubers were the result of *Fusarium* infections, not including tubers injured and presenting a *Fusarium* development on injured area, but without further rot. In another 1% of Soft Rots, the main cause of rot was impossible to be identified, but according to our experience, most of these rots also had *Fusarium* sp. as primary cause. Other rots found (Table 2) were due to downy mildew (*Phytophthora infestans*), *Verticilllium tricorpus* and *Phialophora parasitica*. Besides, losses due to the tuber rot, another 12% of tubers were qualitatively reduced because of Scab (*Streptomyces scabies*) and Black scurf (*Rhizoctonia solani*) attacks on tuber skin (Table 2).

Table 2: Rot agents causing losses in market potato tubers

	Losses			
	Quantitative		Qualitative	
Cause of rot	No.	%	No.	%
Dry rots (*Fusarium* spp.)	378	15.12	-	-
Soft rots	25	1.00	-	-
Downy mildew (*Phytophthora infestans*)	20	0.80	-	-
Verticillium tricorpus	26	1.04	-	-
Phialophora parasitica	24	0.96	-	-
Black scurf (*Rhizoctoni solani*)	-	-	176	7.04
Scab (*Streptomyces scabies*)	-	-	128	5.12

In table 3, losses are indicated according to the three areas from which the samples were originating.

Table 3: Quantitative and qualitative losses in market potato tubers from three areas in Macedonia

			Losses			
	Number of		Quantitative		Qualitative	
Area of sampling	Samples	Tubers	No	%	No	%
Nevrokopi	15	1500	314	20.9	236	15.7
Ano Vrondou	5	500	314	17.6	68	13.6
Orestiada	5	500	88	14.2	0	0
Total		2500	71	18.92		12.6

Finally, because the two fungi *V. tricorpus* and *P. parasitica* were identified for the first time in Greece (Thnassoulopoulos and Giapanoglou, 1994), the survey of the following year was made concerning rots caused by these two fungi only, as it is indicated in table 4.

Table 4: Losses caused by *Verticillium tricorpus* and *Phialophora parasitica* in market potato tubers

				Number of rotted tubers	
Area of sampling	Year	Samples	Tubers	V. tricorpus	P. parasitica
Nevrokopi	1993	15	1500	1.73	1.00
	1994	12	1242	1.60	3.14
Ano Vrondou	1993	5	500	0.00	1.80
	1994	3	303	0.33	0.90

From our results it is clearly evident that approximately a 31% of tubers in the market are not of excellent quality and a number of them are completely lost during home storage. Qualitatively losses are very significant, particularly in washed tubers, influencing the price in the market because of decreasing quality. In addition, the presence of *Fusarium* rot in a loft of potato tubers not only reduces the quantity of tubers because of the rot of them but, usually under home storage conditions, the rotted tubers are multiplied by infection of the tubers from the already infected ones and sometimes the total quantity of potatoes is destroyed.

The other two fungi *V. tricorpus* and *P. parasitica* at the present time do not seem to be a significant problem, but under favorable conditions for their growth they could be considered having the potential produce considerable losses.

Fungi causing rots in market apples and pears

From the isolations made from rotted apples and pears found in several fruit stores or in open market of Thessaloniki, were identified the fungi reported in Table 5. From these fungi, *A. alternata*, *Cladosporium sp.*, *Venturia inaegualis* and *Penicillium expansum* are very well known post-harvest parasites. The three fungi *Colletotrichum* sp., *Stemphyllium* sp. and *Penicillium glaucum* have not been yet reported on these hosts in Greece and for this reason all three fungi were tested in order to evaluate their pathogenicity. The pathogenicity test was evaluated on the same varieties of apple or pear or of both, in which the fungus had been found; all tests performed were positive.

Finally, the two fungi *Acremonium* sp. and *Penicillium* sp., the latter different from the two aforementioned *Penicillia*, were not pathogenic according to the pathogenicity test, so they were considered to be saprophytes on the rots produced from other causes.

Table 5: Fungi isolated from rotted apples and pears in the market

Fungi:	Isolated from:
1) Pathogenic:	
1. *Alternaria alternata*	Apples (Black Ben Davis, Golden Delicious, Starking Delicious Pears (Krystalli)
2. *Cladosporium* sp	Pears(Krystalli)
3. *Colletotrichum* sp. [*1]	Apples (Starking Delicious)
4. *Venturia inequalis*	Apples (Starking Delicious)
5. *Stemphylium* sp. *	Apples (Granny Smith)
6. *Penicillium expansum*	Apples (Black Ben Davis, Golden Delicious, Starking Delicious, Renetta, Mutsu) Pears (Krystalli, Passa Crassana, General Leclerc)
7. *Penicillium glaucum* *	Apples (Starking Delicious, Granny Smith, Jonathan, Renetta)
2) Isolated from rots	
1. *Acemonium* sp.	Pears (Krystalli)
2. *Penicillium* sp.	Apples (Starking Delicious, Granny Smith)

[1] The fungi noted with * are reported for the first time in Greece on these hosts

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