International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:6, No:9, 2012

An Example of post-harvest Thermotherapy as a non-Chemical Method of Pathogen Control on Apples of Topaz Cultivar in Storage

M. Grabowski, K. Macnar, J. Skrzyński

***Abstract*—**Huge losses in apple production are caused by pathogens that cannot be seen shortly after harvest. After-harvest thermotherapy treatments can considerably improve control of storage diseases on apples and become an alternative to chemical pesticides. In the years 2010-2012 carried out research in this area. Apples of 'Topaz' cultivar were harvested at optimal maturity time for long storage and subject to water bath treatment at 45, 50, 52, 55°C for 60, 120, 180 and 240 seconds. The control was untreated fruits. After 12 and 24 weeks and during so called simulated trade turnover the fruits were checked for their condition and the originators of diseases were determined by using the standard phytopathological methods. The most common originator of 'Topaz' apple infection during storage were the fungi of genus *Gloeosporium*. In this paper it was proven that for effective protection of 'Topaz' apples against diseases, thermotherapy by using water treatments at temperature range of 50-52°C is quite sufficient.

***Keywords*—**apple storage diseases, prolonged fruit storage, 'Topaz' apples, thermotherapeutic treatments.

I. Introduction

APPLE diseases that cannot be seen shortly after harvest and become noticeable only after prolonged storage cause huge losses in production [1]. This affects primarily apples coming from more and more common ecological growing systems where chemical plant protection is strongly restricted. Thus, it is justified to search for environmentally friendly methods of fruit disease control. It seems that post-harvest therapy may be quite promising for pathogens causing disease symptoms during fruit storage.

Post-harvest heat treatment is successfully used in disinfection and desinsectisation of increasing number of various plants, including fruits and vegetables [7]. In recent years it was proven that heat treatment can effectively control storage diseases on mangos [12], citrus fruits [11], peaches and nectarines [5], persimmons [10] and bananas [9]. For apples, thermotherapy by hot water treatments is considered to be one of the most efficient method of pathogen control in organic orchards [1], [16]-[17]. So far, experiments were focused mainly on the use of warm water baths to improve the fruit storage ability. Such treatments enable high flesh firmness to be maintained after storage and cause advantageous changes in extract content and apple acidity [6], [14].

Marek Grabowski, Department of Pomology and Apiculture, University of Agriculture, Al. 29 Listopada 54, 31-425 Kraków, Poland, (e-mail: m.grabowski@ogr.ur.krakow.pl)
Katarzyna Macnar, Department of Pomology and Apiculture, University of Agriculture, Al. 29 Listopada 54, 31-425 Kraków, Poland, (e-mail: katarzyna.macnar@gmail.com)
Jan Skrzyński, Department of Pomology and Apiculture, University of Agriculture, Al. 29 Listopada 54, 31-425 Kraków, Poland, (e-mail: jskrzy@ogr.ur.krakow.pl).

For establishing a new organic apple orchard, 'Topaz' cultivar is especially recommended due to its resistance to scab and flavour qualities [3], [15]. Bompeix and Cholodowski-Faivre [2] consider that susceptibility of various apple cultivars to heat treatment is differentiated. Thus, it is of utmost importance to establish the temperature ranges and durations of water baths for particular cultivars. The aim of this paper is to assess the suitability of 'Topaz' apples for post-harvest thermotherapy.

II. Material and Methods

In the years 2010-2012 at the Department of Pomology and Apiculture at the University of Agriculture in Kraków the experiments were carried out to find an effect of post-harvest baths on condition of apples in storage.

The test material consisted of apples of Topaz cultivar originated from the Experimental Station of the University of Agriculture in Garlica Murowana. Undamaged fruits showing no disease symptoms were plucked at random from various parts of apple tree-crowns at optimal maturity time for long storage and then treated in a water bath. The subject of the experiment was both temperature of thermotherapeutic treatment (45, 50, 52, 55°C), and exposition time (60, 120, 180, 240 seconds). In each test treatment 50 apples were used. The control was untreated fruits. Apples were stored in a standard cold storage room (temperature of 3°C, humidity of 92%) for 6 months in plastic crates placed on pallets and wrapped with polyethylene sheeting to reduce transpiration.

The fruits were checked for overall condition after 12 and 24 weeks in storage. The number of apples showing symptoms of fungal infestation was recorded and expressed in percentage of all stored fruits subject to the same treatment. Pathogenic fungi were identified based on disease symptoms caused by them as well on microscopic features of isolates taken from fungal cultures growing on a solidified potato dextrose agar (PDA). To isolate pure culture fungi from infected apples, the fragments of infected apples of 0.5 cm in diameter were cut within lesions and then subject successively to washing in distilled water (for 2 minutes), surface disinfection in 70% alcohol (for 4 minutes) and washing once again in distilled water (for 2 minutes), and afterwards they were left on a filter paper until drying. The fruit fragments decontaminated in such a way were put on the surface of solidified PDA in Petri dishes. The dishes were kept at temperature of about 21°C for 10-12 days. All the developed fungal cultures were split on PDA slants. After the next 10-12 days the fungal isolates developed on slants were grouped according to macroscopic comparisons and identified based on available mycological keys [4], [8].

In experiments also condition of 'Topaz' apples after thermotherapy was checked during so called simulated trade turnover. To do it at time of two analyses (after 12 and 24 weeks of storage) 10 fruits were chosen at random for each treatment and were kept in plastic crates for one week. Afterwards the number of apples showing infestation symptoms was recorded and the originators of infection were identified.

III. Results And Discussion

During the first year of experiment much severe infestation of stored fruits was recorded compared to that of the next analysed season (table I). In the control group 16% of apples showed symptoms of infection with fungal pathogens after 12 week in storage.

TABLE I
PERCENTAGE INFESTATION OF 'TOPAZ' APPLE CULTIVAR WITH PATHOGENS DURING STORAGE AT INDIVIDUAL DATES OF ANALTSIS

Treatment	Number of infested apples [%]							
	after 12 weeks		simulated trade turnover I		after 24 weeks		simulated trade turnover II	
	1 year	2 year	1 year	2 year	1 year	2 year	1 year	2 year
control	16.0	0.0	5.9	0.0	28.6	5.0	0.0	7.9
45°/60''	0.0	0.0	0.0	0.0	6.3	0.0	0.0	2.5
45°/120''	0.0	0.0	0.0	0.0	20.0	2.5	0.0	0.0
45°/180''	8.0	0.0	10.5	0.0	26.8	0.0	12.5	2.5
45°/240''	8.0	0.0	0.0	0.0	40.0	0.0	28.6	0.0
50°/60''	4.0	0.0	4.8	0.0	17.7	2.5	9.1	0.0
50°/20''	0.0	0.0	0.0	0.0	12.5	0.0	10.0	2.5
50°/180''	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0
50°/240''	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52°/60''	0.0	0.0	4.6	0.0	11.1	0.0	0.0	5.0
52°/120''	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0
52°/180''	0.0	0.0	0.0	0.0	6.7	0.0	10.0	0.0
52°/240''	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0
55°/60''	0.0	0.0	0.0	0.0	0.0	0.0	18.2	0.0
55°/120''	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55°/180''	0.0	0.0	0.0	0.0	6.7	0.0	10.0	0.0
55°/240''	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

In the second year of examination the symptoms of infection were recorded only after 24 weeks of fruit storage. Most likely this was related to weather conditions in the orchard in individual years.

In performed experiments the most common originator of 'Topaz' apple infection during storage were the fungi of genus *Gloeosporium* (83,9%), that cause lenticelrot (fig. 1). According to Auinger et al. [1] this disease can cause up to 50% fruit losses in storage rooms.

Bompeix and Cholodowski-Faivre [2] state that apples treated at appropriate high temperature directly after harvest and then stored in a storage room show only a minute infection with lenticelrot. Schirra et al. [13] claim that a lower fruit infestation with pathogens after thermotherapy is connected with high temperature that make germinating spores harmless, thus reducing the amount of effective inoculums.

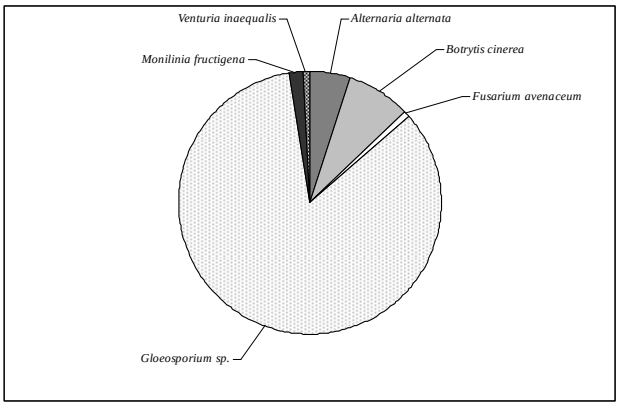

Fig. 1 Percentage share of fungi isolated from 'Topaz' apples in storage (%)

This is consistent with the results of experiments presented in this paper. At all dates of analysis the percentage of fruits infested with pathogens (including fungi of genus *Gloeosporium*) was significantly lower than that of the control combination for water treatment at temperature of 50°C and higher (fig. 2). However, an adverse effect of treatment temperature of 55°C on quality parameters of 'Topaz' apples was observed. He peel of fruits treated with water at that temperature (regardless of exposition time) was slightly creased already after 12 weeks in storage. This was probably connected with dissolving and washing off an epicuticular wax protective layer, thus enhancing transpiration.

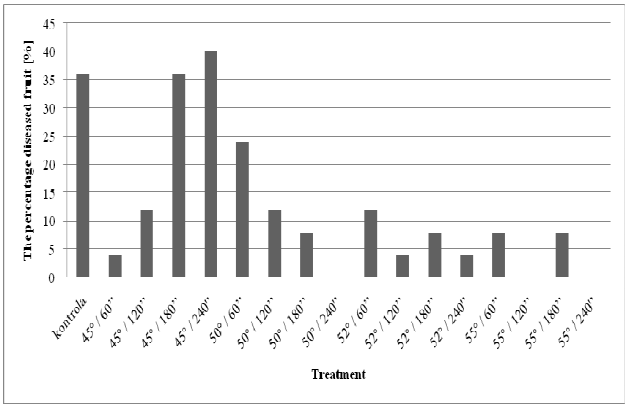

Fig. 2. Percentage infestation of 'Topaz' apples with pathogens during storage in the years 2010-2012

Trierweiler et al. [17] showed high efficacy of post-harvest water treatment at 53°C for 120 seconds in restricting infestation of 'Topaz' apples with pathogens. In this paper it was proven that for effective protection of 'Topaz' apples against diseases, thermotherapy by using water treatments at temperature range of 50-52°C is quite sufficient. In addition, by using lower temperatures it is possible to avoid an effect of fruit peel creasing during storage. The performed experiments confirm uniquely that Topaz apple cultivar is suitable for post-harvest fruit treatment in hot water bath to constraint incidence of storage diseases.

REFERENCES

[1] A. Auinger, B Trierweiler, F.K. Luecke, B. Tauscher, Influence of hot water treatment on different quality parameters of apples during storage, Journal of Applied Botany and Food Quality, vol. 79, no. 3, 154-156, 2005.
[2] G. Bompeix, D. Cholodowski-Faivre, Use of Thermotherapy and Natural Antifungal Compounds against Post Harvest Diseases on Apples, In: M. Boos (Ed.), Ecofruit - 10th International Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing, Weinsberg, Germany 31st January to 2nd February, 55, 2006.
[3] A. Czynczyk, A. Mika, P. Bielicki, A. Krawiec, Suitability, evaluation of several apple cultivars for organic fruit production. Journal of Fruit and Ornamental Plant Research, vol. 16, 7-15, 2008.
[4] M. Ellis, J.P. Ellis, Microfungi on Land Plants. An Identification Handbook, Macmillan. Publishing Company, New York, pp. 818, 1985.
[5] O.A. Karabulut, L. Cohen, B. Weiss, A. Daus, S. Lurie, S. Droby, Control of brown rot and blue mold of peach and nectarine by short hot water brushing and yeast antagonists, Postharvest Biol. and Technol. vol. 24, 103-111, 2002.
[6] J.D. Klein, S. Lurie, Heat treatments for improved postharvest quality of horticultural crops. Hort. Technology, vol. 2 no. 3, 316-320, 1992.
[7] S. Lurie, Postharvest heat treatments, Postharvest Biol. and Technol., vol. 14, 257–269, 1998.
[8] J. Marcinkowska J, Oznaczanie Rodzajów Grzybów Ważnych w Patologii Roślin, Fundacja. Rozwój SGGW, pp. 328, 2003.
[9] A. Mirshekari, P.Ding, J. Kadir, H.M. Ghazali, Effect of hot water dip treatment on postharvest anthracnose of banana var. Berangan, African Journal of Agricultural Research, vol. 7, no. 1, 6-10, 2012.
[10] A.E. Özdemir, E.E. Çandır, C. Toplu, M. Kaplankıran, E. Yıldız, C. Inan, The effects of hot water treatments on chilling injury and cold storage of fuyu persimmons, African Journal of Agricultural Research, vol. 4, no. 10, 1058 - 1063, 2009.
[11] R. Porat, A. Daus, B. Weiss, L. Cohen, E. Fallik, S. Droby, Reduction of postharvest decay in organic citrus fruit by a short hot water brushing treatment, Postharvest Biol. and Technol., vol. 18, 151–157, 2000.
[12] D. Prusky, Y. Fuchs, I. Kobiler, I. Roth, A. Weksler, Y. Shalom, E. Fallik, G. Zauberman, E. Pesis, M. Akerman, O. Ykutiely, A. Weisblum, R. Regev, L. Artes, Effect of hot water brushing, prochloraz treatment and waxing on the incidence of black spot decay caused by Alternaria alternata in mango fruits, Postharvest Biol. and Technol., vol. 15, no. 2, 165-174, 1999.
[13] M. Schirra, G.D D'hallewin, S. Ben-Yehoshua, E. Fallik, Host–pathogen interactions modulated by heat treatment, Postharvest Biol. and Technol., vol. 21, 71–85, 2000.
[14] J. Skrzyński, Prestorage heat treatment of apples, Vegetable Crops Research Bulletin, vol. 67, 197-202, 2007.
[15] I. Sosna, Growth and cropping of several scrab-resistant apple cultivars on six rootstocks, Acta Sci. Pol., Hortorum Cultus, vol. 4, no. 1, 109-118, 2005.
[16] I. Tahir, Control of pre- and postharvest factors to improve apple quality and storability. Doctoral thesis no. 2006:35, Acta Universitatis Agriculturae Sueciae, Alnarp, 63ss, 2006.
[17] B. Trierweiler, V. Gräf, H. Schirmer, B. Tauscher, Thermo-Behandlung ökologisch produzierter Äpfel zur Verbesser-ung der Lagerfähigkeit. Frischelogistik, vol. 1, no. 2, 34-36, 2003.