COMPARING PULSATED ULTRAVIOLET LIGHT AND POSTHARVEST FUNGICIDE FOR PEACH FRUIT DECAY CONTROL

C. H. Crisosto, X. Seguel
University of California, Davis
Pomology Department
Davis, CA 95616
U.S.A.

T. Michailides
University of California, Davis
Plant Pathology Department
Davis, CA 95616
U.S.A.

Additional index words : Fruit quality, skin blemish, *Botrytis cinerea, Monilinia fructicola*

Abstract

Decay control comparison between pulsated ultraviolet light (PUV) and postharvest fungicide was evaluated on commercially packed peaches. PUV (1J/cm^2) treated fruit had earlier and more severe *Botrytis cinerea* and *Monilinia fructicola* decay than the commercially postharvest fungicide treated fruit. The same results were obtained with wounded and not wounded inoculated fruit. Fruit quality measured at harvest and after simulated shipment was not affected by any of the treatments. However, a blemish developed on the surface of the peach fruits as a consequence of the PUV treatment. Water loss, carbon dioxide and ethylene production rates were higher on the PUV treated fruit than on the untreated fruit despite only treating a small portion of the total fruit with PUV. These results indicate that more detailed work on the effectiveness and safety of PUV as a fungicide replacement must be done before this technique can be used commercially.

Résumé

On a comparé le contrôle de la pourriture de pêches emballées commercialement après traitement par de la lumière ultra violette pulsée (PUV) ou par fongicide appliqué en post-récolte. Les fruits traités par PUV (1J/ cm^2) ont une dégradation plus rapide et plus sévère par Botrytis cinerea *et* Monilinia fructicola *que ceux traités par un fongicide après récolte. Les mêmes résultats ont été obtenus avec des fruits inoculés avec ou sans blessure. La qualité des fruits, mesurée à la récolte et après un transport simulé, n'a pas été affectée par aucun des deux traitements. Toutefois, des taches se sont développées à la surface des fruits traités par PUV. Les pertes en eau, les niveaux de production de gaz carbonique et d'éthylène, étaient plus élevés sur les fruits traités par PUV que sur les non traités même si seulement une petite portion de la totalité du fruit était traitée par PUV. Ces résultats indiquent qu'un travail supplémentaire plus détaillé, sur l'efficacité et l'innocuité du traitement PUV en remplacement d'un fongicide, doit être fait avant que cette technique puisse être utilisée commercialement.*

1. Introduction

Pulsated ultraviolet light (PUV) has been proposed as a treatment for decay control on peach and nectarine cultivars. The objectives of this study were to: 1) determine the effectiveness of PUV treatment on decay control and 2) evaluate the initial and postharvest quality of PUV treated fruit after different cold storage periods.

2. Materials and Methods

2. 1. Treatments

'Summer Lady', and 'O'Henry' peaches were subjected to the following treatments:

1. Commercial (fungicide and wax).
2. PUV after waxing, without fungicide.
3. PUV after waxing, with fungicide.

All fruit samples were collected from a commercial packinghouse near the University of California, Kearney Agricultural Center (Parlier, CA) and then transported to the Crocker Nuclear Laboratory in Davis, CA. The PUV illumination treatments were carried out at the Crocker Nuclear Laboratory. The PUV treatment of 248 nm UV photons (20 nsec pulses) was performed with the Complex 110 excimer laser operated at 30 KV with 10 Hz repetition rate. Energy fluence of 14 mJ/cm²-30 mJ/cm² was utilized for a total energy of 1J/cm² per sample. Time of exposure was 7±1 sec (timed with automatic timer). After PUV treatment, the fruit were immediately transported back to the F. Gordon Mitchell Postharvest building at Kearney Agricultural Center (Parlier), for quality evaluations and cold storage.

2. 2. Decay evaluation

To determine the effectiveness of localized PUV for decay control, fruit (18 per treatment) were marked on one cheek with a 2.5 cm diameter circle (this area represented ~1/32 of the total fruit surface area for peaches). Only this marked area was treated with PUV because of a limitation of the localized PUV emitter device. Fruit were treated according to the following summary (Table 1).

Table 1. Treatment Summary

Cultivar	Wax+ Fungicide	Wax + PUV	Wax + Fungicide + PUV	PUV	Inoculated with Wound	Drop	Inoculum
'Summer Lady'	+	+	+		+	+	*M. fructicola*
Peach	+	+	+		+	+	*B. cinerea*
'O'Henry' Peach	+		+		+		*M. fructicola*

The inoculum consisted of one drop (40µl) from a spore suspension of 25,000 cfu/ml of *Botrytis cinerea* or 20,000 cfu/ml for *Monilinia fructicola* (Michailides' protocol 1995). After inoculation, fruit were precooled to 0°C for at least 20 h and then the marked area was treated with PUV (1J/cm^2). After PUV treatment, the fruit was held in cold storage for 10 days (0°C, 85% RH), then moved to room temperature (20°C, 95% RH) to observe decay development. Decay development was evaluated daily as incidence (%) and intensity (mm^2).

2. 3. Quality and storage potential evaluation

Quality evaluations included measurement of visual blemishes, flesh firmness, soluble solids concentration (SSC), acidity (TA), pH at harvest and after cold storage. Ten fruit per cultivar were evaluated at harvest (initial evaluation). Flesh firmness was measured using a U.C. firmness tester with an 8 mm tip for stone fruit. SSC was measured using an Atago temperature compensated refractometer. To measure acidity, five grams of juice were weighed into a beaker and 20 ml of distilled water added and the pH measured. The samples were titrated with 0.1N sodium hydroxide (NaOH) to an end point of pH 8.2, and the acidity expressed as the percent malic acid.

After localized PUV treatment 'O'Henry', and 'Summer Lady' (18 fruit per treatment) were handled under the following temperature regimes:

1. 2 days at 20°C
2. 15 days at 0°C + 3 days at 20°C
3. 30 days at 0°C + 3 days at 20°C

Following these temperature regimes SSC, TA, pH, and skin cosmetic damage on fruit treated with PUV were evaluated as well as symptoms of internal breakdown according to Crisosto's protocol.

2. 4. Respiration and ethylene production rates

Carbon dioxide (CO_2) evolution and ethylene (C_2H_4) production of 'Summer Lady' peaches were measured for all treatments. Five fruit from each treatment were placed in individual sealed, modified 1.5 pint plastic containers attached to a flow board and held at 20°C. Air flow through the sample jars was adjusted using the flow board to avoid high CO_2 accumulation. Fruit were allowed to equilibrate for 24 h, then air samples were taken from the outlets of the jars every other day for five days. Carbon dioxide concentrations in the gas samples were measured with a Horiba infrared CO_2 gas analyzer and C_2H_4 concentrations with a Carle gas chromatograph equipped with a flame ionization detector. Respiration and ethylene production rates were calculated from the gas concentrations, fruit weights, and air flow rates.

2. 5. Fruit water loss

Groups of 18 fruit per treatment from each cultivar were carefully weighed after treatment and placed in a temperature-controlled room (0°C, 85% RH). Fruit were re-weighed after 15 and 30 days. Water loss was calculated as the percent reduction in weight from the original weight.

3. Results and discussion

3.1. Decay evaluations

On 'Summer Lady' peach wound inoculated + PUV treated, the first visible symptoms of *Botrytis cinerea* decay were observed after 4 days storage at 20°C (Fig. 1) and after 8 and 13 days at 20°C, *Botrytis* was visible on the fungicide + PUV and fungicide treated fruit respectively. Fruit treated with fungicide + PUV showed more decay and developed it earlier than fruit treated with just fungicide. Decay intensity of the fungicide treated fruit was low. Decay scores were higher in the PUV treated fruit than in fruit from the fungicide + PUV treatment.

On 'Summer Lady' peach fruit inoculated with *Botrytis cinerea* (not wounded), the first visible symptoms of decay were observed after 7, 10 and 15 days at 20°C on the fruit from the PUV, fungicide + PUV, and fungicide treatments, respectively (Fig. 2). Decay developed earlier and with greater intensity on fruit treated with PUV + fungicide than on fruit only treated with fungicide. Decay intensity and score for both fungicide treatments was lower than for the PUV treatment. A similar situation occurred on 'O'Henry' peaches.

3. 2. Quality and storage potential evaluations.

On 'Summer Lady' peach there were no differences between the PUV, fungicide + PUV, or the fungicide treatments with respect to SSC, TA, pH, SSC:TA, or flesh firmness measured immediately after the PUV treatment (data not shown). The same occurred after 15 days cold storage. By 30 days cold storage, localized PUV applications with or without fungicide reduced fruit browning. Flesh mealiness symptoms became visible after 30 days cold storage, but there were no differences between the treatments. In approximately 70% of the 'Summer Lady' fruit (data not shown), skin burning was observed after 15 days cold storage in both of the PUV treatments. Skin burning symptoms were observed on wounded + PUV and not wounded + PUV treated fruit after 3 days at 20°C (Fig. 3a). Eighty percent of the PUV treated 'Summer Lady' fruit had skin burning symptoms. These symptoms were never observed on fruit without PUV treatment.

On 'O'Henry' peach. There were no differences between the fungicide or fungicide + PUV treatments with respect to SSC, TA, pH, SSC:TA, or flesh firmness measured immediately after the PUV treatment (data not shown). The same occurred after 15 and 30 days cold storage. On these evaluation dates, localized PUV did not affect peach storage potential. Flesh mealiness and browning symptoms became visible after 15 days cold storage, but there were no differences between the treatments. In approximately 60% of the 'O'Henry' peaches, skin burning was observed after 15 days cold storage in the PUV treatment (data not shown). Skin burning symptoms were observed on PUV treated fruit after cold storage plus 3 days at 20°C (Fig 3b). Approximately 80% of the 'O'Henry' peaches had skin burning symptoms after 15 days cold storage followed by 5 days at 20°C. These symptoms were never observed on fruit from the fungicide treatment without PUV.

3. 3. Respiration and ethylene production rates.

On 'Summer Lady' peach respiration and ethylene production rates measured for a 5 day period after treatment were lower on the fungicide treated fruit (control) than on fruit from the fungicide + PUV treatment (Fig. 4). Localized PUV treated fruit produced approximately 18% more CO_2 and approximately 50% more ethylene than fruit not treated with PUV. These differences in physiological activity between the not PUV and PUV treated fruit (only 1/32 of the total fruit area was treated with PUV) suggests that the quality and the storage potential of fruit treated with PUV over their entire surface may be reduced. A similar situation happened with 'O'Henry' peach. Further studies on the effect of completely PUV treated fruit on storage performance should be pursued.

3. 4. Fruit water loss.

PUV treated 'O'Henry' peaches had a higher rate of water loss than fruit not treated with PUV at 15 days but not after 30 days of cold storage (data not shown). For 'Summer Lady' peaches (data not shown), the rate of water loss was similar for from the fungicide + PUV and PUV treatments after 15 and 30 days cold storage.

4. Conclusions

1. PUV ($1J/cm^2$) treated peach fruit had significantly earlier and more severe decay development than the commercially postharvest fungicide treated fruit.
2. PUV applied under these conditions to peaches did not control *Monilinia fructicola* (data not shown) and *Botrytis cinerea* under the cuticle (wounded, Fig. 1) or on the surface (not wounded, Fig. 2) of the fruit despite causing skin discoloration.
3. Fruit quality measured at harvest and after simulated shipments was not significantly affected by any of the localized PUV treatments.
4. PUV induced a significant discoloration on the surface of peach fruit. This blemish will be a cause of rejection according to the United Standards for Grades.
5. Water loss rates, carbon dioxide and ethylene production rates were higher on the localized PUV treated fruit than on the untreated fruit in spite of only small portion of the total fruit being treated with PUV (Fig. 4).
6. These results indicate that more detailed work on the performance of PUV as a replacement for fungicide need to be done before commercial use is attempted in peaches and nectarines.

References

Michailides T. J., Morgan D. P., Holtz B. A., Liyun Guo, Chuan Hong, Crisosto C. H., Johnson R. S. and Andris H., 1995. Cultural and chemical controls of preharvest and postharvest brown rot of peach, nectarines, and plums, and mucro rot of late varieties of nectarines and plums. 1995 Research Reports, California Tree Fruit Agreement, pp. 86-101.

Crisosto C. H., Scott Johnson R., Luza J. G. and Crisosto G. M., 1994. Irrigation regimes affect fruit soluble solids concentration and rate of water loss of 'O'Henry' peaches. HortScience 29(10):1169-1171.

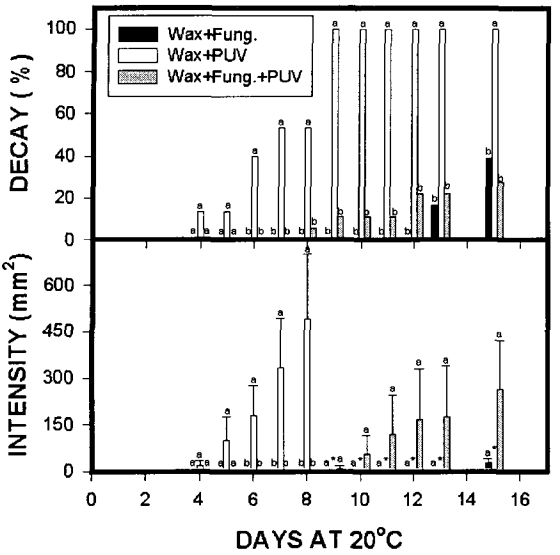

Figure 1 - Decay development on wounded and *Botrytis cinerea* inoculated 'Summer Lady' peaches measured during a warm period (20°C, 95% RH) after 10 days cold storage (0°C, 85% RH). Different letters indicate significant difference between treatments on that evaluation date by $LSD_{0.05}$; * = treatment completely decayed, no data collected.

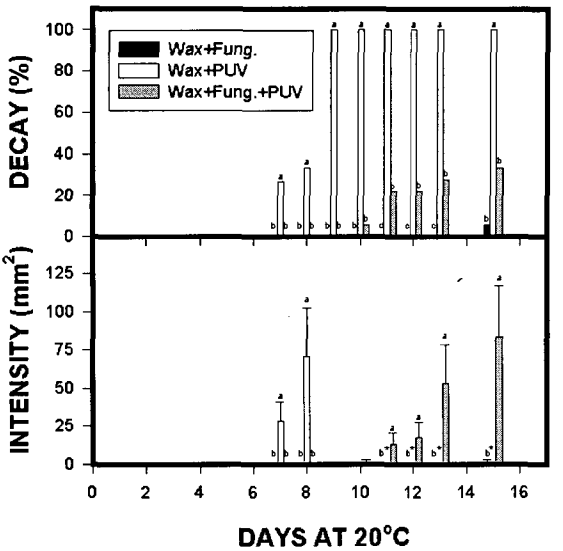

Figure 2 - Decay development on *Botrytis cinerea* inoculated (not wounded) 'Summer Lady' peaches measured during a warm period (20°C, 95% RH) after 10 days cold storage (0°C, 85% RH). Different letters indicate significant difference between treatments on that evaluation date by $LSD_{0.05}$; * = treatment completely decayed, no data collected.

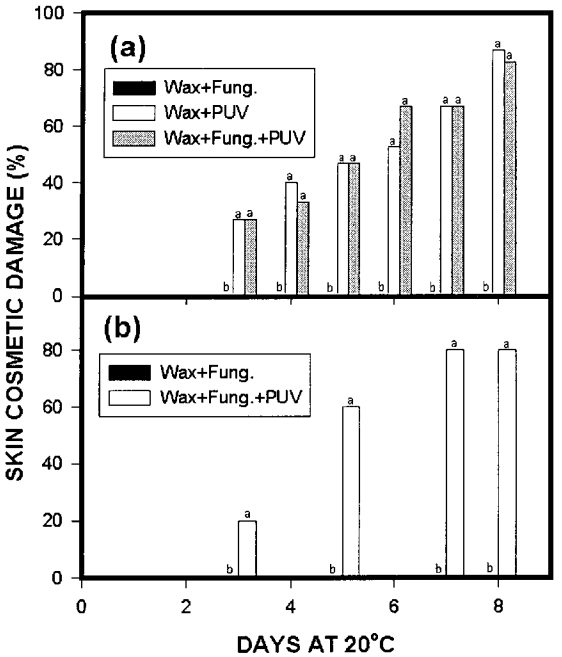

Figure 3 - Skin cosmetic damage on PUV treated and control (a) 'Summer Lady', and (b) 'O'Henry' peaches evaluated during display at 20°C. Different letters indicate significant difference between treatments on that evaluation date by Fisher's Exact Test, $P = 0.05$.

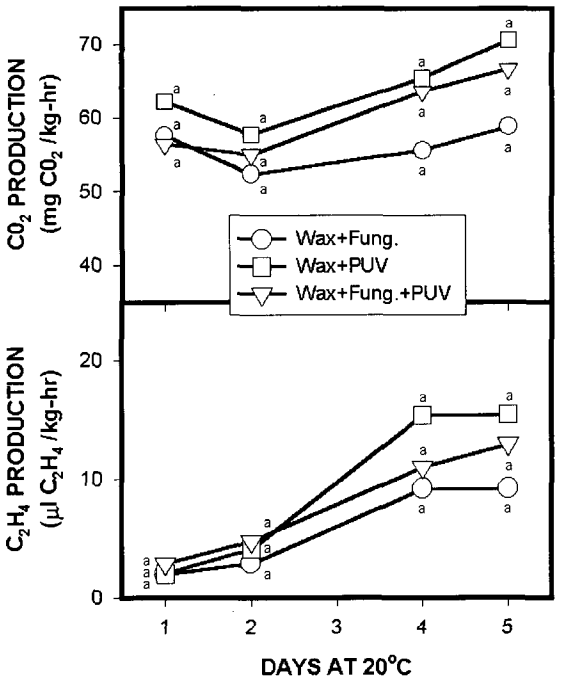

Figure 4 - Pattern of CO_2 and C_2H_4 production of 'Summer Lady' peaches after treatment during storage at 20°C. Different letters indicate significant difference between treatments on that evaluation date by $LSD_{0.05}$.