



HOKKAIDO UNIVERSITY

Title	Potential Benefits of Using Hydrogen Peroxide in Crop Production Systems
Author(s)	Lin, W.C.; Block, G.S.
Relation	国際会議「持続可能な農業と環境」．平成20年7月2日～平成20年7月6日．札幌市
Issue Date	2008-07-04
Doc URL	https://hdl.handle.net/2115/34423
Type	conference presentation
File Information	31-033.pdf



Potential Benefits of Using Hydrogen Peroxide in Crop Production Systems

W. C. Lin and G. S. Block

Agriculture and Agri-Food Canada

Pacific Agri-Food Research Centre

Agassiz, BC, Canada



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Why Hydrogen Peroxide (H₂O₂)?

Crop stress

- Crop plants subject to various stresses in their life cycle
- Crops develop stress tolerance or lose yield
- Most stresses are related to oxidative stress

H₂O₂

- Low concentration – a signaling compound
- High concentration – toxic causing cell death

In this presentation

- Can exogenous H₂O₂ reduce chilling injury?



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Why Chilling Injury?

Greenhouse vegetables – chilling sensitive

- Tomatoes
- Cucumbers
- Sweet peppers

Chilling sensitivity – storage temperature of higher than 10°C is recommended

Consequence of chilling injury ($< 10^{\circ}\text{C}$)

– Decay



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Chilling Injury – symptoms and cause

Symptoms of chilling injury

- Pitting
- Decay
- Other (e.g. reduced radicle elongation)

Symptoms – most obvious after returning to room temperature

Causes – reactive oxygen species (ROS)



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Objectives – H₂O₂ to Reduce Chilling Injury

Chilling stress

- Experimental plant – sweet potato
- Greenhouse crop – sweet pepper

Sweet potato – leaves and shoots (during production)

- Chilling injury < 10°C

Sweet peppers – colored fruits (during storage)

- Chilling injury < 7°C
- Decay, high CO₂, high C₂H₄
- *Alternaria* rot (< 7°C)
- *Botrytis* decay (< 4.5°C)

Sweet potato and sweet peppers – used in our study



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Sweet Potato – Leaf

(Injury index of 0 to 5 after 3 days at 2.5°C followed by 3 days at room temperature)

H ₂ O ₂	Non-chilled	Chilled
0 mM	0.12	2.25
15 mM	0	0.38

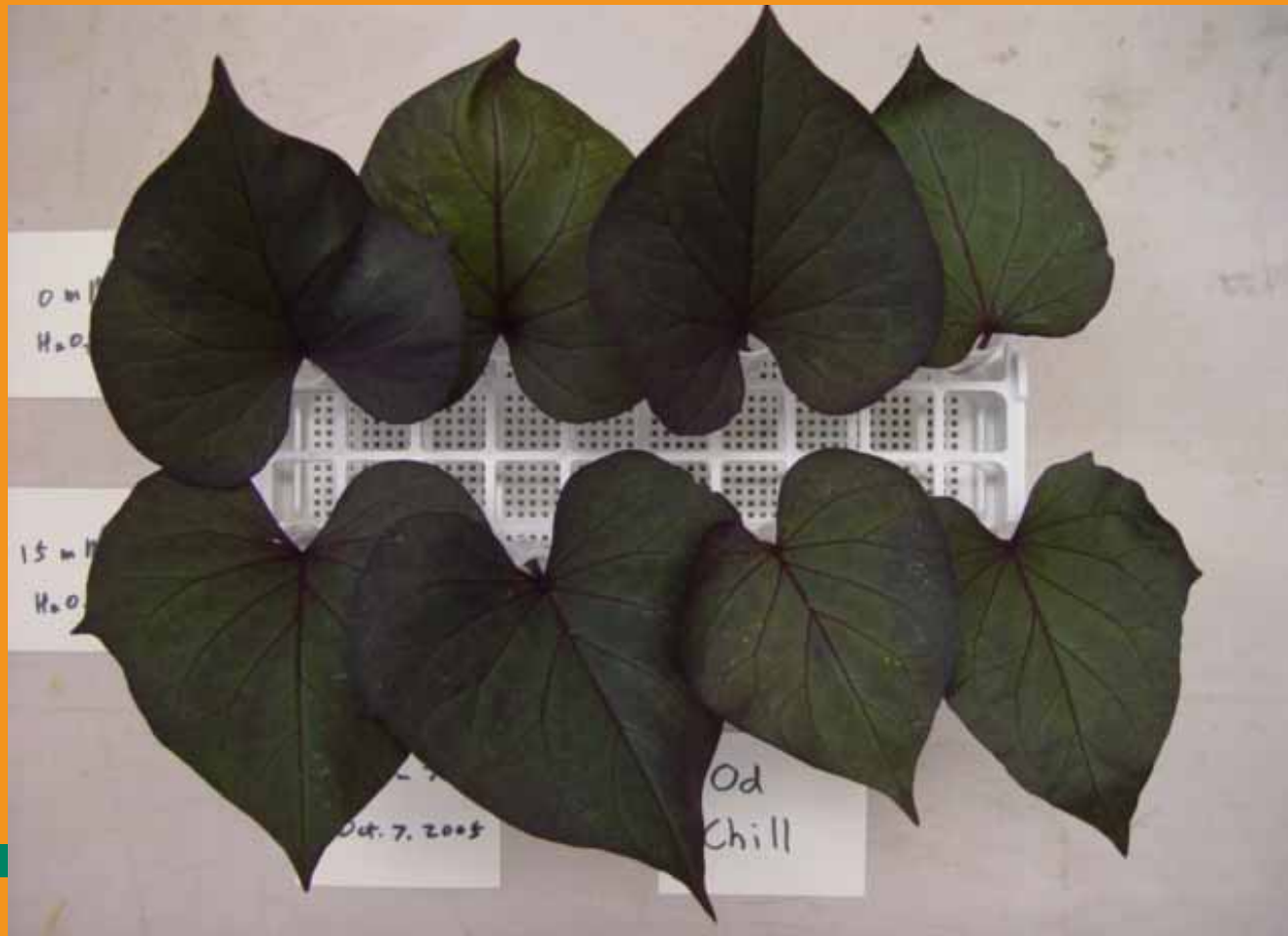


Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Sweet Potato – Leaf (Non-Chilled)



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Sweet Potato – Leaf (Chilled)



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Sweet Potato – Shoot Tip (3-day chill at 2.5°C followed by 2 or 7 days at 20°C)

150 mM H₂O₂ + 16h photoperiod
Increased antioxidant capacity
(ORAC) of chilled shoot tips
2 days after chilling

150 mM H₂O₂ + 16h photoperiod
Reduced injury index of chilled
shoot tips
7 days after chilling

Fig. 2A - ORAC-d9 affected by photoperiod and H2O2 conc

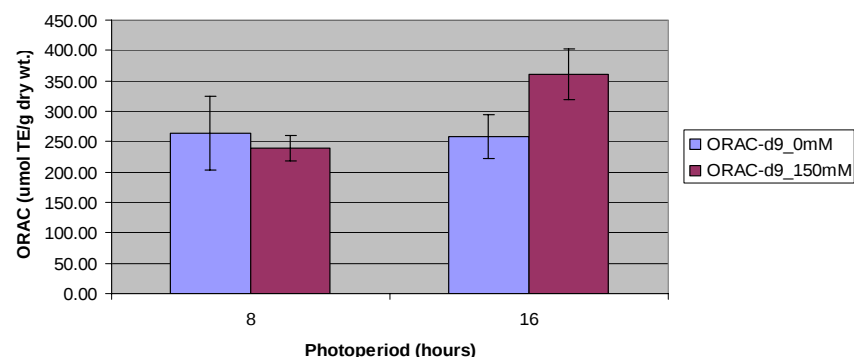
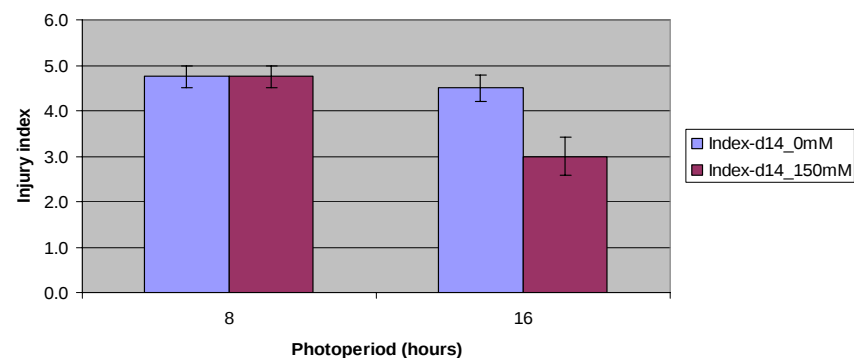


Fig. 2B - Injury Index affected by photoperiod and H2O2 conc



Agriculture and
Agri-Food Canada

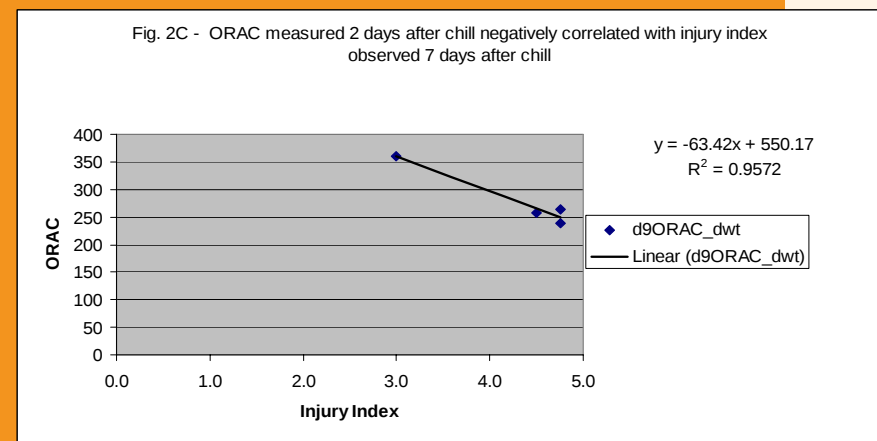
Agriculture et
Agroalimentaire Canada

Canada

Sweet Potato – Shoot Tip (3-day chill at 2.5°C followed by 2 or 7 days at 20°C)

Negative correlation between antioxidant capacity (ORAC) and chilling injury

Increase of ORAC preceded the reduction of injury index



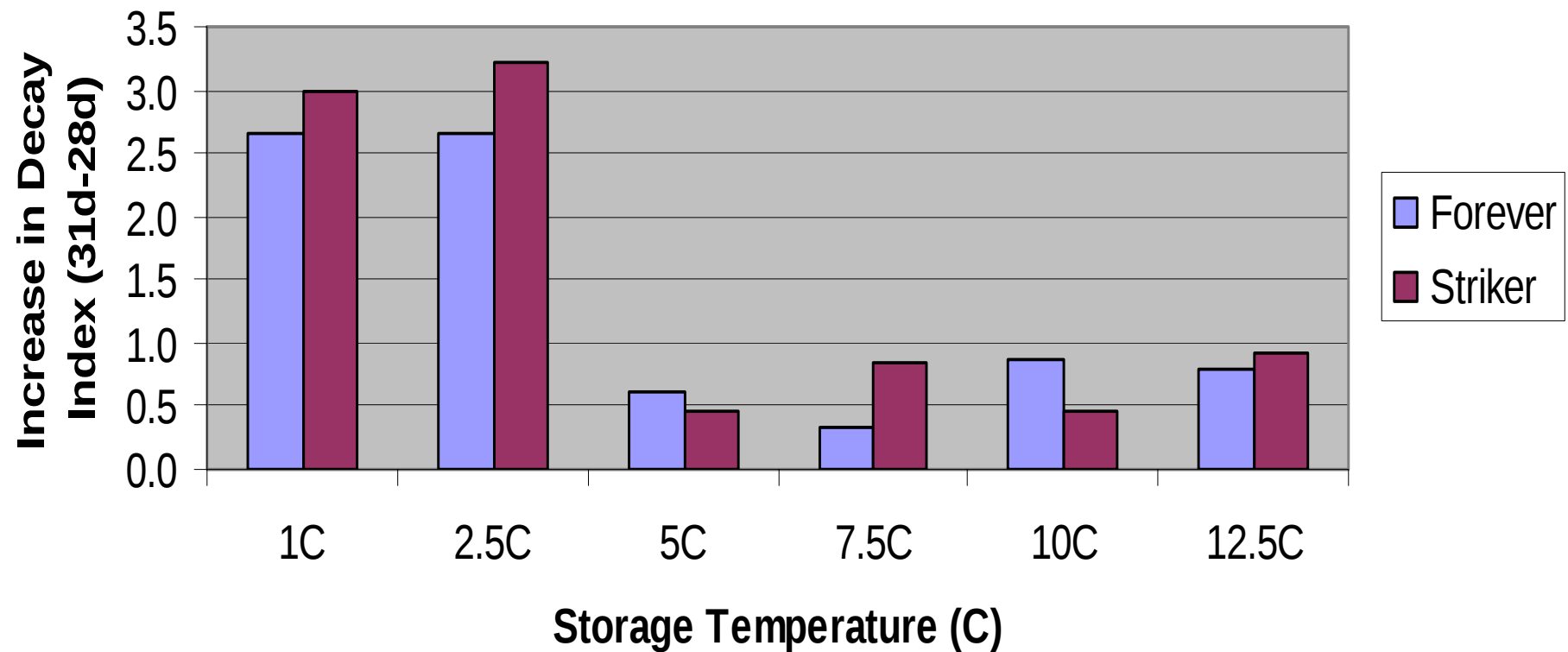
Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Sweet Pepper - Commercial Harvests

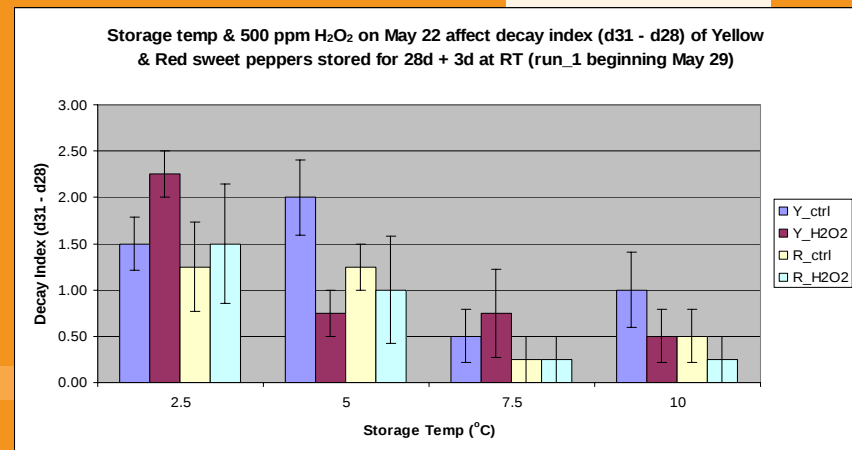
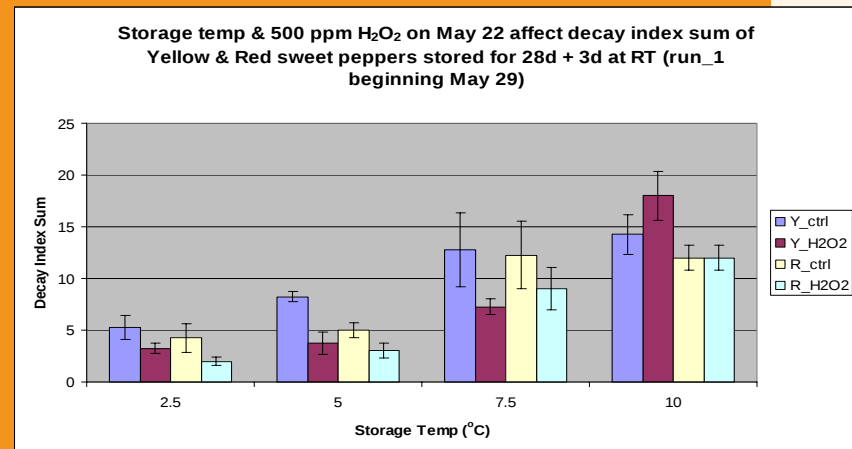
Increase in Decay Index after Storage - Commercial Harvests



Effects of pulsed 500 ppm H₂O₂ (ca. 14.7 mM) on decay of stored sweet peppers

H₂O₂ decreased the decay of stored sweet peppers

At 2.5° or 5°C, chilling injury occurred



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Sweet Pepper – Fruit (decay index after 4-week storage plus 3 days at room temperature)

Weeks after pulse H ₂ O ₂ application	2.5°C	5.0°C	7.5°C	10.0°C	
Week 1	4.6	6.9	13.6	21.8	
Week 2	6.0	8.5	15.3	17.7	
Week 3	7.5	12.7	17.4	19.9	



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

H₂O₂ – Induced Chilling Tolerance

Survival rate: after a 36h, 4°C chilling stress

- 8°C pre-treated seedlings – 97 %
- H₂O₂ pre-treated seedling – 71%
- Control (25°C) – 33%

Chilling of mung bean seedlings induces symptoms of oxidative stress. Both acclimation at 8°C and H₂O₂ pre-treatment stimulate protective mechanisms that alleviate chilling stress. Glutathione is an essential, but not the only, protective compound.

Yu et al., 2002. H₂O₂ treatment induces glutathione accumulation and chilling tolerance in mung bean. *Funct. Plant Biol.* 29: 1081-1087.



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

H₂O₂ – Induced Salt Tolerance

Barley: 5 – 25 mM H₂O₂ induced maximal accumulation of osmoprotectant (e.g. glycinebetaine)

Rice: 10 µM H₂O₂ enhanced salt tolerance in rice seedlings

Tomato: 50 mM H₂O₂ increased sugar content in tomato fruit by 1.5 fold

Uchida et al. 2006. Induction of biosynthesis of osmoprotectants in higher plants by hydrogen peroxide and its application to agriculture, in A.K. Rai and T. Takabe (eds.), *Abiotic Stress Tolerance in Plants*, 153-159, Springer, The Netherlands.



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Conclusion – Our Study Indicates

Sweet Potato – H_2O_2 increased chilling tolerance of excised leaves (15 mM H_2O_2) and shoot tips (150 mM H_2O_2)

Sweet Pepper – pulsed 500 ppm H_2O_2 (14.7 mM) application in greenhouse decreased storage decay at 2.5 or 5°C

Beneficial effects of H_2O_2 appear to vary with environments under which crop plants are grown

Careful experiments are necessary to define parameters of practical uses of H_2O_2 in crop production systems



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Pacific Agri-Food Research Centre, Agassiz, British Columbia, Canada



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada