The effects of netting, fruit position and maturity on the development of soft scald in *Malus domestica* 'Honeycrisp' during storage

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Background

In 1999, 'Honeycrisp' was first planted in Washington State, USA. Superior returns have spurred feverish planting of new orchards. Strong demand helped market the crop within three months during the first decade of production in Washington, well before major storage problems arose. To date, long term storage remains a gamble, since packouts can suffer dramatically due to rising incidences of physiological disorders such as bitter pit and soft scald (Figure 1).

OBJECTIVE: The purpose of this study was to investigate the influence of fruit position, harvest sequence and light environment on the occurrence of soft scald during storage of *Malus domestica* 'Honeycrisp' apples.

Materials and Methods

- Fruit was harvested from a 10 year old commercial 'Honeycrisp' apple orchard trained as multiple leader V-trellis (0.6 m x 3.9m spacing) near Gleed, WA in 2015.
- Three fruit positions within the tree were investigated: top (2.1 meters above ground), middle (1.5 meters) and bottom (1.2 meters).
- Fruit was harvested three times in weekly intervals under netting (Extenday™, 20% reduction in radiation) and control (no netting) (Figure 2).
- After harvest, fruit was analyzed using standard maturity indicators (soluble solids content, titratable acidity, firmness and starch index).
- The remaining fruit was stored in a commercial cold room for three months at 0.5 °C and semi-weekly measurements of the DA-index and soft scald occurrence (absent/present) were performed.

Results

Table 1: Selected maturity parameters at harvest time in 2015 (mean ± SD, n = 10, different letters indicate statistical significance (Tukey test, α = 0.05)).

Pick	Fruit position	Treatment	Starch (1-6)	Weight (g)	Background color (1-4)	Red color (1-4)	Firmness (lbs)	SSC (%)[1]	TA (% malic acid)[1]
1st	top	control	2.5± 0.9 ab	167± 44 a	1.9± 0.7 ns	3.2± 0.5 a	16.9± 1.4 a	12.3± 0.5 a	0.57± 0.06 ab
		netting	3.5± 1.2 ab	157± 36 ab	1.9± 0.9 ns	2.6± 0.7 ab	15.9± 1.4 c	12.1± 0.6 ab	0.49± 0.06 ab
	middle	control	3.1± 1.1 ab	143± 28 ab	1.8± 0.8 ns	2.8± 0.5 ab	16.5± 1.7 ab	12.2± 0.5 a	0.53± 0.06 ab
		netting	3.6± 1.4 a	145± 29 ab	1.6± 0.8 ns	2.6± 0.5 ab	15.5± 1.1 c	12.0± 0.5 ab	0.47± 0.04 b
	bottom	control	2.2± 1.2 b	129± 24 ab	1.4± 0.5 ns	2.2± 0.7 ab	16.8± 1.1 a	12.0± 0.6 ab	0.58± 0.08 a
		netting	2.4± 1.2 ab	117± 23 b	1.2± 0.6 ns	2.0± 0.9 b	16.1± 1.1 bc	11.3± 0.7 b	0.54± 0.04 ab
		Pr>F							
2nd	top	control	4.4± 0.9 ab	210± 41 a	1.6± 0.7 ns	3.5± 0.6 a	14.3± 1.4 ns	13.2± 0.5 a	0.51± 0.05 ns
		netting	4.1± 1.2 ab	183± 45 ab	1.8± 0.7 ns	3.5± 0.5 a	15.1± 1.8 ns	12.7± 0.4 b	0.50± 0.06 ns
	middle	control	4.4± 0.9 ab	170± 35 ab	1.8± 0.8 ns	3.1± 0.6 ab	14.2± 1.1 ns	12.7± 0.4 b	0.50± 0.04 ns
		netting	4.7± 1.0 a	168± 32 ab	1.6± 0.7 ns	3.1± 0.5 ab	14.8± 1.2 ns	12.1± 0.5 c	0.50± 0.04 ns
	bottom	control	3.9± 1.4 ab	139± 24 b	1.5± 0.7 ns	2.5± 0.9 b	15.1± 1.0 ns	12.1± 0.6 c	0.52± 0.04 ns
		netting	3.4± 1.2 b	139± 32 b	1.3± 0.5 ns	2.5± 0.6 b	15.0± 1.4 ns	11.7± 0.4 c	0.52± 0.04 ns
		Pr>F							
3rd	top	control	5.0± 0.6 ns	168± 39 b	2.9± 1.0 ns	3.4± 0.7 ns	14.4± 1.0 ns	13.7± 0.4 a	0.49± 0.04 ab
		netting	4.8± 0.5 ns	224± 63 a	2.7± 0.7 ns	3.1± 1.0 ns	14.4± 1.0 ns	13.8± 0.5 a	0.54± 0.05 a
	middle	control	5.2± 0.4 ns	169± 44 b	2.3± 0.9 ns	3.0± 0.7 ns	14.3± 1.0 ns	13.2± 0.5 b	0.45± 0.06 b
		netting	4.8± 0.7 ns	173± 39 b	2.6± 0.7 ns	2.7± 0.8 ns	14.7± 1.1 ns	13.2± 0.4 b	0.52± 0.05 a
	bottom	control	4.9± 0.5 ns	142± 36 b	2.2± 0.8 ns	2.4± 0.8 ns	15.1± 1.4 ns	12.9± 0.6 b	0.48± 0.06 ab
		netting	4.9± 0.6 ns	142± 35 b	2.5± 0.9 ns	2.7± 0.9 ns	15.0± 1.0 ns	13.0± 0.4 b	0.53± 0.04 a
		Pr>F							

[1] Significance based on arcsine data transformations

Figure 1: Example of soft scald symptom appearance on Honeycrisp apples after 3 months of storage under refrigeration (0.5 °C)

Figure 2: Layout of the orchard drape netting in a commercial 'Honeycrisp' apple orchard trained as multiple leader V-trellis (0.6 m x 3.9m spacing) near Gleed, WA in 2015

Fruit quality of Honeycrisp apples was affected by fruit location within the tree, picking date, and netting (Table 1). For example, apples had the highest amount of red color when grown in the top canopy. While firmness decreased with advanced harvest date (regardless of fruit position or netting), fruit from the first pick was firmest when grown without net. Both, fruit location within the tree and picking sequence affected soluble solids content. Fruit from netted sections were indistinguishable for sweetness from fruit grown without shade net. Titratable acidity decreased with advanced maturity. Fruit from netted sections had significantly higher titratable acidity levels at the time of the third pick. Starch degradation pattern and background color remained largely unaffected by any of the treatments imposed during this experiment.

The first soft scald symptoms were observed two weeks after harvest (Figure 3). At the conclusion of the study, fruit with advanced maturity at harvest (third pick) showed higher incidence of soft scald (up to 79 %) than samples from the first (0 %) and second (4 - 8 %) pick (Figure 3 and 4). Furthermore, fruit position within the tree influenced the onset and the severity of soft scald symptoms. For example, fruit from the third pick, showed a higher soft scald occurrence (79 %) in fruit samples from the bottom than the fruit from the middle (54 - 58 %) and top (33 %) part of the canopy. There was no significant difference between the netting and control treatment (Figure 3 and 4).

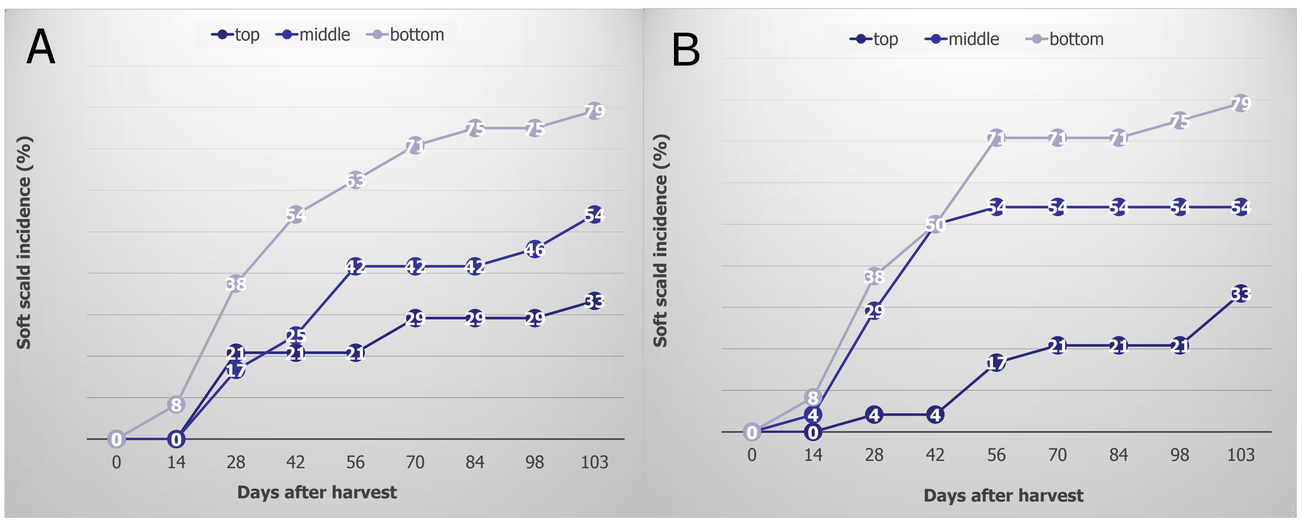

Figure 3: Development of soft scald in Honeycrisp apples during 3 months of storage under refrigeration (0.5 °C). Fruit was picked at 3 different locations of the tree (top (2.1 meters above ground), middle (1.5 meters) and bottom (1.2 meters)) and grown with (B) and without shade net (B). Only results of third pick are shown.

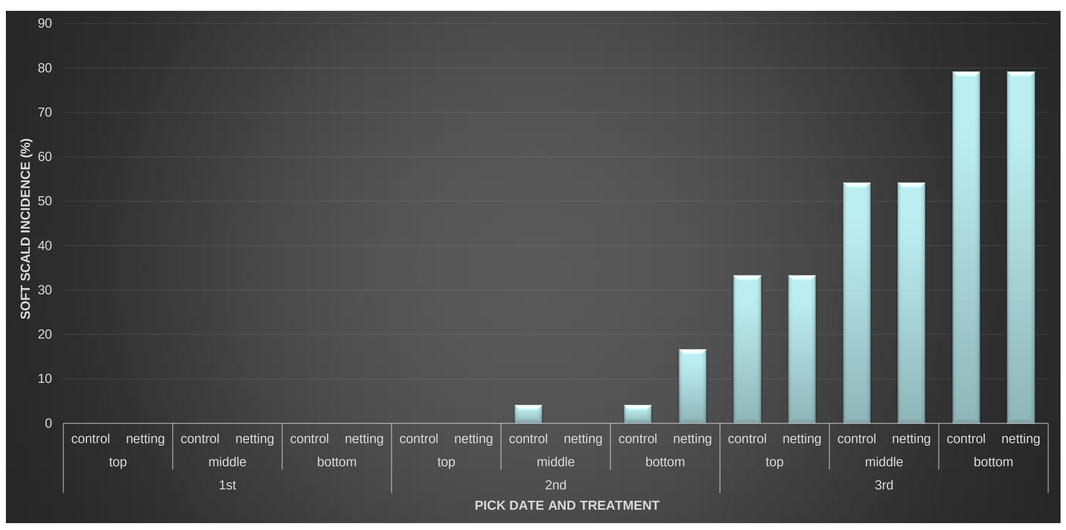

Figure 4: Incidence of soft scald (in %) in Honeycrisp apples after 3 months of storage under refrigeration (0.5 °C). Fruit was picked at 3 different locations of the tree (top (2.1 meters above ground), middle (1.5 meters) and bottom (1.2 meters)), grown with and without shade net, and picked three times.

Conclusions

- The possibility to improve postharvest performance of 'Honeycrisp' apples based on orchard criteria or harvest fruit quality remains complicated.
- However, this study shows that chilling injury sensitivity (such as soft scald) is not only related to fruit maturity as reported by others (Watkins, et. al. 2004). Light environment and fruit position within the tree also influence the potential of fruit for the development of chilling related physiological storage disorders.

Watkins, C., J.F. Nock, S.A. Weis, S, Jayanty, R.M. Beaudry. 2004. Storage Temperature, diphenylamine, and pre-storage delay effects on soft scald, soggy breakdown and bitter pit of 'Honeycrisp'™ apples. Postharvest Biology and Technology.32:213-221.

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