HIGH PRESSURE WASHING AND ORGANOSILICONES: IMPROVEMENTS AND IMPACTS ON PEAR QUALITY, PATHOGENS, AND SURFACE ARTHROPODS

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The use of high pressure washer in the apple and pear industry in the Pacific Northwest became increasingly popular after the advent of Surround, or kaolin clay applications to control small arthropods and sunburn. However, these spray systems employed a closed loop, recirculating water stream. While this system saves water usage in the packing line, it became apparent that it was also a reservoir for decay pathogens. When high levels of decay pathogens accumulated in the reservoir, they spread throughout the load as it was passed under the high pressure sprays. Pears, being especially susceptible to decay, were eventually not used in this system.

Another problem with commercially processed and packed apples and pears is the presence of surface arthropods. In many cases, an upper tolerance level of 5% presence of European red mite eggs is exceeded, and fruit destined to many export markets have to be redirected, at a considerable cost to the grower, shipper and packing house. Spider mites, which are usually present as diapausing females in the calyx end of the fruit, pose an especially problematic challenge. Even if the species is not a quarantine pest to a particular importing country, it is difficult to make a definite species identification, since the taxonomic keys are for the males of the species. In these cases, loads are rejected, redirected, or fumigated; again, at a considerable cost to the fruit industry.

Researchers in Israel developed a hot water, high pressure washing system that they claim controls both pathogens and surface arthropods. Most of the crops tested in this system were tropical and sub-tropical fruits and vegetables. To our knowledge, they did not use this system on pome fruits. The usefulness of this system on apples and pears grown in the cooler climates of the Pacific Northwest was questionable.

Evidence in the late 1990’s indicated that a common spray adjuvant, SilWet L-77, was also a potent miticide and effective in killing diapausing spider mites in postharvest situations. In Washington State, current regulatory laws classify even spray adjuvents as actual pesticides, posing problems with use and disposal of solutions containing these chemicals. Also, there are no postharvest uses registered for this chemical. However, there are a few food grade organosilicones registered for use, one being a common defoamer currently being used in the fruit industry. It is possible that one of these could facilitate the removal of surface arthropods in conjunction with a high pressure washing system.

As with all postharvest handling practice changes, it is paramount to assess the impact on fruit quality. This is especially true in the case of pears, where small amounts of damage early on can have dramatic effects after storage and ripening.

In 2001, we organized a group, consisting of Robert Spotts, Eugene Meilke, Paul Chen, Jihen Bai, and Clark Severt of Oregon State University (OSU) in Hood River and James Hansen and myself, from the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) in Wapato, WA, to study the impact of high pressure washing systems (HPWS) and organosilicones on arthropod removal, quality and decay using a pilot plant packing line at the Oregon State University Mid-Columbia Research Station in Hood River, OR. Heath Rush was the engineer who constructed the system and installed it at OSU Hood River.

Our first order of business was to design an addition to the line which would incorporate a high pressure washing system modified with a heated contact loop and heat exchangers (Figure 1). The contact loop was designed to treat a portion of the recirculating water stream to 60 °C for 60 seconds to kill most of the common decay microorganisms common to pears. The heat exchangers were placed to reduce the water stream temperature and control spray water temperatures. We also added a temperature monitoring program to record loop and spray water temperatures.

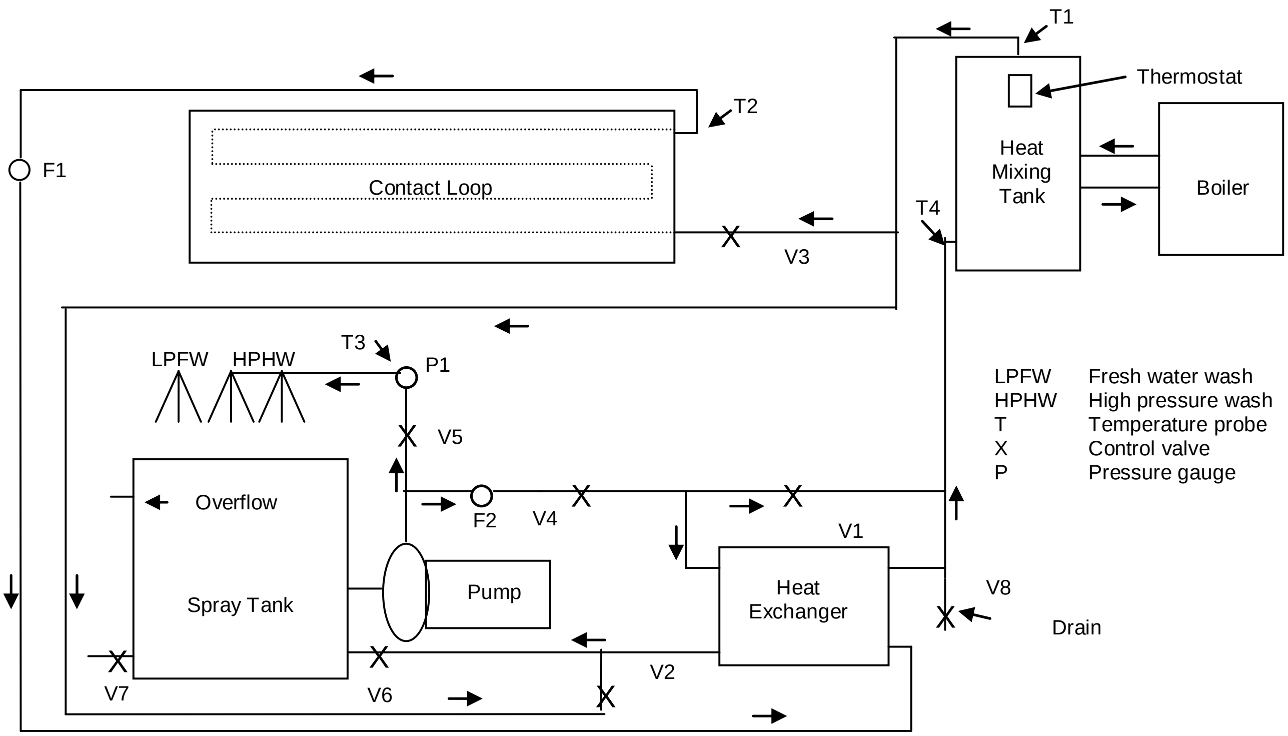

Figure 1. High-pressure washing system.

We conducted tests over the 2001 and 2003 seasons using regular and controlled atmosphere (CA) early and late stored fruit. We tested spray water temperatures from 20 to 60 °C and water spray pressures from 0 to 120 psi. We also examined the impact of pre-wash dips in various organosilicones from 0 to 0.3%.

We found that the spray water temperatures of 40 and 50 °C were no more effective in removing eggs and surface arthropods than spray water temps at 20 °C (Figures 2 and 3). We found that the most important components of the system to remove surface arthropods were the high pressure sprays and neoprene brushes (Figures 4 and 5). We also found that high temperature washing was detrimental to fruit quality, especially in late stored fruit. High pressure washing up to 120 psi, surprisingly, did not cause additional damage to the fruit (Figures 6 and 7). We did have a slight problem with scuffing, which was reduced by changing to brushes with softer neoprene bristles.

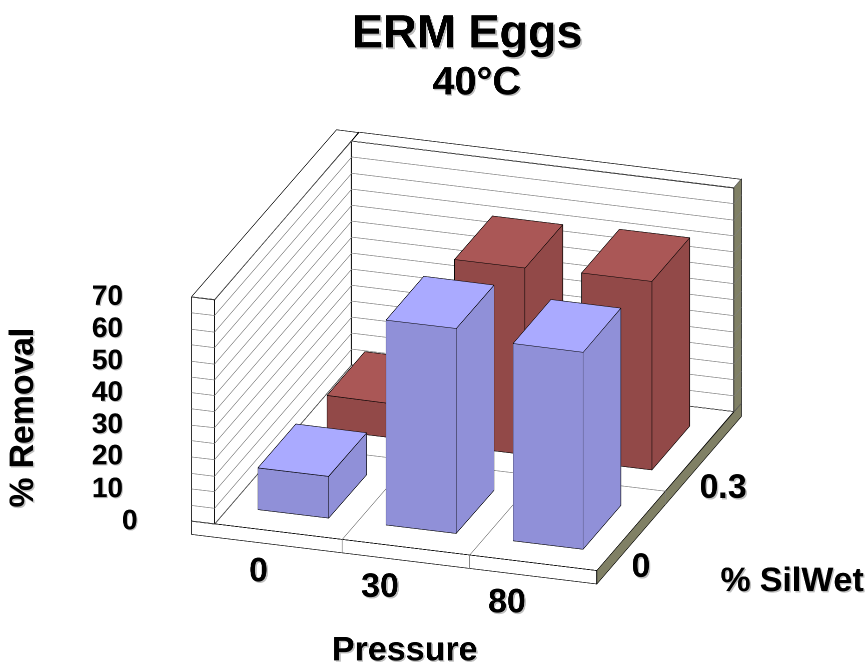

Figure 2. Effects of SilWet and high pressure sprays at 40 ºC on the removal of European red mite eggs from fruit.

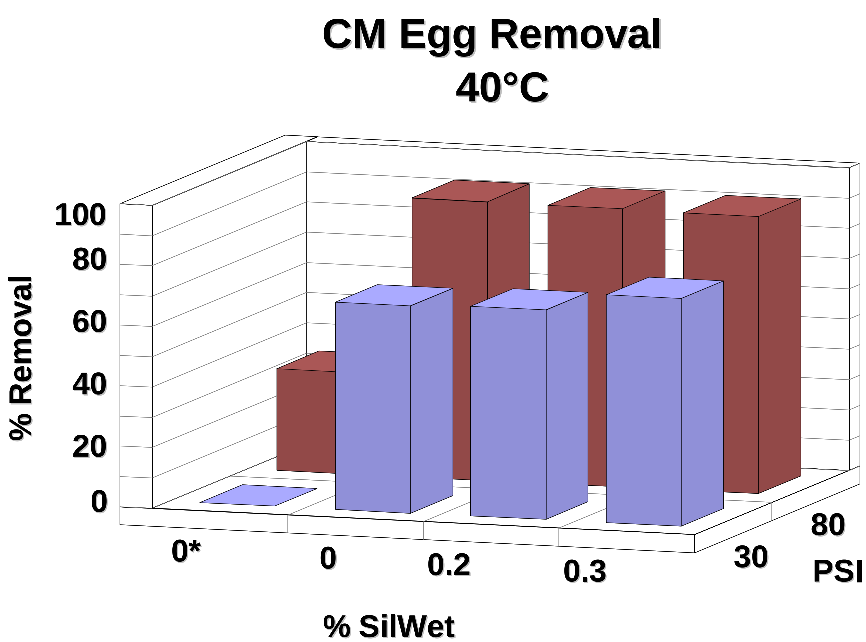

Figure 3. Effects of SilWet and high pressure sprays at 40 ºC on the removal of mature codling moth eggs from fruit surfaces.

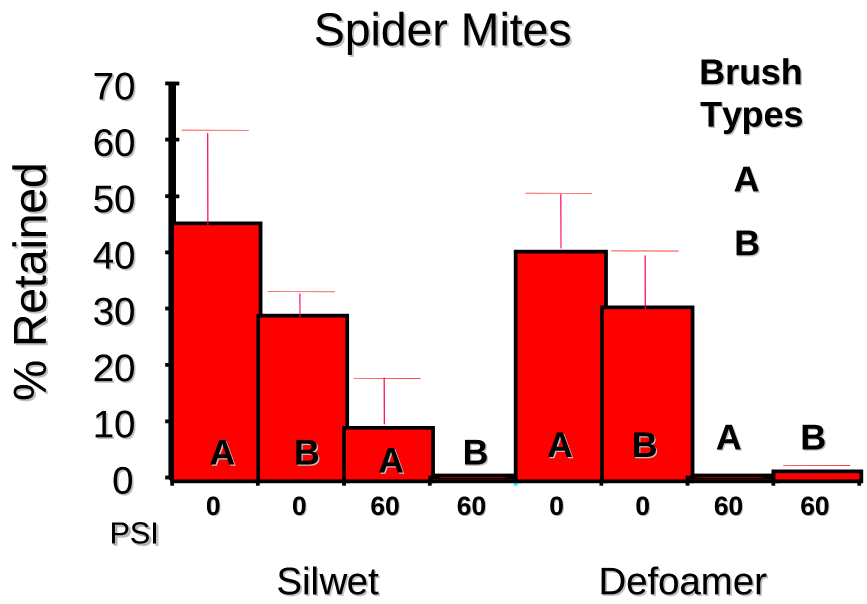

Figure 4. Effects of SilWet and organosilicone defoamer at 0.1% rates. Firm (A) and soft (B) brush types, and high spray pressures on the retention of spider mites on d'Anjou fruits.

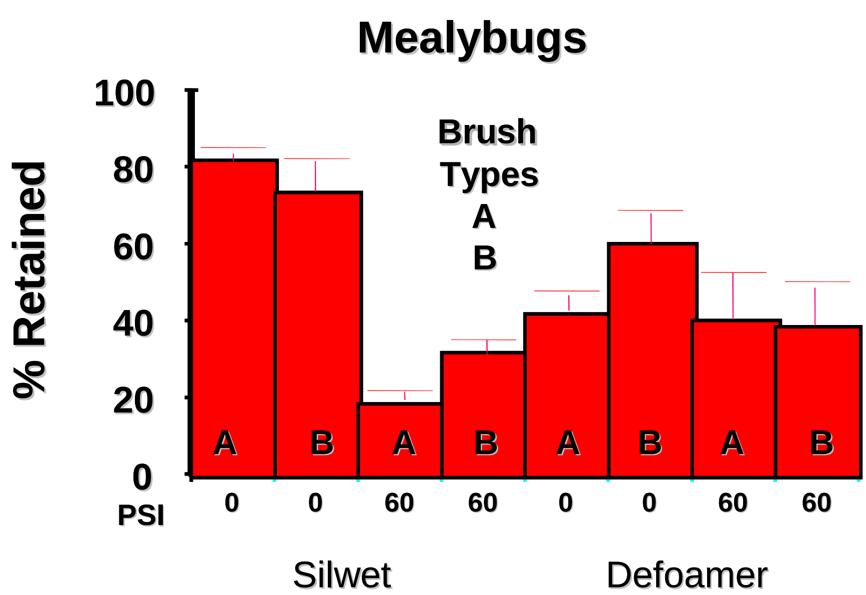

Figure 5. Effects of SilWet and organosilicone defoamer at 0.1% rates. Firm (A) and soft (B) brush types, and high spray pressures on the retention of grape mealybugs on d'Anjou fruits.

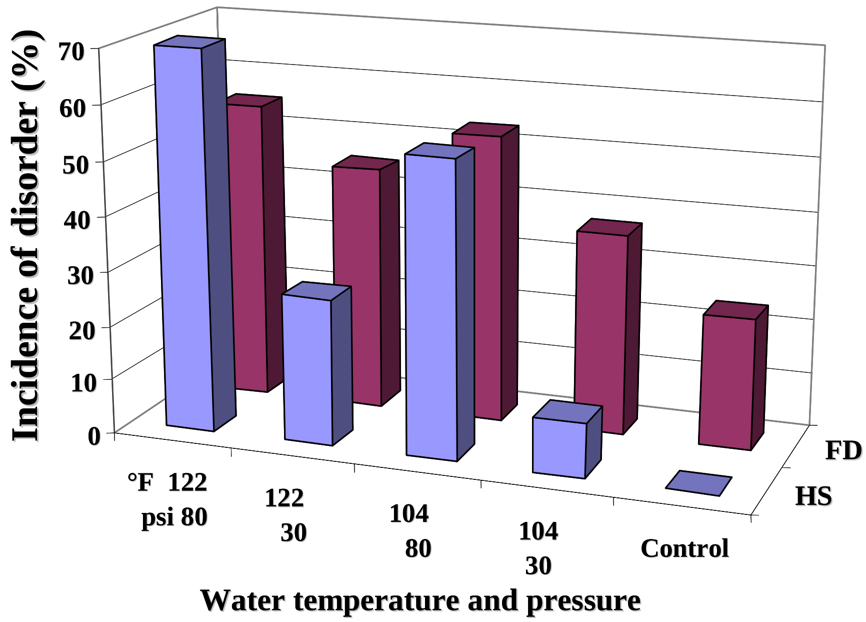

Figure 6. Effect of water temperature and pressure of washing system on incidences of heat scald (HS) and friction discoloration (FD) of d'Anjou pears after 3 months of RA storage.

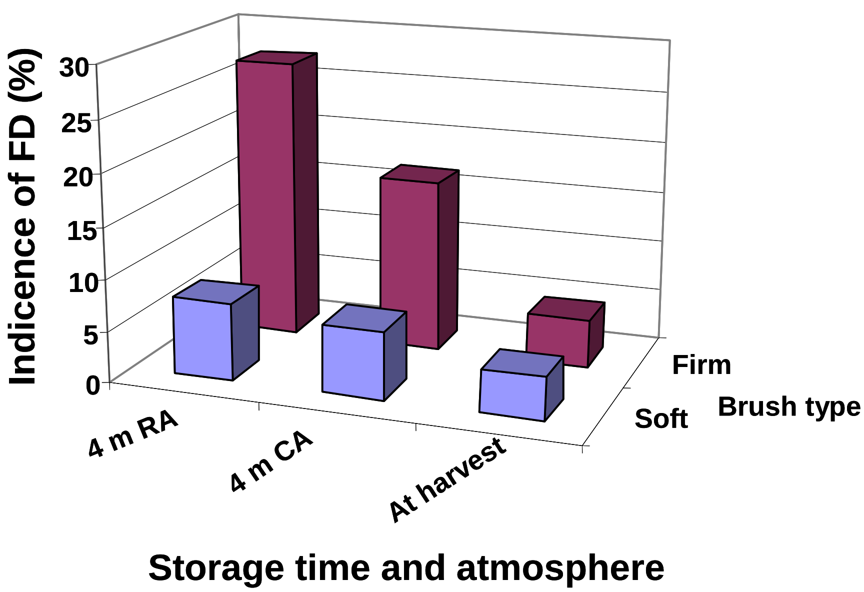

Figure 7. Effect of different brushes, storage time and atmosphere on friction discoloration (FD) of d'Anjou pears.

The most important effect of the modified system was the reduction in decay spores in the spray water and the lack of the spread of decay throughout the load (Tables 1 and 2). The simple addition of the heated contact loop caused a dramatic reduction in decay microorganisms, which was not correlated to a simple dilution effect from the addition of fresh water into the system. Reductions in decay in the system were 36, 29, and 13 % for gray mold, blue mold, and mucor rot, respectively.

Table 1. Effect of hot water on survival of spores of *Penicillium* and dilution of blue food dye.

Time (min)	86 °F		104 °F	
	CFU/mL	Absorb	CFU/mL	Absorb
1	5,083	4.8	89,875	5.2
5	500	2.1	4,083	2.2
15	0	1.6	1,583	2.0
30	75	1.1	250	1.8
45	75	0.8	75	1.7
60	0	0.6	333	1.5
75	0	0.4	0	1.3
Contact loop water temperature was 140°F.				

Table 2. Effect of hot water on incidence of decay of d'Anjou pear fruit.

Date	Wounds infected (%)			
	Gray mold		Mucor rot	
	Heat	No heat	Heat	No heat
12/13/01	9a	14b	56a	81b
3/20/02	39a	81b	40a	59b
9/23/03	20a	29b	18a	43b
1/16/04	67a	87b	86a	98a
Nozzle water temperatures were 122, 104, 86, and 86 °F for 2001, 2002, 2003, and 2004, respectively. Contact loop water temperature was 140 °F in all years.				

In conclusion, we found that the high pressure washing system with a heated contact loop was extremely effective in removing surface arthropods and eggs and in reducing the spread of decay while maintaining fruit quality. Organosilicones were more effective in aiding in the removal of surface arthropods, and will most likely be the focus of further research to optimize formulations, concentrations, and duration of exposure.