

PROCHLORAZ RESIDUE REMOVAL BACKGROUND AND PROTOCOL

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BACKGROUND MOTIVATION

Prochloraz has been used as one of the main post-harvest fungicides in subtropical crops for the control of anthracnose, stem-end rot and the *Dothiorella / Colletotrichum* complex in avocado as well as suppression of soft brown rot in mango. The allowable level (import tolerance) was 7.0 ppm for EU imports for avocados in 2023.

Due to recent changes in the residue tolerances of Prochloraz in Europe for both avocado and mango (LOD at 0.03 ppm) implemented from August 2024 onwards, it is crucial to eliminate all Prochloraz residues from packing lines to prevent detection of the active ingredient for fruit arriving in the EU after the deadline date. Any fruit with a level of detection of above 0.03 ppm will be rejected, leading to major financial implications to the industry.

According to the MSDS sheet and additional technical information from manufacturers, the Prochloraz molecule is unstable at a pH of 4.0, hence an acid wash is proposed. Care should be taken to ensure only plastic and stainless steel surfaces are washed/wiped with acid to avoid rust reactions. It is essential that a follow-up wash is done with the ICA product Skimmer Plus, formulated to encapsulate and remove residues from surfaces. However, thorough washing and scrubbing is required to enable the product to encapsulate residues. A final wash with clean water

directly after the acid and Skimmer Plus is necessary to remove residues. It is important not to allow product to dry on the line.

OBJECTIVES

- Removal of Prochloraz residues from avocado packing lines – adjust protocol to pack line setup:
 - o Compact
 - o Pakman.
- Establish initial residue loading with swabs on different sections of the packing line before the cleaning process commences.
- Establish the residue load with swabs after cleaning the packing line with acid (pH 4.0) to determine the efficacy of the acid wash.
- Establish residue load with swabs after Skimmer Plus washing to determine the reduction in percentage of residues.
- Write a protocol for washing of packing lines.

RESULTS

Maximum residue level to be 0.03 mg/kg on fruit – note that the following results are in mg/5 cm² detected from swabs which is much more sensitive to residue detection.

First packhouse: Amondel Pakkers

Table 1: Initial residues on swabs prior to washing process (pre-acid wash), after the acid washing process and after the Skimmer Plus wash and rinse

Packhouse	Location	Result		
		Pre acid (mg)	Post acid (mg)	Post skimmer (mg)
Amondel	Fungicide tank	>1	0.0008	ND
	Rollers in fungicide app	>1	0.0012	0.00019
	Brushes after fungicide app	>1	>1	>0.001
	Donuts after fungicide app	0.0024	0.0035	0.00016
	Belts after fungicide app	0.0015	0.0029	0.00062
	Feeding lines	0.0009	0.0028	>0.001
	Feeding line brushes	0.003	0.0016	0.00026
	Weighing cups/rollers	0.0012	0.0016	0.0009
	Final packing belts	0.0004	0.0007	0.00012

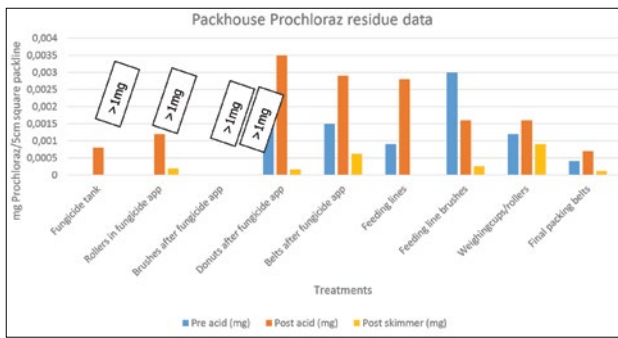


Figure 1: Indications of the levels of Prochloraz detected with swabs per mg/5 cm². Results from Table 1 summarised in graph format. Note: initial results (> 1 mg/5 cm²) from fungicide tank, rollers, and brushes are not indicated on graph due to the difference being too great to optimally represent results in proportion. All residues are below the allowable 0.03 mg residue but this is per swab and per 5 cm² section, not fruit running over all sections of pack line.

Key observations

- Brushes after fungicide application: brushes are the most difficult to wash and penetrate with Skimmer Plus.
- It is advisable to replace the brushes.
- All brush hairs are not connected to the stainless steel roller hence it is important to make sure from the pack line supplier which surfaces are stainless steel.
- If all components are made from stainless steel then soak brushes for 15 min in water at pH 4.
- Use a high pressure spray to rinse the brushes. Alternatively: Soak brushes in Skimmer Plus water for an hour (in big bins or bath) and wash off with a high pressure spray (clean water) and dry brushes in sunlight for a few days (UV breaks down chemical residue). Repeat this process a few times and swab to analyse results.
- Residues are drastically reduced but may increase where components in the packing line are not properly rinsed with clean water.

Interpretation and conclusions from results

Initial swabs (prior to the commencement of the wash) showed high levels of Prochloraz residues especially in the fungicide tank, flooder/bath, nozzles, and brushes (areas where the chemical itself is in direct contact with the packing line). These areas will be referred to as **primary areas**. Sections in the packing line where the active is present but transferred from fruit to the packing line will be referred to **secondary areas**.

Explanations of results: Amondel Packers

Fungicide tank: A primary area with continuous high-level exposure of active ingredients hence the residue buildup at this contact point. The majority of fungicide tanks are stainless steel. After the acid wash, no further residues were detected. However, the Skimmer Plus wash occurred due to selected areas where low levels of Prochloraz residues were still detected.

Rollers in the fungicide application tank/flooder: Amondel had high levels of Prochloraz on the roll-

ers due to this being a primary contact point. After the acid wash, no further residues were detected. However, the Skimmer Plus wash continued.

Brushes: Highly contaminated due to brushes being used to absorb and brush chemicals/wax etc. onto the fruit. The brush hair concentrates the active ingredient and the absorbance of the roller base where the brush hairs are fixed onto the base of the roller. The brushes were not washed with acid due to possible corrosion. After washing and rinsing with Skimmer Plus and a high-pressure spray, the brushes were left in the sun for the rest of the week. The levels of Prochloraz dropped after the Skimmer Plus wash, but still not to acceptable levels. Hence new brushes were required. The contaminated brushes can undergo the same process until they are limited to no residues detected on the brush. Another option is to use contaminated brushes when not exporting to still get value from the brushes.

Donuts after the fungicide application: Donuts prior to the acid wash contained lower levels of Prochloraz than after the acid wash. The reason behind this is that the donuts were not rinsed with clean water directly after the acid wash, hence the concentration built up. The adjustment in the protocol was made with The Fruit Farm Group, and a successful drop in residue levels was obtained.

Belts after fungicide application: Similar results were obtained as with donuts due to not rinsing the belts after the acid wash. A reduction in residue levels was evident after the Skimmer Plus wash and rinse.

Feeding lines: Similar results were obtained as with the donuts and belts. A reduction in residue levels was evident after the Skimmer Plus wash and rinse.

Feeding brushes: The brushes were removed from the machine and washed in a drum with acid water (residues could drip off into solution while being washed). A reduction in residue levels was seen after the Skimmer Plus wash and rinse.

Weighing cups/rollers: Similar results were obtained with the weighing cups due to not rinsing the cups after the acid wash. A reduction in residue levels was evident after the Skimmer Plus wash and clean water rinse.

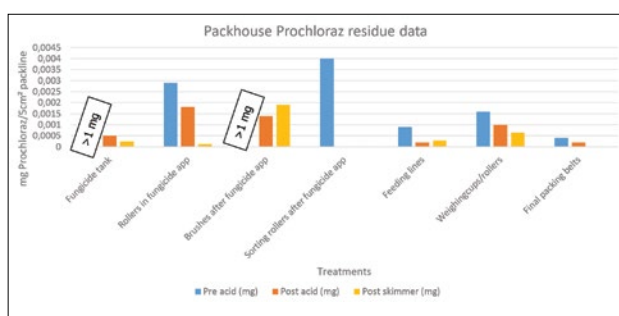
Final packing belts: Similar results were obtained with the final packing belts, with higher levels after acid wash. However, a reduction in residue levels was evident after the Skimmer Plus wash and clean water rinse.

Second packhouse: Mopani Fruit Packers (The Fruit Farm Group)

Explanations of results:

Fungicide tank: A primary area, with continuous high-level exposure of the active ingredient hence

Packhouse	Location	Result		
		Pre acid (mg)	Post acid (mg)	Post skimmer (mg)
The Fruit Farm Group – Mopani Packers	Fungicide tank	>1	0.0005	0.00024
	Rollers in fungicide app	0.0029	0.0018	0.00012
	Brushes after fungicide app	>1	0.0014	0.0019
	Sorting rollers after fungicide app	0.0014	NA	0.000009
	Feeding lines	0.0009	0.0002	0.00028
	Weighingcups/rollers	0.0016	0.001	0.00065
	Final packing belts	0.0004	0.0002	0.000054



the residue buildup at this contact point. The majority of fungicide tanks are stainless steel. After the acid wash, there was an obvious reduction in residue levels and a further reduction after the Skimmer Plus scrub and rinse with clean water.

Rollers in fungicide application: After the lessons learnt from Amandel Packers, the protocol was adjusted to wash the area with clean water directly after the acid wash. There was a definite reduction in residue levels as well as after the Skimmer Plus wash and rinse with clean water.

Brushes after fungicide application: Initially a high level of residue (> 1 mg) was detected. A small section of the brush and roller was rinsed and washed with acid water and swabbed. However, this could not be done for the whole brush as it causes corrosion. The levels were tested again before commencing with Skimmer Plus. After the final rinsing with clean water, the residue levels on the swabs showed a promising decline in Prochloraz levels. The rollers were left in the sun for the week. Brushes were not fully free of Prochloraz even after a repetition of washing.

Sorting rollers after fungicide tank: The sorting rollers had great reductions in Prochloraz residues after the acid wash. Slight levels were picked up after the Skimmer Plus wash, indicating that if one swab did not pick up residue on one surface then residue will not be detected on another area of that section.

Feeding lines: Low residue levels were detected here hence not a drastic reduction in levels with the first wash. After the Skimmer Plus was, a slight increase was seen, confirming the importance of covering the

whole surface area and proper scrubbing and rinsing immediately afterwards with clean water.

Weighing cups/rollers: The whole process of this section showed a decline in residue detection but not to levels of detection, thereby motivating a second wash.

Final packing belts: This section had the least residues to start off with. This confirms that residues are present throughout the whole packing line where treated avocados made contact with the packing line, even till the end.

Both pack lines had to undergo the process at least twice, and certain areas of high/primary contact 3 to 4 times. It is a lengthy process to strip, scrub, wash, and repeat before assembling the machine again.

Procedure

Acid wash: only plastic and stainless steel surfaces and components as it will induce rusting on other materials such as aluminium and iron.

- Ensure people wear PPE, specifically rubber gloves and respiration masks.
- Use/spray anti-rust products on bolts, nuts, chains, etc. close to surfaces being washed with acid to reduce the risk of rusting.
- Use clean 20 L paint buckets or similar containers, and fill with 15 L of water.
- Initial wash (to remove dust/wax/soap/etc.) on the pack line. Wash with normal soap and water. This allows acid wash water and Skimmer Plus water to stay cleaner for longer and reduce the frequency of changing the washing water.
- Use a calibrated pH meter (pH strips are not as accurate).
- Add a small volume of HCl/pool acid to water (\pm 2 ml to 3 ml acid per 15 L water will give a water pH of between 3.0 and 4.0. Do not go below pH 2.0). Use a syringe to draw up 2 ml.
- Test to ensure that the pH is optimal.
- If the fungicide tank and fungicide rollers are stainless steel, remove from the pack line and use soft brushes to scrub and wash with acid water. Rinse with clean water immediately after the acid wash without letting the surface dry off, as this allows residues to stick onto the surface area. Rollers need

to be removed and washed separately so that the acid wash does not make contact with other materials e.g., bolts, nuts, chains, etc.

- Wet the new cloths in the acid water, remove excess water, and wash/wipe plastic belts or surfaces.
- Immediately after the acid wash, follow up with a new cloth dipped in clean water and rinse the section washed before it dries off.
- Use one set of cloths for the fungicide tank and rollers, which have high concentrations of Prochloraz (the active sticks to the cloth and deposits onto other surfaces) OR start from where the lowest levels of Prochloraz would be present (final packing belts) and wash backwards to end at the fungicide tank.

Skimmer Plus wash

- Mix a 20% Skimmer Plus solution in 20 L buckets.
- Use brushes and sponges to scrub all surfaces of the pack line, from final packing belts to the fungicide tank (low concentrations of residues to higher concentrations of residues) (better to remove rollers/cups/donuts etc.).
- Pressure and proper scrubbing are important for the efficacy of this product as it encapsulates the remaining residues on the line.
- Immediately after the Skimmer Plus wash (while the surface is still wet), rinse with clean water so that encapsulated residues are removed from the pack line and do not dry on the surface.
- All surfaces can be washed, give special attention to aluminium and other surfaces not washed with acid as these superficial Prochloraz levels will still be present at higher concentrations.
- Change the Skimmer Plus water regularly.

To determine the levels of residues still present on selected areas of the pack line, swab and use the following protocol:

- Use normal cotton earbuds.
- Use 3 earbuds per section. Dip the cotton ends in a 20% Skimmer Plus solution.
- Swab on a \pm 5 cm surface area with both sides of the cotton earbud on the sections from the chemical application point onwards.
- Mark clearly the location of the swab for reference.
- Place in small zip lock bag (a separate zip lock bag for each area).
- Mark to test for postharvest chemicals, Prochloraz, and send to Hortec Analytical Services as they are familiar with the protocol.

Proposed areas to swab:

- Fungicide tank
- Rollers in the fungicide application tunnel
- Brushes after the fungicide application
- Donuts after the fungicide application
- Belts after the fungicide application
- Feeding lines
- Feeding brushes
- Weighing cups/rollers
- Final packing belts/ packing bins.

Critically important: Employees to wear PPE (arm

length rubber gloves, eye protection, and a face mask/respirator during the acid wash). Please note that following this protocol is a guideline and a document pointing out the risks and reasoning behind the protocol. It is the responsibility of every packhouse to ensure they optimise their risk management and results. SAAGA or Auxano IPM Consulting will not be held responsible or liable for any damages or lack of results from following this protocol.

For any questions/guidance in the process, contact the author.

Areas of possible Prochloraz contamination in the avocado supply chain with associated risks and likely cleaning methods

Mode of action of products

Acid wash: The Prochloraz molecule is unstable and dissociates at a low pH of 4.0. Hence an acid wash with pH between 3 and 4 will assist in the breakdown of the molecule.

Skimmer Plus: The product encapsulates the remaining residues/molecules (force and scrubbing with brushes is crucial for this process). Directly thereafter, wash/rinse with clean water to wash off the encapsulated product. If it is left to dry, the encapsulated molecule remains on the surface.

Sun/UV light: Chemical residues break down under UV light. Prolonged UV exposure assists in the breakdown of these chemical molecules.

Risks

Pruning/harvesting shears

Shears should be a low risk for Prochloraz contamination due to the shears being used prior to the dipping into Prochloraz. If the shears were in contact with Prochloraz, or the fruit already dipped into Prochloraz, scrub the shears with a brush and 20% Skimmer Plus. Wash afterwards with clean water to remove the residues and leave in the sunlight for a few days.

Bins/lugs/plastic feet under bins

High risk for Prochloraz contamination due to fruit being placed in bins after dipping into Prochloraz. Plastic bins with no metal components can be dipped and washed/scrubbed with acid water (pH of 3 to 4). Directly after the scrubbing, wash with clean water. Do not let the bin dry after the acid wash. Directly follow up with 20% Skimmer Plus wash/scrubbing, and rinse with clean water. Leave in sun for several days for the UV to assist in the breakdown of remaining residues.

Plastic buckets and sponges/cloths

High risk for Prochloraz contamination: change and use completely new buckets and sponges to eliminate the risk.

Harvesting bags

High risk if fruit are placed in the harvesting bag after dipping the stem-end in Prochloraz. *Low risk* if fruit is placed in the bag, removed, dipped, and placed in

plastic bins/crates. If high risk, replace the harvesting bag. If low risk, for the odd possibility of Prochloraz detection, turn the bag inside out, scrub with acid water, rinse with clean water, scrub with Skimmer Plus, rinse with clean water, and let it dry in the sun for a couple of days.

Revise the whole picking process to identify all possible contamination points, and inform the packhouse manager to ensure all aspects are covered. If unsure of possible residue/contamination points, phone/e-mail the author.



Rubber gloves



Brushes and sponges

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