DEPARTMENT OF
PRIMARY INDUSTRIES

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Guidelines for postharvest drenching of apples and pears

- Department of Primary Industries, Victoria
- Apple and Pear Australia Ltd
- National Residue Survey, Agriculture Fisheries and Forestry Australia
- Horticulture Australia Ltd

April 2007

Victoria
The Place To Be

Guidelines for postharvest drenching of apples and pears

CHECKLIST ☑

Before the drenching season

- Measure the drench reservoir tank or use a water meter to calculate the tank volume. ☐
- Make sure the drench tank is of sufficient size (ideally 1500-2000 L). ☐
- Check that DPA flow rate is sufficient (normally 1000 L per minute per bin). ☐
- Make a chart for quantities of DPA and fungicide required for the different varieties you will treat. ☐
- Prepare a system to measure drench liquid volume for top-ups (eg calibrated dip-stick). ☐
- Make sure that a competent and trained staff member will always be in charge of the drench preparation and topping up. ☐
- Have enough measuring jugs and a white board available to record quantities added to drench. ☐
- Make sure that there is an automatic cut-off for the drench pump which stops the drench shower when the bin conveyer is full. ☐
- Make sure that there is sufficient draining time (3-4 min) between a chlorine or water pre-wash and the DPA treatment. ☐

Preparing the drench and treating fruit

- Read and follow all information on the product labels. ☐
- Pre-mix DPA by adding a small amount of water to the DPA, then add to tank. ☐
- Add fungicides one at a time. ☐
- If using calcium, dissolve it in water and add it to the drench, last. ☐
- Mix drench thoroughly before treating fruit (run pump and agitator for at least 5 minutes). ☐
- Do not treat fruit for too long (ideally 10- 30 seconds). ☐
- If fruit or drench temperatures are colder than 15°C or hotter than 30°C, contact your reseller before drenching. ☐

- Test drench strength regularly. ☐
- Follow safety precautions as detailed on the DPA product label. ☐

Topping up

- After treating 50 bins test drench strength. ☐
- Measure top-up volumes accurately, do not estimate. ☐
- Make sure that pre-washed fruit do not dilute the drench. ☐
- Keep the system free from leaves and other debris to maintain effectiveness of the drench and to avoid build up of fungal spores. ☐
- Do not top-up more than three times. ☐

Be aware of factors which can cause excessive DPA residues ☐

Fungicides

- What rot control strategy will you use? Consider the risk potential of each variety, use of hygiene practices and fungicides (if any). ☐
- Each product will have specific use information. Read the entire label. ☐

Calcium

- Do you need calcium in the drench? Liquid and granular forms of calcium are available which may improve the quality of apples after storage. ☐

Disposal

- Have you an appropriate disposal method for spent drench solution? Consult local authorities such as EPA, water authorities, Agriculture Department and resellers. ☐

Possible alternatives to DPA

- Have you considered alternatives to DPA for scald control?

eg. Smart Fresh; forecasting scald risk; use ultra-low oxygen storage. ☐

DPA labels

- Have you read and do you understand the current DPA product label? ☐

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1. Introduction

Superficial scald is a cold storage disorder affecting many apple and pear varieties. It is a browning of the skin, caused when the skin cells die. It may appear during storage, but more usually following storage, because its development is accelerated at warmer temperatures. It is affected by fruit variety, harvest maturity, weather conditions and fertiliser use.

Fruit varieties vary in their susceptibility to scald. Table 1 lists the susceptibility of common apple and pear varieties.

Table 1. Fruit susceptibility to superficial scald

Fruit type	Highly susceptible	Moderately susceptible	Slightly susceptible
Apple	Granny Smith, Lady Williams, Red Delicious	Cripps Red (Sundowner), Jonathan, Firmgold, Fuji	Golden Delicious, Gala, Cripps Pink (Pink Lady)
Pear	Packham's Triumph	Josephine, Beurre Bosc, Winter Nelis	

Susceptibility to scald increases in growing conditions that are hot, dry and sunny. Fruit are most susceptible before they reach the maturity for commercial harvest and susceptibility declines over the normal harvest period. However, riper fruit with lower susceptibility to scald may be unsuitable for long term storage. Fruit are more susceptible when grown under a high nitrogen regime and less susceptible when grown under a high calcium regime.

Scald can be effectively controlled by treating fruit with the antioxidant Diphenylamine (DPA). DPA is currently the most effective treatment and it is available in three products, Ag-Farm DPA Fruit Dip Liquid™, Campbell DPA 310 Scald Inhibitor™ and Chemley No Scald DPA Fruit Dip Liquid Concentrate™. DPA is most effective when applied within a few days after harvest and is most commonly applied by dipping or drenching fruit in bins. The level of DPA needed to control scald depends on the fruit maturity, storage time and the susceptibility of the variety.

The incidence of **bitter pit, fruit softening**, **scald** and **rot** in stored fruit can be reduced by a number of field and postharvest practices, including raising fruit calcium levels with postharvest drenches of calcium.

Storage **rots** are also affected by the amount of inoculum (the number of fungal spores), the fruit susceptibility as influenced by nutrition and maturity, the storage conditions, cultivar characteristics, fruit skin damage and the effectiveness of any post-harvest fungicide treatments.

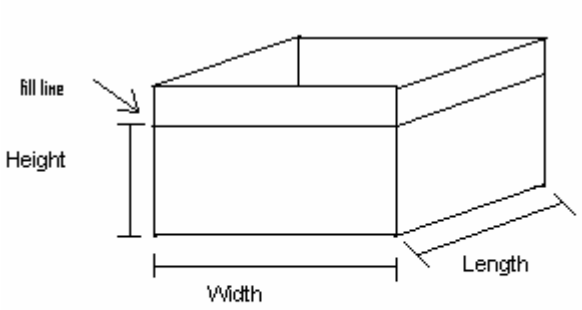
This manual covers key aspects of postharvest drenching of apple and pear fruit.

Note: Always refer to the current product label attached to the product before use.

2. Before the drenching season

2.1 How to measure the drench reservoir tank and calculate its volume

Knowing the tank volume is critical for the application of correct strength DPA. The volume of rectangular sided tanks can be easily calculated from the tank dimensions (see below). Tanks with irregular dimensions can be measured using a water flow meter. Be sure to include any large pipes etc., which are filled with drench solution, in the calculation. The volume of pipework can be calculated from the internal diameter (i.d.) and the length which contains liquid. Pipe volume (litres) = 0.314 x internal radius^2 (cm) x length (m).



Volume = length (L) x width (W) x height (H)

Tank capacity= Volume(m3)*1000 litres

Example: Drench tank has the dimensions

Length **2.0** m, Width **1.0** m, Height **1.5m**

Volume = **L** x **W** x **H**

= **2** x **1** x **1.5** m^3

= **3** m^3

Tank Capacity (litres) = Volume (m^3) x 1000

= 3 x 1000

= 3000 litres

2.2 Ensure drench tank is sufficient size

The usual tank volume is 1500 to 2000 L. Dilution of DPA associated with fruit throughput is faster when the tank size is small. When the reservoir is large, the amount of times the total volume of the drench is pumped through is less. This lowers the risk of the DPA emulsion breaking down due to the mechanical agitation of pumping. If the tank is small, the lost volume of drench needs to be replaced more frequently to avoid air being sucked into the pump.

2.3 Ensure DPA flow rate is sufficient (normally 1000L/min per bin)

A pumping rate of 1000 litres/minute is required to adequately cover all fruit in a bin in 30 seconds. In a double tiered drench system the pumping rate should be doubled to 2000 L/minute, and in a triple tiered system the rate should be 3000 L/minute. Tank size needs to increase with increased pumping rate.
Drenches (in a recycling drench system) should be able to be pumped for up to 200 minutes without causing any significant drop in DPA strength.

2.4 Make a chart for quantities of DPA, fungicide and calcium required to drench the different varieties you will treat.

This should indicate the amounts required for preparing a new drench and also for topping-up the drench after various volumes have been lost.

To prevent high residue levels of DPA in fruit receiving post-harvest treatments, the DPA concentration of drenches should be varied according to the susceptibility of the variety being treated. Also note that rates of DPA can be reduced if fruit are to be stored under ultra-low oxygen Controlled Atmosphere (CA) - *see product label*.

It is critical that top-up volumes are measured and not assumed.

Determining DPA Requirements

To calculate the quantity of DPA concentrate required to make up drenches of various tank sizes, the following formula can be used.

Litres of DPA Concentrate = Drench strength (ml/100Litres)/1000 x Tank capacity (litres)/100

Example: The tank capacity is **1350 litres**, required drench concentration for Granny Smith grown in the Goulburn Valley and stored in conventional CA is **1170 ml/ 100 Litre** *(from product label).*

Required quantity of DPA in litres is: (1170/1000) x (1350/100) = 15.8 Litres

EXAMPLE ONLY:

Table 1. Chart for preparing and topping up DPA and other drench components, for three varieties of apples grown in Queensland, NSW, Victoria only (*note that higher rates may be required for fruit grown in the Goulburn Valley, Victoria-see product label*). Fruit to be stored in air or CA at 3% oxygen only.

	DPA (litres)					
Water volume (litres)	Granny Smith	Lady William	Red Delicious	Calcium chloride (kg)	Rovral Aquaflo (litres)	Bavistin FL (litres)
2000	12.80	6.80	12.80	40	2.0	1.00
1900	12.16	6.46	12.16	38	1.9	0.95
1800	11.52	6.12	11.52	36	1.8	0.90
1700	10.8	5.78	10.88	34	1.7	0.85
1600	10.2	5.44	10.24	32	1.6	0.80
1500	9.60	5.10	9.60	30	1.5	0.75
1400	8.96	4.76	8.96	28	1.4	0.70
1300	8.32	4.42	8.32	26	1.3	0.65
1200	7.68	4.08	7.68	24	1.2	0.60
1100	7.04	3.74	7.04	22	1.1	0.55
1000	6.40	3.40	6.40	20	1.0	0.50
900	5.76	3.06	5.76	18	0.9	0.45
800	5.12	2.72	5.12	16	0.8	0.40
700	4.48	2.38	4.48	14	0.7	0.35
600	3.84	2.04	3.84	12	0.6	0.30
500	3.20	1.70	3.20	10	0.5	0.25
400	2.56	1.36	2.56	8	0.4	0.20
300	1.92	1.02	1.92	6	0.3	0.15
200	1.28	0.68	1.28	4	0.2	0.10
100	0.64	0.34	0.64	2	0.1	0.05

2.5 Prepare a system to measure drench volume for top-ups (eg. calibrated stick)

To make sure that drenches are topped up accurately a calibrated measuring stick (or calibrations on the tank) should be made. The person responsible for operating the drench must be aware of the markings on the stick and their relationship to the volume left in the drench. This ensures that correct concentrations of DPA and other chemicals are maintained when topping up. A flow meter on the filling hose would be an equally effective way to determine the top-up volume.

2.6 Ensure that a competent staff member will always be in charge of the drench preparation and topping up

Mixing and topping up drench liquid is a critical operation and there is little margin for error. Staff in charge of these operations must be capable of consistent accuracy and should be adequately trained in measurement of volumes and calculation of quantities.

2.7 Ensure sufficient measuring jugs and a white board or similar are available

The harvest season is a hectic time and it is helpful to have aids to keep tally of bin throughput, number of top-ups and chemical quantities added. It is recommended that there are sufficient measuring jugs available to measure out all the DPA concentrate required at one time (eg three 3 litre jugs could be used to measure out 8 litres of DPA at one time). A whiteboard or similar should be available so that quantities are checked off as they are added. This procedure should avoid the uncertainty that could occur if the operator is called away during the preparation or topping up of a drench tank.

2.8 Ensure that there is an automatic cut-off for the drench when the bin conveyor is full

If the drench continues to operate after the bin line is full there is an increased risk of over exposure of the fruit to the DPA mix. This can result in fruit burn and DPA residue problems.

2.9 Ensure draining time between pre treatment chlorine or water wash and the DPA treatment is sufficient (3-4 min)

It is important that fruit is allowed sufficient drainage time (3-4minutes) before drenching to prevent dilution of the DPA drench solution. If chlorine compounds are carried through to the DPA drench they will break down the DPA and scald will not be controlled.
To minimise the chances of this happening-

- Ensure fruit is well drained before drenching
- Only use registered chlorine and chloro-bromo compounds at the label rates (other registered sanitisers have not been tested in this situation).
- Use a chlorine monitoring and metering device to ensure the correct chlorine concentration in the water
- Use chlorine test strips to ensure there is no chlorine remaining on the fruit surface before DPA treatment.

3. Preparing a new drench and fruit treatment

3.1 Premix DPA in a small amount of water and add to tank

To ensure that DPA is mixed throughout the tank it should be pre-mixed in a bucket with water and then added to the tank. *It is important to add water to the DPA, and not DPA to water, when pre-mixing*. If DPA is added straight to the tank it can sink to the bottom and not mix properly causing uneven concentration of DPA in the drench.

3.2 Add fungicides one at a time if required

Reactions between fungicides can occur if they are mixed together as concentrates. Therefore, it is important that fungicides are added to the drench separately. This will make sure that they are most effective in controlling storage rots. Rovral and similar products may loose their effectiveness if the drench pH is above 7. As a result a pH buffering agent may be required. Some fungicides have a resistance warning and a resistance strategy should be followed to maximise rot control.

3.3 If using calcium, dissolve it in water and add it to the drench, last

3.4 Mix drench thoroughly before treating fruit (run pump and agitator for at least 5 min)

All drenches should be agitated prior to use or whenever a delay occurs between drenching bins. This ensures that concentrations of DPA and fungicides are evenly distributed throughout the tank.

3.5 Avoid treating fruit for too long (ideally 10- 30 seconds)

Fruit should be treated for at least 10 seconds to ensure uptake of DPA, but beware that longer treatment times can lead to excess DPA residues in fruit. - Slow drying of fruit will also increase DPA uptake - ensure bins are adequately drained before stacking on other bins. This will help prevent undesirable residues from occurring.

3.6 Fruit or drench temperatures

For optimal treatment with DPA, fruit should be at a temperature between 15-30°C before drenching. DPA uptake, and resulting residues, may be too high when fruit and drench temperatures are high. This may also increase the incidence of skin injury, characterised by a dull muddy brownness, which affects most of the surface area of non-coloured varieties. In red varieties the red colour loses clarity and becomes “inky”.

High drench temperatures can also lead to increased residues, therefore, locate drench tanks where they will be shaded and remain fairly cool. Contact your reseller if the drench temperature exceeds 30°C.

3.7 Test drench strength regularly

It is important that the strength of the drench is monitored and maintained at the label rates. If the strength is too high then residue problems will arise. Testing of drench tank strength can be done using test kits or by the titration method as a service from chemical resellers. Contact your DPA supplier for details before the season begins.

3.8 Observe safety precautions as detailed on the DPA product label

Copies of the DPA product labels are located in the appendix.

4. Topping-up drenches

4.1 After treating 50 bins test drench strength

DPA emulsions can lose their effectiveness with throughput of fruit. This may become significant in a system with a 1000 L tank after about 50 bulk bins have been drenched, although with current DPA formulations this is not usually the case. One potential problem can occur with the "breaking" of the emulsion with the DPA separating out as very fine crystals. The effective end of the emulsion is seen in a drench system when the drench loses its milky appearance and tiny DPA crystals can be seen. Another problem can occur with dilution from drenching of wet fruit from pre-washing. Pre-washing with chlorinated water can also reduce the effectiveness of DPA as the chlorine can breakdown the DPA.

The age of a drench or dip is not critical - what is most important is the amount of agitation or time a drench is pumped. Current DPA labels indicate that the product is stable for 200 minutes pumping. Leaving a drench/dip to stand will not have any marked effect on the emulsion, however, if it is to be left for more than a day it should be covered to prevent dust entering and reduce evaporation.

4.2 Measure top-up volumes accurately, do not estimate

Topping up of drench tanks is usually required after 50 bins of fruit have been drenched per 1000 Litres. Record volume lost and top-up accordingly. *Refer to top-up chart prepared pre-season.*
Do not top-up more than 2-3 times, replace the drench if more top-ups are required.
Very dusty fruit should be hosed down before drenching.
Replace drench solutions that are older than 2 weeks irrespective of the number of bins treated.
Keep drench tanks covered and out of sunlight when not in use. Avoid bare iron surfaces - hot galvanise or use an epoxy resin on the interior surfaces of drench tanks.
Tanks should have some form of agitation to avoid excessive settling

4.3 For pre-washed fruit ensure that drench does not become diluted.

Sufficient draining time is required before drenching fruit that has been pre-washed. This will make sure that DPA concentrations don't become too low for adequate scald control. At least 3 minutes time between pre-washing and drenching is usually adequate

4.4 Keep the system free from leaves and other debris to avoid build up of fungal spores

The number of fungal spores that are found in the drench will increase if plant material and other debris are allowed to build up. This will make storage rot control more difficult, even with the use of fungicides. It also may reduce the effectiveness of anti-scald treatments.

4.5 Do not top-up more than three times

It is important that the entire drench solution is replaced after topping up has taken place on three occasions. The drench can start to break down at this point and its effectiveness in controlling scald is greatly reduced. Leaves, debris and dust also build up and can reduce the effectiveness of anti-scald treatments and can by contaminating fruit with fungal spores, increase rot development.

5. Factors which can lead to excessive DPA residues or damage to fruit

Table 2. Factors which can lead to excessive DPA residues, their cause and possible solution

factor	background	solution
inappropriate rates	using off-label rates	check and use label rates
	this can also occur when 2 or more varieties are being harvested and drenched at the same time, and all are treated with the same drench	use smaller drench tank volumes to allow for more changes in drench tank; operate 2 drench tanks to allow simultaneous treatment of 2 cvs which have different DPA requirements; arrange for drenching at another shed which has appropriate equipment
	new cultivars not on label	more research needed
incorrect top-up	drench volume is lost after treating fruit	accurately measure volume lost and top-up with label rate for that volume
long drench time	bins moving too slowly through drench	adjust bin speed
	bins banking up under drench	check that automatic cut-off of drench is working
russetted, sunburnt or bruised fruit	DPA moves into damaged skin at a faster rate	do not treat
high temperature fruit and/or drench	DPA is absorbed more rapidly at high temperatures	check with distributor if fruit or drench temperatures are >30°C

Table 2 (Continued)

factor	background	solution
breaking of the DPA emulsion	DPA emulsion can break with prolonged pumping. This can lead to uneven residues on fruit and inconsistent scald control	check drench condition regularly, especially after 200 minutes (total) pumping
slow drying of fruit after drenching	continued DPA absorption occurs while fruit remains wet	ensure fruit dries as soon as possible before storing
fungicide or calcium in the drench	fungicide and calcium formulations may contain additional wetting agents which enhance uptake	only use products which are known to be compatible with DPA
entry of drench into core via open calyx	cultivars such as Red Delicious and others with an open calyx channel can have this problem	use DPA on-line or other scald control measures
pooling of drench in calyx or stem depression	excess DPA can be absorbed where this occurs	gently tilt or agitate the bin to displace excess drench
type of storage (ultra-low O2 or conventional CA)	fruit to be stored in ultra-low oxygen storage must not be treated with rates for conventional CA	follow product label
contamination of untreated fruit with DPA	fruit not intended to be treated in DPA can pick up detectable residues of DPA from contact with the packing line, with wooden bins or from vapour movement of DPA from nearby treated fruit if such fruit is held in the same cold room	thoroughly clean the packing line and fruit bins before packing untreated fruit; replace brushes or any parts which cannot be adequately cleaned; do not store untreated fruit in the same cool room as treated fruit

6. Fungicides

There are a number of fungi that cause postharvest rot in pome fruit. Important rots are Blue mould caused by species of *Penicillium*, Mucor rot caused by *Mucor piriformis*, Anthracnose rots (including Bitter rot, Target rot and Ripe spot) caused by several fungi including *Gloeosporium* species and Grey mould rot caused by *Botrytis cinerea*. These rots can infect through wounds, via lenticels or directly through the fruit skin. Apple cultivars with an open sinus between the calyx and the core (eg. Red Delicious) are prone to Mouldy core. This can develop from infections by various fungi initiated at any stage of fruit development or postharvest.

Many conditions in the orchard and postharvest environments have an influence on the incidence of rots. These include:

- The number of spores in the drench liquid (can be reduced by minimising leaf litter and other debris and by using clean bins)
- The susceptibility of the fruit tissue to fungal attack which is in turn greatly influenced by fruit maturity, nutritional status and rough handling
- The storage duration, temperature and atmosphere
- Varietal characteristics of the apples or pears
- Fruit shape and drenching practices
- The effectiveness of fungicidal treatments, both pre- and post-harvest
- wet weather before harvest and harvesting fruit when wet
- contamination of fruit bins with orchard soil

Rot control can be influenced by attention to the above practices. In particular it is important to follow good hygiene to remove sources of infection from the storage shed. Use of fungicides should only be a part of an overall plan to minimise rots in stored fruit. Table 3 lists currently registered fungicides available for post-harvest use to help reduce problems of fruit rotting in storage.

Table 3. Fungicides approved for postharvest use on apples and pears [1]

Group	Activity group	Trade name	Active ingredient
A	Benzimidazole	4 Farmers carbendazim 500 fungicide WP	carbendazim 500 g/kg
		BASF Bavistin FL Systemic Fungicide	carbendazim 500 g/L
		Campbell Goldazim 500SC systemic fungicide	carbendazim 500 g/L
		Chemag carbendazim 500 SC fungicide	carbendazim 500 g/L
		Conquest Commodore 500 fungicide	carbendazim 500 g/L
		Crop Care Bavistin FL Systemic Fungicide	carbendazim 500 g/L
		Farmoz Howzat SC systemic fungicide	carbendazim 500 g/L
		Halley Carbendazim 500 systemic fungicide	carbendazim 500 g/L
		Kendon Carbendon SC systemic fungicide	carbendazim 500 g/L
		Kenso Agcare Carbendazim 500 SC systemic	carbendazim 500 g/L
		Nufarm Carbend fungicide	carbendazim 500 g/L
		Nufarm Spin Flo systemic fungicide	carbendazim 500 g/L
		Ospray Carbendazim 500	carbendazim 500 g/L
		Sava 500 fungicide	carbendazim 500 g/L
		Shincar 500 SC fungicide	carbendazim 500 g/L
		Superway Carbendazim 500 systemic fungicide	carbendazim 500 g/L
		Farmoz Storite Flowable SC	thiabendazole 500g/L
		Tecto Flowable SC [1]	thiabendazole 500g/L
B	Dicarboximide	Campbell Ippon 500 Aquaflo fungicide	iprodione 500g/L
		Corvette Flowable fungicide	iprodione 500g/L
		Farmoz Civet Aquaflo fungicide	iprodione 500g/L
		Farmoz Chief Aquaflo fungicide	iprodione 500g/L
		Rovral Aquaflo fungicide	Iprodione 500g/L
		Rovral 750 WG fungicide	Iprodione 750g/kg
C	Demethylation inhibitor	Campbell Magnate 750 WSP fungicide	imazalil sulphate 750 g/kg
		Campbell Magnate 750 WG fungicide	imazalil sulphate 750 g/kg
		Dow Agrosciences imazalil 750 SP fungicide	imazalil sulphate 750 g/kg
		Farmoz Imazagard 750 WSP fungicide	imazalil bisulphate 750 g/kg
		Fungaflor 750 SG Janssen fungicide	imazalil sulphate 750 g/kg
		Fungaflor 500 EC Janssen fungicide EC	imazalil 500 g/L
		Fungaflor 750 WSP Janssen fungicide	imazalil sulphate 750 g/kg
		Fungazil 500 EC fungicide	imazalil 500 g/L
		Magnate 750 WSP fungicide	imazalil sulphate 750 g/kg
		Magnate 750 WG fungicide	imazalil sulphate 750 g/kg

Notes:
[1] Tecto Flowable SC does not have approval for pears.

Always refer to the product label before use. Products current at time of revision (April 2007)

If export is intended check chemical registration/use requirements of importing countries.
To achieve the required control spectrum, especially where fungicide resistance occurs, products of more than one group may need to be used together. Products with a resistance warning should have a resistance management strategy on the label. Tank mix chemicals only where compatibility has been established (check labels). Rovral and similar products may loose their effectiveness if the drench pH is above 7. As a result a pH buffering agent may be required. Suppliers can provide further information.

7. Calcium

The calcium content of fruit has a large effect on its quality, particularly on the quality after cold storage. Low calcium levels in apples are associated with bitter pit, both on the tree and during storage, and with breakdown and softening during storage. Raising the calcium levels in apples and pears, by tree sprays and/or postharvest drenches, decreases bitter pit, softening and the storage disorders breakdown, superficial scald and rot.

Rates of calcium:
Fruit from healthy or young trees - commercial grade calcium chloride can be used at up to 3 kg/100litres of drench
Fruit from older or less vigorous trees - more sensitive to lenticel spotting - commercial grade calcium chloride can be used at up to 2.5 kg/100litres of drench
STOPIT - liquid calcium chloride is as effective as the commercial grade or flaked calcium chloride when used at a rate of up to 1.3 L / 100L of drench.
Check compatibilities with other drench chemicals before use.
Never add concentrates to concentrates - dilute all chemicals in water before adding to "multimix" drenches
Remember calcium can cause injury to sensitive varieties ie lenticel spotting on Jonathans

8. Disposal of used drench

Consult local authorities such as EPA, water authorities, Agriculture Department and resellers.

National guidelines for the disposal of waste post-harvest drenches are in the process of being developed and approved by all states.

The Victorian Environment Protection Agency (EPA) has an information bulletin “Interim guidelines for the disposal of waste fungicides produced by apple and pear growers” publication 645, April 1999 which outlines procedures for the disposal of waste post-harvest drench.

9. Possible alternatives to DPA

There alternative scald controls which may be suitable in some circumstances. These include:

- I-MCP (Smart Fresh)
- Cultivars of fruit which are less susceptible to developing scald
- Use forecasting systems to predict which fruit are at risk of developing scald
- Use ultra-low oxygen storage to minimise the risk of scald and allow reduced DPA rates
- Use vegetable oils as anti-scald treatments. This is less effective than DPA, but is suitable for extending the life of organic fruit.

10. Safety

For safe handling of DPA refer to the product label.

11. Further reading

"Storage Technology for Apples and Pears" by Colin Little and Robert Holmes. Department of Natural Resources and Environment, Victoria, May 2000.

"Orchard Pest and Disease Handbook 2000-2002. Victoria – all regions & South Australia" 10th Edition. Editorial panel D. Williams *et al*. Published by Deciduous Fruit Australia Inc. 2000.

Appendix- DPA product labels (not included in PDF file)

Obtain the latest revisions of the product labels. Always read and carefully follow the label directions on the product container.