

STEM DECAY ON COLD STORED PEARS

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Research financed by DFPT-Research on behalf of the South African Apple and Pear Producers Association

Decay on the stems of cold stored pears exported from South Africa to discerning overseas markets, has to varying degrees, created problems over the past few years. In some cases, stem decay has resulted in rejections of pear consignments, with threats by importers to de-list suppliers until the problem has been resolved. The focus of this small-scale research initiative was to identify the pathogens responsible for stem decay on pears and to test the efficacy of various chemicals, with the objective to identify “soft” alternatives. It is hoped that these preliminary findings will lead to viable solutions for use in the pome fruit business in the not too distant future.

What is the fuss about ?

The pictures below show stem decay on packed Forelle pears after cold storage in 37 micron polyethylene bag liners. In most cases only the stem is affected, with no detrimental effect to the fruit itself (Figure 1). However, it is clear that the impaired cosmetic appearance of stems would not be acceptable to many clients. In advanced stages of development, mycelial fungal growth may be visible, presenting aesthetically unappealing fruit (Figure 2). In extreme cases, the decay can effect the fruit itself (Figure 3).

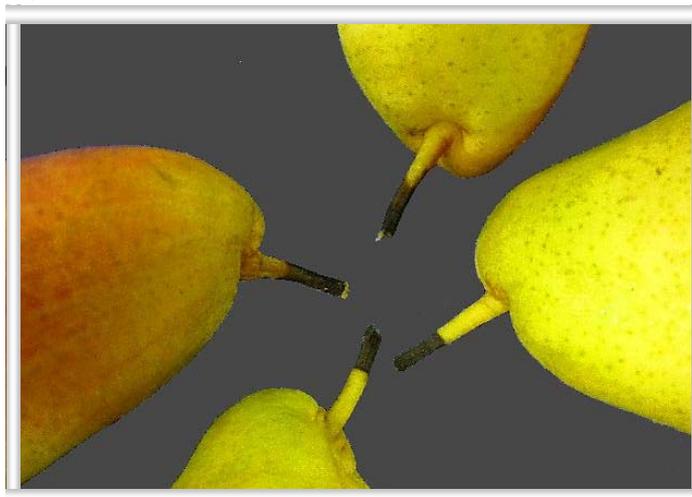


Figure 1: Forelle pears exhibiting stem decay with restricted mycelium growth

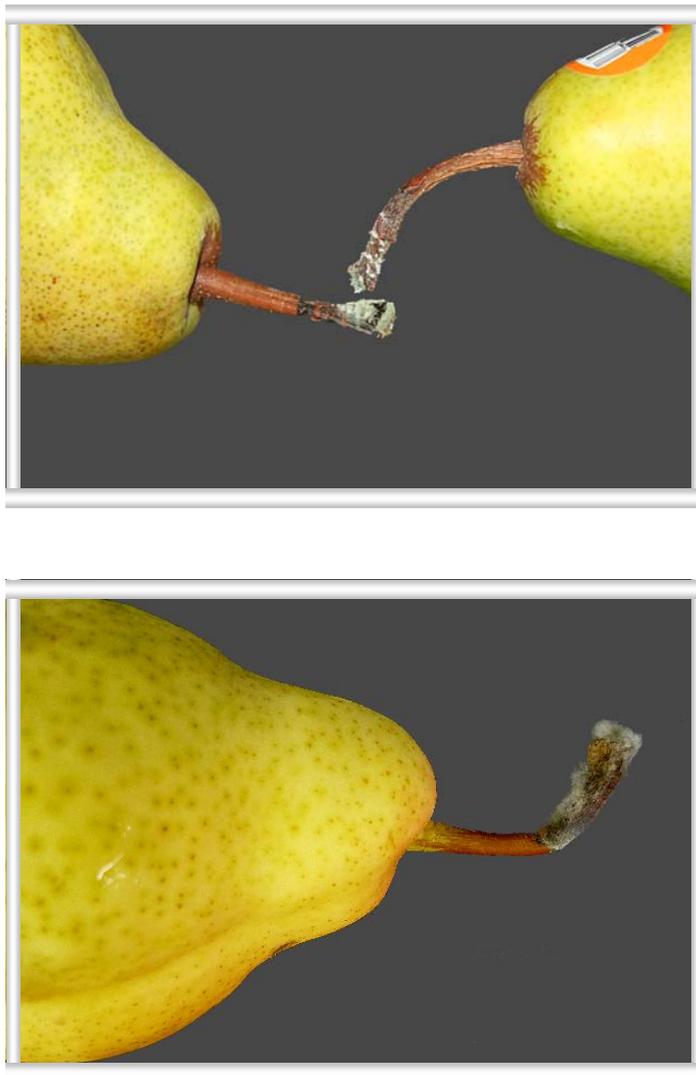


Figure 2: Forelle pears exhibiting stem decay with prolific mycelium growth



Figure 3: Pear exhibiting stem decay which has spread onto the neck of the fruit

Identification of pathogens responsible for stem decay in pears

Ten populations of Forelle pears stored under regular atmosphere (RA) and 10 populations stored under controlled atmosphere (CA) cold storage were evaluated. Fruit samples were taken before and after the various commercial post-harvest fungicide treatments on commercial pack-lines. Immediately thereafter, the stems were surface sterilised with 70% ethanol and sections of stems isolated onto nutrient enriched media in petri dishes. These were incubated at 21°C to isolate pathogens growing from within pear stems prior to packing. Incidence of fungal growth was determined by counting the number of petri dishes showing a particular pathogen, and expressing this as a percentage of the total number of dishes incubated.

No visible symptoms of stem decay were evident before or after the post-harvest fungicide applications, prior to packing. Hence, the isolations were conducted using stems with no visual symptoms of stem decay. It was found that *Alternaria* and *Penicillium spp.* were the predominant pathogens growing from stems of Forelle pears used in this study, while various other fungi and yeasts were also isolated. It must also be mentioned that previous research by [ExperiCo](#) has shown that in some instances, *Botrytis cinerea* can also be the cause of stem decay on pears.

Generally, controlled atmosphere stored fruit (Figure 4) exhibited a lower total pathogen count from the stems, compared to fruit stored under RA (Figure 5). As expected, generally, fewer pathogens were isolated from pears subjected to fungicide treatment prior to isolation. Irrespective of the cold storage atmosphere and pre-packing fungicide treatment, a complex of pathogens with the ability to create stem decay problems during transportation to the market, were isolated and identified. This means that improved technologies and/or products need to be developed to eliminate the potential problem of stem decay on packed pears. Levels of *Alternaria spp.*, and other fungi, were reduced by fungicide treatment (Figure 4 & 5), irrespective of the storage atmosphere.

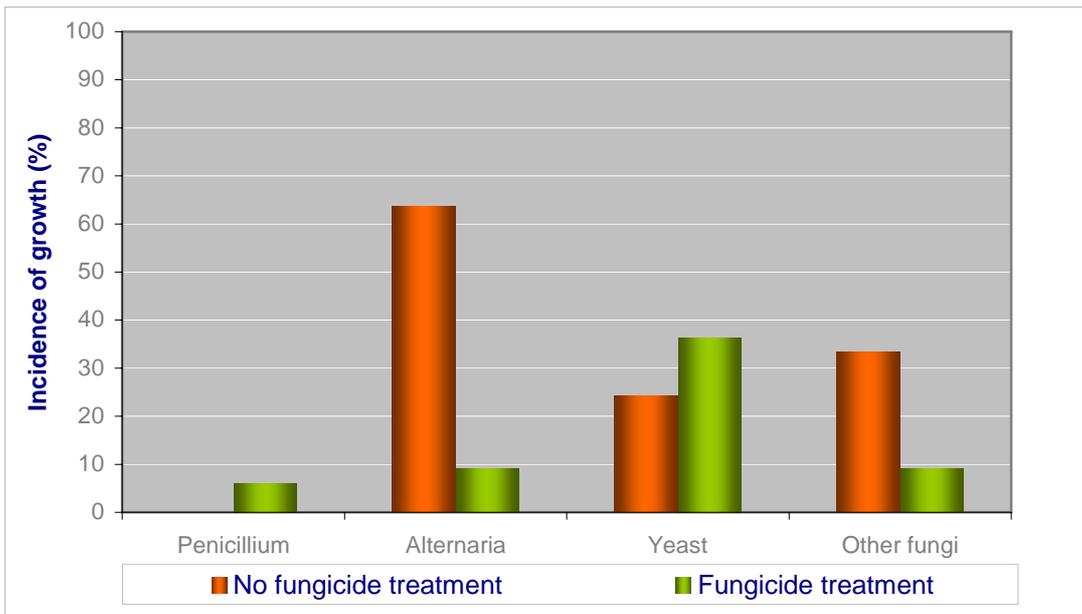


Figure 4: Incidence of growth of pathogens isolated from controlled atmosphere stored Forelle pear stems before and after pre-packing fungicide treatment

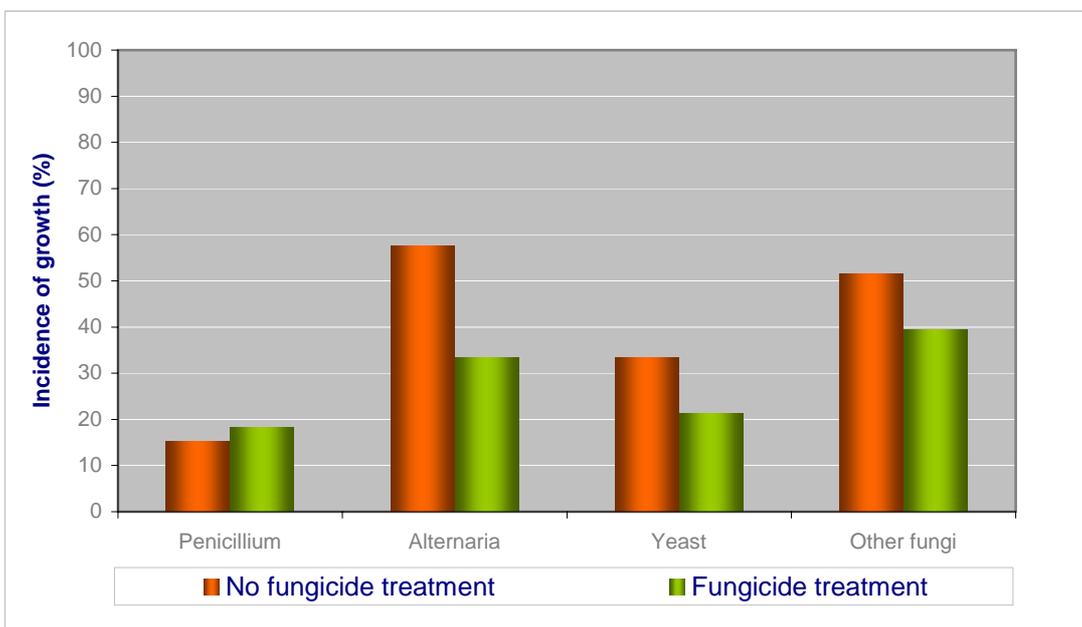


Figure 5: Incidence of growth of pathogens isolated from regular atmosphere stored Forelle pear stems before and after pre-packing fungicide treatment

Development of stem decay during cold storage of packed pears

Forelle pears sampled from the fruit populations used in the above trials, comprising CA and RA stored fruit, were either subjected to, or not subjected to pre-packing fungicide treatments (Table 1). The fruit was packed as for export in 37 micron polyethylene bags in 12.5 kg boxes, and cold stored for eight weeks at -0.5°C , followed by a simulated distribution period/shelf life comprising of one week at 20°C , and then examined for stem decay.

Controlled atmosphere stored fruit treated with fungicides at packing exhibited the highest incidence (99.9%) of healthy stems, with no stem decay (Table 1). CA stored fruit not subjected to fungicides developed an incidence of 19.1% stem decay during storage in the box, and of this, 2.1% exhibited prolific mycelium growth, as shown in Figure 2. The cause of this high level of stem decay is uncertain. In the case of the RA stored fruit, the fungicide treatment also reduced stem decay compared to no treatment, with levels relatively low at 3 to 4%.

Table 1: Effect of fungicide treatments applied on the pack-line onto different populations of regular and controlled atmosphere stored Forelle pears, on the incidence of stem decay, after storage for 8 weeks at -0.5°C + 7 days at 20°C

Storage prior to packing	Fungicide treatment	Incidence of stem decay (%) according to severity stem rating ¹			
		0	1	2	3
CA	No fungicide treatment	80.9	10.2	6.8	2.1
CA	Fungicide treatment	99.9	0.0	0.1	0.0
RA	No fungicide treatment	96.6	2.3	0.9	0.2
RA	Fungicide treatment	97.4	1.5	1.1	0.0

1 Stem decay was rated according to a scale from 0 to 3, where 0 = no fungal growth, and 3 = apex of stem covered with compact mycelium

While not tested in this study, other research by [ExperiCo](#) suggests that stem decay may be exacerbated by use of non-perforated bags, which result in high levels of relative humidity. Use of bags is usually required to retard skin colour development, maintain flesh firmness, and control moisture loss and associated shrivel. Therefore, removal of bags, or perforations in bags, is not seen to be a viable solution to this possible cause of stem decay. A more feasible solution will be to develop effective and acceptable pre-packing fungicidal control measures.

Efficacy of various chemicals and fungicides to control stem decay on pears

To conduct this study it was necessary to develop a method for successful inoculation of pear stems with the applicable pathogens. Spore suspension inoculation was compared to a pathogen mycelium impregnated agar-plug method. It was found that the agar plug method was more successful in inducing stem decay, and hence, this technique was used in the chemical efficacy studies. Forelle pears not treated with a pre-packing fungicide were sampled from a pack-house. Sound fruit with stems longer than 2.0 cm were selected and the apexes excised to provide stems with a healthy appearance, approximately 1.5 cm in length. Mycelia plugs with *Penicillium* and *Alternaria spp.* were placed on the stems for a 24h incubation period and then removed. Thereafter, fruit were immersed in the different chemical treatments for 1 minute, allowed to dry, and then packed as per export standard. A cold storage regime comprising eight weeks at -0.5°C , followed by a simulated distribution period/shelf life comprising of five days at 20°C was employed. Stems were examined for decay at the end of the total storage period.

Stem decay resulting from inoculation with *Penicillium spp.* (Table 2) was more severe than that obtained using *Alternaria spp.* (Table 3). In the case of *Penicillium spp.*, Sporekill[®], sodium bicarbonate and Iprodione treatments, in order of decreasing efficacy, gave significant control of stem decay compared to the water control treatment (Table 2). Sporekill[®] utilised at 2 ml/L gave significantly improved control compared to the same sanitiser applied at 1 ml/L by dip treatment. Levels of sporulation were low overall, but were lowest using Sporekill[®] at 2 ml/L and Iprodione. The finding that Sporekill[®] and sodium bicarbonate were more effective in controlling *Penicillium spp.* induced stem decay than Iprodione, is not all that surprising, since Iprodione is known to be more specific for control of *Botrytis* decay, the more prevalent decay causing pathogen on the fruit itself.

Table 2: Effect of dip treatments (immersion for 1 min) on the development of *Penicillium sp.* on inoculated stems of Forelle pears, after storage for 8 weeks at -0.5°C followed by 5 days at 20°C

Treatments	Length of stem decay (mm) ²	Sporulation ^{2,3}
Water	12.2a	0.6a
Sodium bicarbonate (5%)	5.8d	0.2bc
Sanitiser – Sporekill [®] (1 ml/L)	9.6bc	0.4ab
Sanitiser - Sporekill [®] (2 ml/L)	3.3e	0.1c
Fungicide – Iprodione a.i. (1 ml/L)	8.0c	0.1c
Prob>F¹	***	**

- 1 One-way ANOVA table where NS = non-significant. *, **, or *** represents significance at 5%, 1%, or 0.1% levels, respectively
- 2 Values in the same column followed by different letters, indicate significant differences ($P < 0.05$) according to the LSD test
- 3 Sporulation was ranked from 0 to 3, where 0 = no sporulation on stems, and 3 = abundant mycelium on stems

Low levels of *Alternaria* stem decay occurred after box storage (Table 3), with no significant differences in control of stem decay between the treatments and the water control. No sporulation was evident.

Table 3: Effect of dip treatments (immersion for 1 min) on the development of *Alternaria spp.* on inoculated stems of Forelle pears, after storage for 8 weeks at -0.5°C followed by 5 days at 20°C

Treatments	Length of stem decay ² (mm)	Sporulation ^{2,3} (0-3)
Water	1.6b	0.0
Sodium bicarbonate (5%)	1.2	0.0
Sanitiser – Sporekill [®] (1 ml/L)	1.0	0.0
Sanitiser - Sporekill [®] (2 ml/L)	0.5	0.0
Fungicide – Iprodione a.i. (1 ml/L)	0.8	0.0
Prob>F¹	NS	-

1 – 3 For definition see Table 2

This preliminary study suggests that Sporekill[®] should be further tested as a possible control agent against stem decay on pears. In addition to efficacy tests to be conducted on the fruit, and on the stems of the pears, application methods also require testing. The current status regarding the postharvest use of Sporekill[®] on export fruit is that the product is registered as a soluble contact fungicide applied as a post harvest dip or drench treatment, for the control of *Penicillium expansum* on apples and pears. In the case of sodium bicarbonate, which was evaluated as a “soft” alternative, further research is required prior to commercial application.

It is likely that fungicide solutions applied for stem decay on pears, will also help control calyx-end decay (Figure 6), which also in some instances adversely affects quality.



Figure 6: Forelle pear exhibiting calyx-end decay

Conclusions

The stage of the fruit handling chain with the most influence on manifestation of stem decay on pears is after packing, when the fruit is enclosed in a polyethylene bag liner inside the box for storage. Under these conditions of high humidity, pathogens already present in and on stems of pears proliferate, resulting in stems with unsightly brown/black discolouration caused by fungal development. In advanced cases, mycelia growth can also be seen on pear stems on opening of the bags at the end of storage.

The pathogens isolated from stems of pears in South Africa include *Alternaria*, *Penicillium* and *Botrytis spp.* Since the problem of stem decay is caused by a complex of pathogens, it stands to reason that a broad spectrum fungicide will be required to control the problem. In this regard, the sanitiser 'Sporekill®' showed potential as a dip treatment in combination with sodium bicarbonate. Prior to commercial implementation of these findings, the research must be repeated for verification purposes. Continued research in this field should also include :

- (i) The search for other "soft" fungicide alternatives, and combinations thereof.
- (ii) Determination of the impact of stem decay inhibiting fungicides on control of decay by different pathogens on the fruit itself.
- (iii) Determination of the most effect methods of post harvest fungicide application.

Currently Sporekill® is commercially registered as a post harvest dip or drench treatment for the control of *Penicillium expansum* on apples and pears, at a dosage of 100 ml/100L water. This means that Sporekill® could be applied to control storage decay on pome fruit, with the possible added benefit of controlling stem decay on pears during cold storage. In the case of sodium bicarbonate, should the need to commercialise this product be pursued, further laboratory and semi-commercial testing will be required to verify efficacy, and obtain permissible usage rates and application methods.