INFORMATION ON THE LITTLE UNDERSTOOD PROBLEM OF SOFT TISSUE BREAKDOWN IN COLD STORED TABLE GRAPES

W R WITBOOI[1], J F FOURIE[2] and M A TAYLOR[2]

1 Article written on behalf and in recognition of work by Werner Witbooi, posthumously

2 ExperiCo (Fruit Technology Solutions), P O Box 7441, Stellenbosch,7599, South Africa

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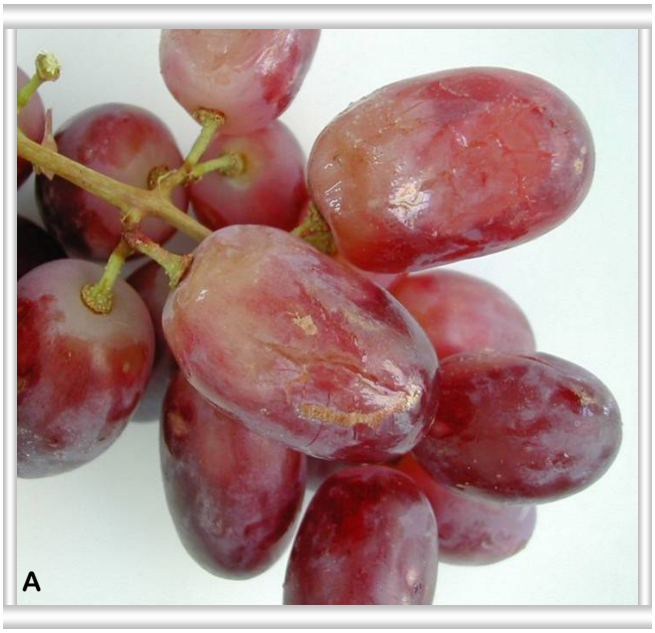
Introduction

Witbooi and Fourie (2002) published the first paper on Soft Tissue Breakdown (STB) for table grapes grown in South Africa. In this communication it was reported that this decay disorder (Figure 1), first identified by Dr Johan Fourie in 1999, was different to *Botrytis* decay. This is because STB is characterised by severe maceration of the flesh tissue of grape berries, and not slip skin, where the overlying skin easily parts from the flesh, which is indicative of *Botrytis* decay (Figure 2). Symptoms of STB on table grapes subjected to storage first manifests as cracking and dissolution of the epidermis (Morgan and Michailides, 2004), followed by sunken decayed areas, usually in the absence of superficial growth (Figure 1 a & b). Grey mould, the most widespread and important disease of grapes, caused by the fungus *Botrytis cinerea*, is characterised during storage by whitish mold growth with or without the production of grey-brown spores (Figure 3). A complex of pathogens, comprising *Penicillium expansum, Rhizopus stolonifer* and *Aspergillus niger,* as well as bacteria and yeasts, were isolated from berries with STB (Witbooi and Fourie, 2002). The research indicated that STB could be induced by inoculations with *Penicillium*, *Rhizopus* and *Aspergillus*, but not by the bacteria and yeast strains isolated from the infected tissue. The finding does not exclude the involvement of bacteria and yeasts in the development of STB, however, it seems that these micro organisms play a smaller role than in the sour rot complex. From a post-harvest control point of view, it was also established that SO_2 could not control STB, and in fact, seemed to contribute to the problem. The inability of SO_2 to control decay caused by *Penicillium* was also been reported by Franck *et al.* (2005). It is uncertain if the association between STB and SO_2 is due to SO_2 damage creating infection sites, or if the complex of pathogens firstly causes berry damage, which then subsequently increases susceptibility to SO_2 damage. Since post-harvest SO_2 application could not control STB, the recommendation was made to practice good pre-harvest hygiene and to prevent injuries to berries that would act as infection sites.



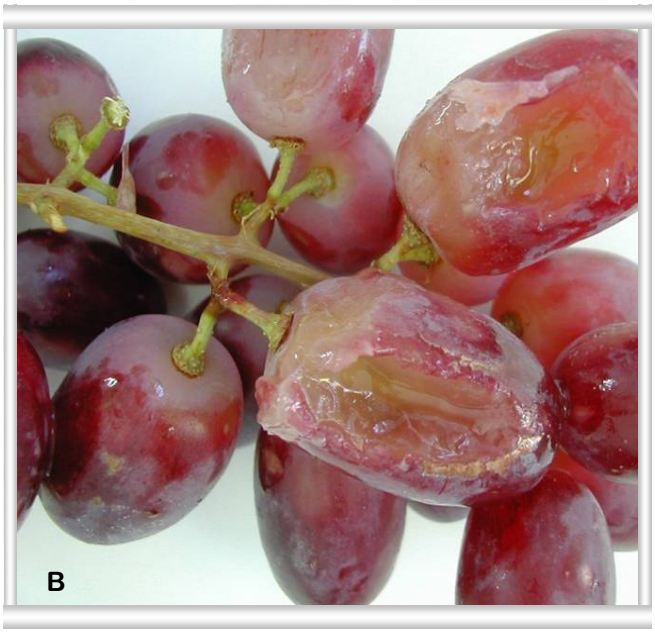


Figure 1 : Soft Tissue Breakdown on Crimson Seedless : (a) First manifests as cracks of the epidermis, followed by (b) sunken/macerated tissue

Market Survey

To establish if STB impacts on the quality of export grapes in the market place, a survey was conducted by examining grapes at the ports of Rotterdam and Antwerp. A total of 154 pallets of Red Globe, Sunred Seedless and Crimson Seedless grapes from different production areas in the Western Cape were examined. Three boxes of grapes were examined per pallet to ascertain the incidence of pallets with STB, as well as to establish the severity of the disorder by counting the number of infected berries per box. The results showed that while there was a high incidence of pallets with STB, the severity per box was quite low (Table 1).

Figure 2 : Botrytis infected grape berry with slip skin symptoms

Figure 3 : Botrytis on cold stored grapes

Table 1: Incidence and severity of Soft Tissue Breakdown on Red Globe, Crimson Seedless and Sunred Seedless grapes from different areas in the Western Cape, after examination at Rotterdam and Antwerp

Area	Sample size (pallets)	Incidence of STB (% pallets)	Severity of STB (number of berries per box)
Wellington	24	60.9	1.7 (± 2.1)[1]
Paarl	13	46.2	2.4 (± 5.4)
Hex River	91	46.2	1.0 (± 1.9)
Riebeek Kasteel	13	76.9	2.2 (± 2.0)
Saron	11	27.3	2.5 (± 5.5)

1 Values in brackets indicate standard deviation

What was disconcerting was the fact that the approximate 50% average pallet incidence of STB was considerably higher than the 3% incidence of *Botrytis* recorded (data not shown). This suggested that STB has the potential to seriously adversely affect the quality of export grapes. This is substantiated by discussions with grape exporters from other countries, where the disorder is often referred to as 'Melting decay' (Morgan and Michailides, 2004). It is highly likely that STB has occurred at various levels on cold stored table grapes for some time now, but that it has been classified under either general decay or *Botrytis* decay.

Research

Having established that STB is in fact cause for concern, the next logical step was to try and develop control methods. Based on discussions with table grape growers, it was decided amongst other things, to evaluate the efficacy of dusting with copper sulphur to lower the inoculum load of the STB pathogens before harvest, in order to try and eliminate the post-harvest problem.

The research conducted over two seasons involved a three pronged approach, namely:

(1) Evaluation of the efficacy of weekly dusting with copper sulphur at 15 kg/ha, commencing four weeks prior to harvest.

(2) Evaluation of sanitisers for pre-harvest control of decay pathogens.

(3) Testing of different SO_2 sheet types in combination with perforated and non-perforated outer bags to establish the impact on STB.

The findings revealed that none of the options tested would provide a satisfactory commercial control method against post-harvest STB. While dusting with copper sulphur resulted in more desiccation of decay infected berries in the vineyard in one year, it had no control effect the next. Similarly, pre-harvest application of sanitisers had no effect on controlling *Penicillium* decay either pre- or post-harvest, and similarly, did not lower STB levels after packing. As surmised during the overseas market survey, the SO_2 sheet and outer bag types also had no significant influence on STB control.

As is generally understood, the results of this study confirmed that the susceptibility of grapes to decay and sour rot increased with advanced maturity (Table 2). While the grape maturity data was unfortunately not measured in this study, the results indicated clearly, that both the incidence and severity of pre-harvest *Botrytis* (Figure 4) and sour rot (Figure 5) escalated drastically one week prior to the harvest of Red Globe grapes. Subsequent studies on other table grape cultivars have also shown a similar pattern. This clearly indicated that until an alternative control method against the STB pathogens present in sour rot can be developed, care should be taken to harvest table grapes at the beginning of the optimum harvest maturity window. This is obviously all the more important if pre-harvest monitoring in the vineyard reveals the presence of *Penicillium* (Figure 6), *Aspergillus* (Figure 7), *Rhizopus* (Figure 8) and/or sour rot infected berries. Based on these findings, it is vital that the frequency of vineyard monitoring for decay and maturity is increased near to the expected optimum harvest date, to enable effective fruit quality management, and where necessary, appropriate damage limitation.

Figure 4 : *Botrytis* on bunches in vineyard : (a) immature and (b) mature grapes

Figure 5 : Sour rot on grape bunches in the vineyard

Figure 6 : *Penicillium* on grape bunches in the vineyard

Figure 7 : *Aspergillus* on a grape bunch in the vineyard

Figure 8 : *Rhizopus* on a grape bunch in the vineyard

Table 2 : Development of *Botrytis* and sour rot in Red Glob table grapes in the four weeks prior to harvest

Disorder	Parameter	Assessment stage relative to harvest			
		3 wk before	2 wk before	1 wk before	Harvest
Botrytis decay	Incidence[1]	5.0	5.0	17.5	17.5
	Severity[2]	0.1	0.1	0.3	0.6
Sour rot	Incidence[1]	8.7	8.7	32.5	47.5
	Severity[2]	0.2	0.1	0.7	1.6

1 Incidence: Average percentage number of infected grape bunches across replicates

2 Severity: Average number of infected berries per grape bunch across replicates

Recommendations

Until a more effective control method for STB can be identified or developed, the following suggestions are made to assist growers in managing the potential problem:

(1) Vineyard monitoring

- Monitor the condition and maturity of grapes weekly in the vineyard up until two weeks prior to expected attainment of the minimum permissible harvest maturity for export grapes.
- From two weeks prior to reaching minimum harvest maturity monitor grape condition at least twice a week.
- Remember, the sooner remedial action is taken against sour rot and decay, the easier it will be to manage the problem nearer to harvest, as well as in the pack-store.

(2) Vineyard sanitation

- Remove wounded berries from bunches even if no decay is visible.
- Remove decayed berries if there are less than five affected berries per bunch.
- Remove bunch from vine if there are more than five decayed berries.
- Remove the entire bunch if oozing from a decay site on grape berries has occurred.

(3) Spray programme

- Follow the appropriate spray programme as recommended by a reputable chemical supplier.
- If specific decay problems have occurred in the past, or become apparent in the season, seek advise from the chemical supplier.

(4) Harvesting

- Monitor changes in harvest maturity by regular measurement of sugars (TSS) and acids, and keep records to show changes over time per block.

- Schedule harvesting as per market specific maturity/ripeness requirement, and harvest at the lowest feasible maturity, in order to lower the risk of STB and *Botrytis* decay.
- Should a high incidence of decay be apparent at harvest, first harvest all bunches exhibiting good condition, and leave those with decayed berries on the vine until a later harvest specifically planned for remedial action. This will assist in limiting spread of decay in the vineyard and the pack-store, and can assist in maintaining good packing speed and lowering the risk for decay development during storage.

(5) Packaging

- Ensure that the appropriate packaging, in particular the correct outer bag, is utilised. As previously mentioned, STB may develop on wound sites on berries which typically become even more damaged by SO_2. Therefore, it is critically important to guard against berry split, which can occur with insufficient ventilation (perforation configuration) in the outer bag.
- Also for control of berry split and SO_2 damage, ensure that use of any moisture absorbing material in the box is compliant with the specific cultivar and SO_2 sheet type recommendation. If there are uncertainties in this regard, contact your exporter for advise.

(6) Post-packing

- To avoid problems like berry split, ensure that temperature management is optimal. It is important to minimize breaks in the cold chain. These lead to the formation of condensation in the box, which in turn can increase berry split and SO_2 damage, and consequently, are also likely to exacerbate STB.
- If signs of *Penicillium* and *Aspergillus*, as well as sour rot, were detected in the vineyard and/or pack-store, it would also be prudent to try and schedule such export consignments to achieve the shortest possible total storage time. This will also assist in limiting berry split (Burger *et al.*, 2005) and development and spread of decay. If it is difficult to identify pathogens in the vineyard, it is imperative to contact a specialist pathologist for advice.

Future plans

This research has unfortunately been terminated due to other priorities. Should research on STB be continued, it would be good to include aspects such as canopy management into the programme, and the efficacy of ‘new’ chemicals for the control of STB. From a post-harvest point of view, it would also be important to ascertain the effects of SO_2, in combination with modified atmosphere packaging and ozone, on overall control of post-harvest pathogens in cold stored table grapes.

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