Returning South African export 'Pinkerton' fruit to mid-2000s' quality

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ABSTRACT

This project addresses the increase in 'Pinkerton' disorders experienced during the latter part of the last decade. During the 2013 season, three research approaches were followed. These were: processing of the SAAGA overseas technical officer's 'Pinkerton' data for the last decade; analysing the feedback received by exporters during the 2013 season; and determining the effect that differential growth and maturation rate patterns have on the size:maturity ratio of the fruit. The results indicated that the increase in physiological disorders experienced during the latter half of the decade is most probably attributable to fruit originating from young trees from the large number of newly established plantings. The situation was further exacerbated by the tendency to stretch the harvest window due to good prices attained at the end of the season. The situation can be rectified by returning to the set of recommendations formulated at the turn of the century. The most important of these are discussed.

INTRODUCTION

This project addresses the increase in 'Pinkerton' rind disorders observed during the latter part of the last decade. In contrast with rind disorders, internal disorders, particularly grey pulp, which was extremely prevalent during the nineties, were effectively controlled during the 2000s. This was most probably due to compliance to the most important recommendations formulated at the turn of the century (Kruger *et al*., 2000, 2001 & Snijder *et al*., 2002), while the introduction of controlled atmosphere and SmartFresh also made significant contributions.

Rind lesions became problematic towards the end of the 2000s. Our initial research on the topic has shown that two types of lesions occur, namely black cold damage (chilling injury) and a fungal infection associated rind senescence (Kruger, 2012). The latter was primarily found in late season fruit of advanced maturity. The rind senescence problem has since been addressed by improved scheduling of late season consignments according to maturation rate, as well as by better management of postharvest fungicide applications (Kruger & Mhlophe, 2013). However, black cold damage has remained problematic. The present paper reports on research conducted to identify the causes of the problem and certain recommendations are made to decrease the incidence of the disorder.

MATERIALS AND METHODS

The 2013 study consisted of three parts:

Processing of the SAAGA overseas technical officer's (OTO) 'Pinkerton' data for the last decade

The current OTO (Richard Nelson) kindly made the black cold damage records available for the 2000 - 2013 period. The mean incidence per season was calculated and the longitudinal prevalence plotted. This was then correlated with climatic data for the different growing regions.

Analysing the feedback received by exporters during the 2013 season

Feedback reports from two exporters are referred to in this report. The first involved 20 'Pinkerton' consignments from a single producer. The second involved 19 consignments with fruit from 12 producers that was exported by a second exporter.

Determining the effect of set specific differential fruit growth rates

During the 2013 season the maturation rates of 19 orchards supplying the Mayo Pack House were followed (Kruger *et al*., 2014). Five samples were taken as from the second week of April to the second week of June. In each case five individual fruit were sampled. The mass of each fruit was taken and the moisture content separately determined. The mass of each fruit was then plotted against its maturity.

RESULTS AND DISCUSSION

Processing of the SAAGA OTO 'Pinkerton' data for the last decade

The incidence of black cold damage recorded by the SAAGA OTO for the period 2000 - 2013 is shown in Figure 1. As may be deduced from the figure, the incidence of black cold decreased sharply from 2000 to 2005. It then increased, also linearly, from 2005 to 2008. The increasing trend continued from 2009 to 2013, but with large variations between years. For instance, the 2009 and 2012 seasons were characterised by lower than expected incidences, while the 2010 season showed a higher than anticipated incidence of black cold.

Three aspects were looked into in an effort to explain the above trends:

Effect of tree age

Due to the problems encountered with this cultivar during the late nineties, virtually no 'Pinkerton' trees were sold by the turn of the century. A drastic improvement in fruit quality set in during the early tens due to, firstly, the recommendations formulated during the late nineties (Kruger *et al*., 2000, 2001 & Snijder *et al*., 2002) and secondly, the aging of the existing trees. Due to the observed improved quality and the excellent productivity of this cultivar, many

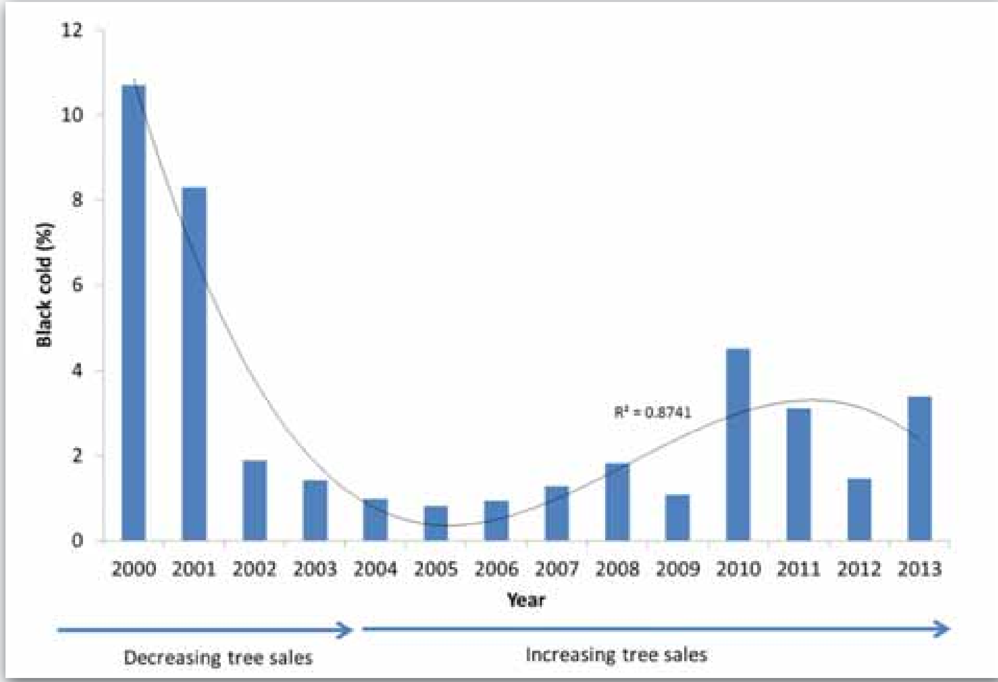

Figure 1. Incidence of black cold damage as recorded by the SAAGA OTO for the period 2000 - 2013.

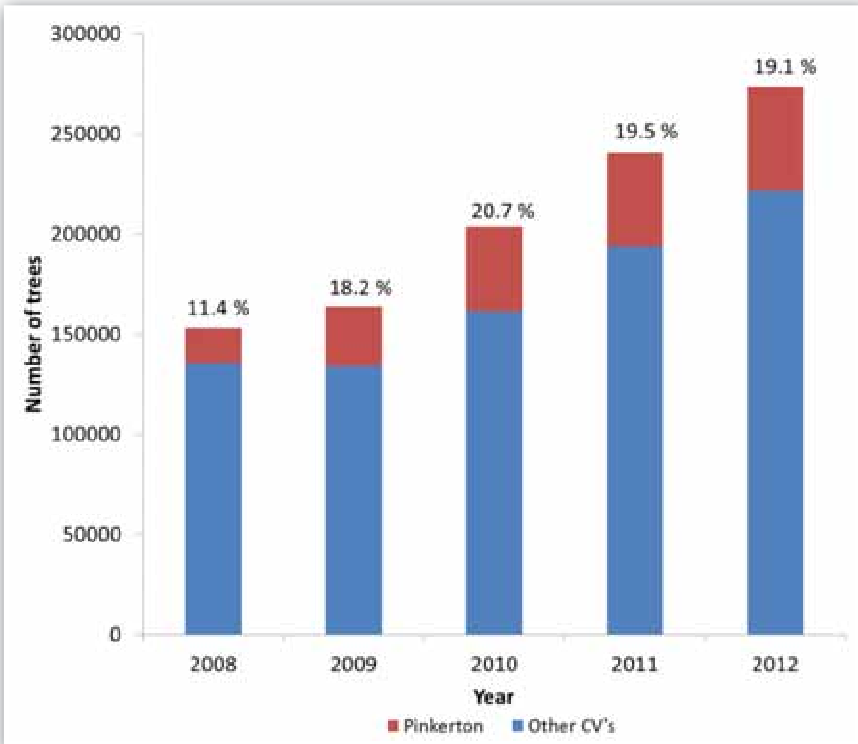

Figure 2. 'Pinkerton' tree sales for the period 2008 - 2012.

producers again started to plant 'Pinkerton' trees by the middle of the decade (Fig. 2). This most likely lead to a resurgence in physiological disorders, especially when the maturity cut off points were simultaneously ignored due to good marketing opportunities.

Possible effect of late summer orchard temperatures

As mentioned, an increasing black cold trend prevailed from 2005 to 2013 (Fig. 1). However, during two of the seasons (2009 and 2012), the incidence of black cold was considerably lower than expected. During another season (2010), it was again higher than anticipated.

Annually, the first 'Pinkerton' shipments usually take place during April. In an attempt to establish what effect pre-harvest orchard temperatures have on the incidence of black cold, the January - March minimum temperatures recorded in one of the production areas (Nelspruit) were plotted (Fig. 3).

Interestingly, the minimum temperature for the (high black cold) 2010 season reduced by only 0.0083ºC per day over the three month period. In contrast, the minimum temperatures reduced at a considerably faster rate (respectively 0.0635ºC and 0.0254ºC) during the (low black cold) 2009 and 2012 seasons.

The possibility therefore exists that pre-harvest orchard temperatures may influence the predisposition of the fruit to black cold damage, thus contributing to the observed variations between seasons.

Possible effect of sudden temperature reductions during the preceding winter

Since late set fruit are known to be more prone to black cold, an attempt was made to identify possible low temperature related late flower induction triggers during the winter preceding each season. To do this, the daily mean temperatures from the beginning of May to the end of August were plotted (Fig. 4).

Interestingly, during June 2009 (the winter preceding the problematic 2010 season) the mean temperature fell by approximately 9°C over a day. Similar reductions also occurred during the winters of 2010 and 2012 which preceded the problematic 2011 and 2013 seasons. In contrast, no such reductions occurred during the winters of 2008 and 2011 (the

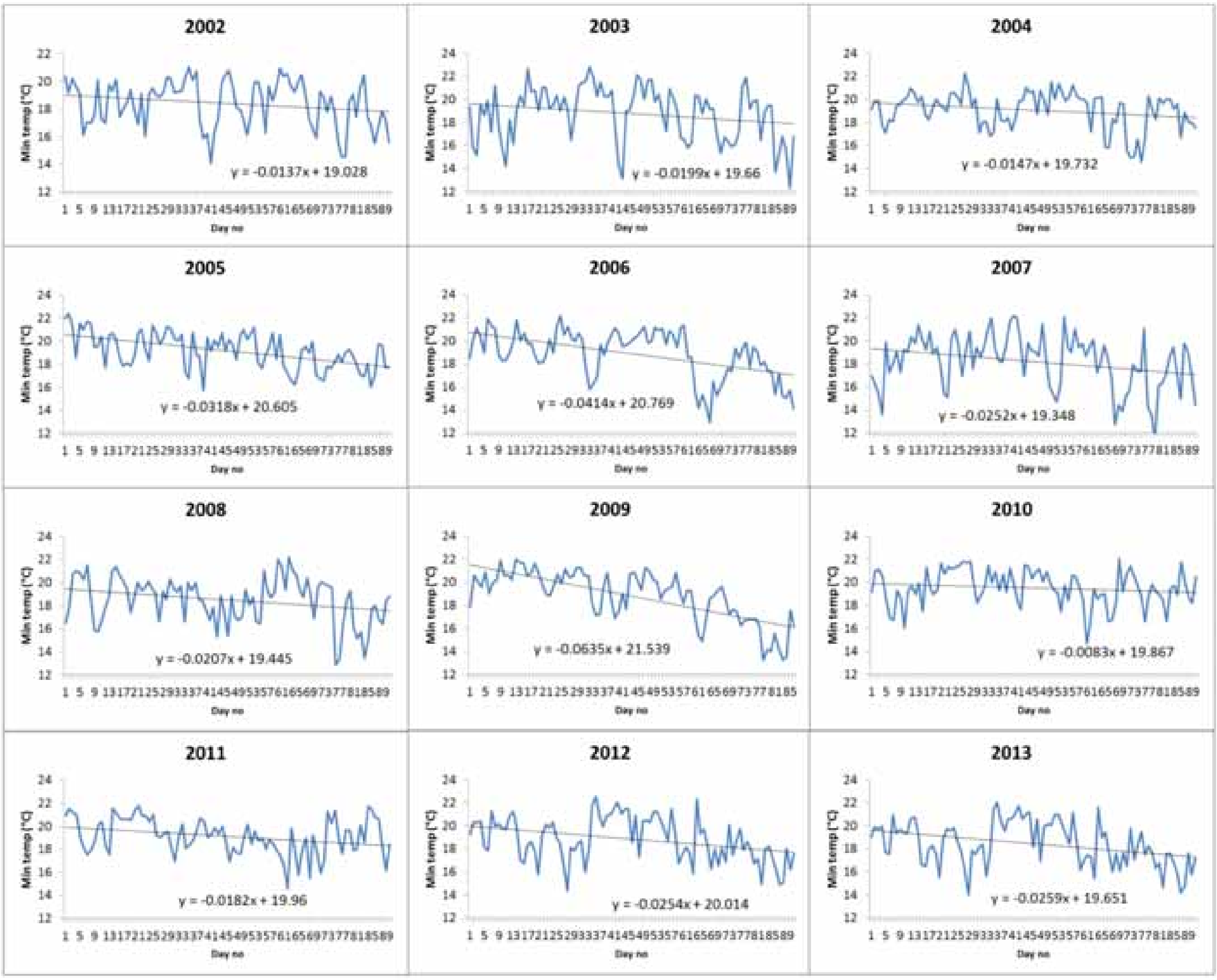

Figure 3. Minimum temperature readings for the period January - March in the Nelspruit area during the 2002 - 2013 seasons.

winter periods preceding the non-problematic 2009 and 2012 seasons).

It will be interesting to establish under experimental conditions whether the above temperature reductions do induce late flowering.

Analysing the feedback exporters had received from their clients during the 2013 season

Exporter 1

The quality of 20 'Pinkerton' consignments exported on nine ships by Exporter 1 is shown in Table 1. All the consignments were from the same grower and packed by a single pack house. The exporter was requested to assign a value between 0 and 3 for black cold/grey pulp to each consignment.

The following trends emerged from the table:

- The older orchards were considerably less prone to develop black cold than the younger orchards.
- Of the younger plantings, fruit from orchard P3 was most likely to develop black cold.
- Fruit from orchard P3 were also more prone to develop grey pulp, even at a relatively immature stage.

Orchard P3 is planted on a high potential soil. The above is thus a classical manifestation of the previously reported 'Pinkerton' problem, namely fruit from young trees planted in high potential soils give the most problems.

The storage temperature logs obtained from the exporter did not indicate that the above trends were associated with too low storage temperatures. For example, the storage temperatures logged for one problematic and two non-problematic consignments are shown in Figure 5. The exporter ensured that the temperature reduced at a relatively slow rate from ambient to 7-8°C during the first week. It was then kept at this temperature for approximately 10 days after which two of the consignments were further stepped to 6-7°C. The temperature regimes for the three consignments were thus quite similar.

Exporter 2

The results recorded by the importers receiving Exporter 2's fruit are shown in Table 2. The logistics of Exporter 2 differed from that of Exporter 1 in the following ways:

- Whereas Exporter 1 handled fruit from one producer, Exporter 2 handled fruit from 12 producers/farms.
- Black cold was scored by Exporter 1 on a scale

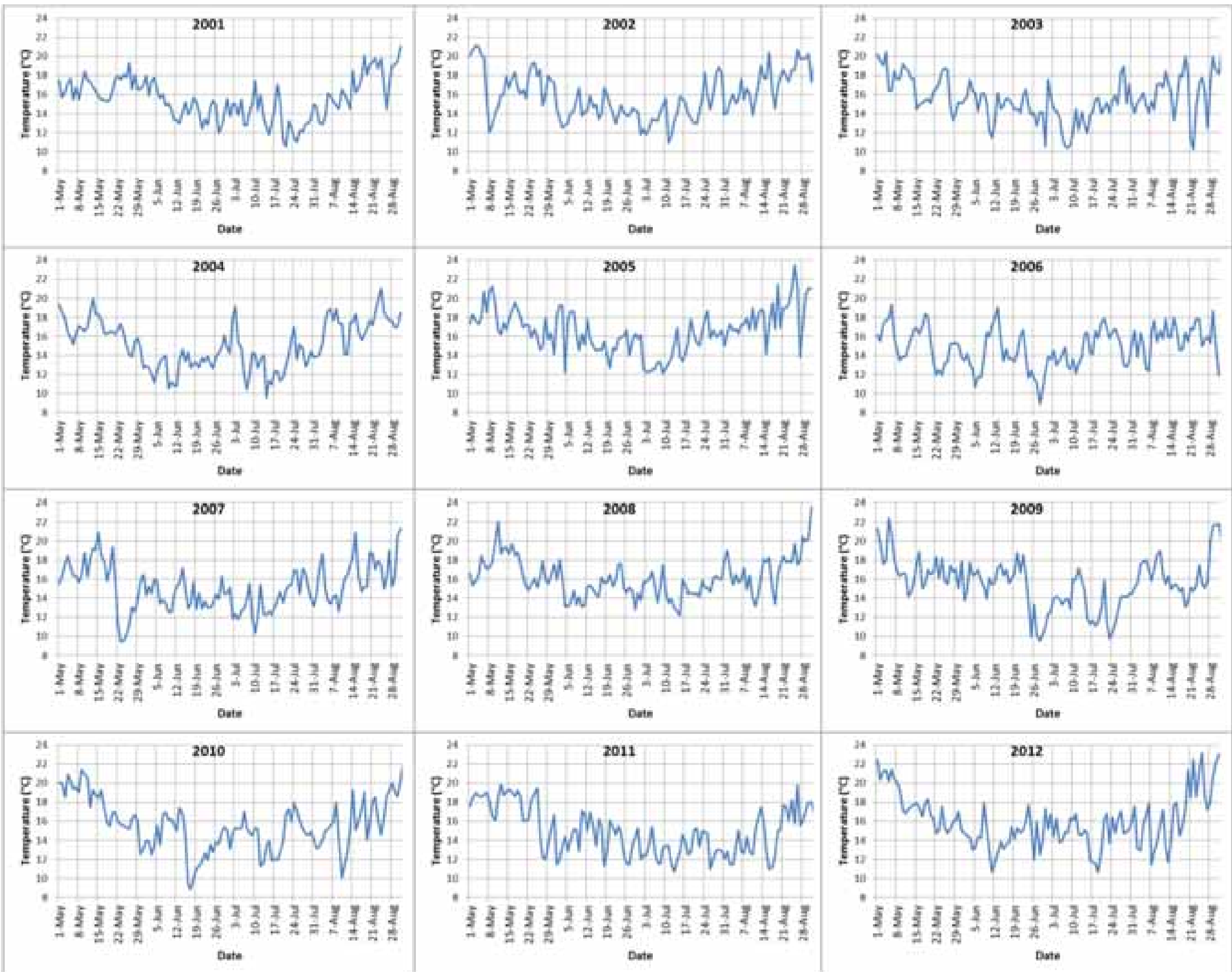

Figure 4. Mean daily temperature readings for the period May - August in the Nelspruit area for the 2001 - 2012 seasons.

between 0 and 3 while Exporter 2 provided a percentage.

- It was not possible for Exporter 2 to exactly date the older trees on many of the farms.
- In cases where two or three containers were packed on the same day with the same fruit, the containers were not shipped at similar temperature regimes. This created the opportunity to accurately compare the different temperature regimes.
- Exporter 2 lacked maturity information.

The first set of data we would like to discuss concerns Container 1. The following may be deduced regarding the background to Table 2:

- The importers in Europe inspected two samples each from, respectively, Producer A, Producer B and Producer C.
- The first set of samples were count ten fruit while the second set were, in that order, count 16, counts 12+14 and count 12.
- The orchards were all very young.
- Grower A, B and C's orchards were planted in, respectively, high potential, medium potential and low potential soils.

The temperatures logged during the journey are shown in Figure 6:

- The temperature was around 8.5 degrees for the first two days.
- It was then reduced to around 6.8°C where it remained until day 11.
- It was then stepped down to around 5.7°C over the next eight days.
- It remained at this temperature for the rest of the journey.

Table 1. Quality of 'Pinkerton' fruit exported by Exporter 1. The consignments were from a single grower and packed in the same pack house. The exporter assigned a score between 0 and 3 to each consignment for black cold and grey pulp.

Packing date	Ship	Orchard	Percentage of consignment	Tree age (yrs)	Fruit moisture	Black cold (0-3)	Grey pulp (0-3)
2 Apr	Dal Karoo	A 3B	21.9	2	74.9	2	0
		A 3C		2	75.3		
		Ra 4A	6.7	2	75.8		
		Ra 4B		2	77.7		
3 Apr		G 1.2F	50.7	4	79.9		
		R 4B	20.7	2	77.7		
4 Apr	Mol Cullinan	G 1.1E	48.2	4	77.4	1	0
		G 1.2E		4	78.7		
		G 1.1F		4	78.7		
6 Apr		G 1.1D	51.8	4	79.0		
		G 1.1C		4	79.3		
11 Apr	Dal Kalahari	G 1.1B	78.6	4	78.1	1	0
		G 1.1C		4	79.9		
		Ro 4A	6.9	25	75		
		Ro 5A		25	75.8		
12 Apr		Ro 1B	2.2	25	76		
		Ro 5A		25	75.8		
		B 20	12.3	5	77.6		
17 Apr	Lars Maersk	P 3.1E	43.2	4	78.6	2	1
		P 3.1D		4	78.3		
		G 1.1A	29	5	79.1		
18 Apr		P 3.2A	27.8	4	77.6		
		P 3.1C		4	77.2		
24 Apr	M. Caledn	P 3.4B	100	4	79.8	3	2
1 May	Saf Nokwanda	P 3.3D	71.7	4	79.2	3	2
2 May		P 3.2C	28.3	4	77.6		
9 May	Saf Nomazwe	P 3.2B	24.7	4	76.9	1	0
		P 3.2C		4	76.8		
		BB 9	27.6	18	77.1		
10 May		BB 9	47.7	18	77.1		
17 May	Maersk Gateshead	Rd 5	72.9	15	73.6	1	1
		Rd 6		15	72		
18 May		Rd 6	12.3	15	72		
		BB 8	14.8	18	73.5		
23 May	Dal Karoo	VR 1	15.7	7	75.4	0	0

The following deduction may be drawn:

- The fruit from Producer A (all counts) were most susceptible to black cold.
- The larger counts from Producer B were as susceptible to black cold as those of Producer A. However, the smaller fruit from Producer B was less susceptible to the disorder.
- The fruit from Producer C was least susceptible, the smaller counts had no black cold.
- The above information again reiterates the danger of exporting fruit from young orchards, especially when planted in high potential soils.

The second set of containers of interest are numbers 12, 13 and 14:

- The three containers were packed on the same date.
- They contained fruit from the same two producers (Producer B and Producer F).
- Feedback received from the importers regarding the above two producers were from the same counts (counts 8-12).

Table 2. Quality of 'Pinkerton' fruit exported by Exporter 2. The consignments were from 12 growers and were packed in the same pack house. Black cold damage is expressed as a percentage.

Container number	Arrival date	Grower	Count	Black cold (%)	Tree age	Soil
1	13-May	A	10	9	3	Good
1	13-May	A	16	8	3	Good
1	13-May	B	10	8	4	Medium
1	13-May	B	12/14	2	4	Medium
1	13-May	C	10	2	3	Poor
1	13-May	C	12	0	3	Poor
3	15-May	All growers		0		
5	22-May	B	12	2	Old	Medium
5	22-May	C	18	2	Old	Good
5	22-May	D	10	2	Old	Good
5	22-May	B	10	2	Old	Medium
5	22-May	B	8	2	Old	Medium
5	22-May	D	16	1	Old	Good
6	29-May	All growers		0		
7	29-May	All growers		0		
8	5-Jun	B	10	2	Old	Medium
8	5-Jun	C	8/10	1	Old	Good
9	5-Jun	E	10/12	10	Old	Good *
9	5-Jun	C	10/12	2	Old	Good
10	12-Jun	B	10	2	Old	Medium
12	20-Jun	B	10	3	Old	Good
12	20-Jun	F	10	2	4	Good
12	20-Jun	F	8	4	4	Good
13	20-Jun	B	12	6	Old	Good
13	20-Jun	F	12	6	4	Good
14	20-Jun	G	16	0	Old	Good
14	20-Jun	B	12	1	Old	Good
14	20-Jun	F	12	0	4	Good
17	26-Jun	F	8/10	3	4	Good
17	26-Jun	H	10	3	Old	
17	26-Jun	F	16	4	4	Good
17	26-Jun	F	18	1	4	Good
17	26-Jun	I	12	2	Old	Poor
17	26-Jun	F	12	3	4	Good
18	26-Jun	F	10/12	10	4	Good
18	26-Jun	I	10/12	8	Old	Poor
18	26-Jun	J	10/12	5	Old	Good
18	26-Jun	K	10/12	7	4	Good
19	17-Jul	L	10/12	15	4	Medium
19	17-Jul	L	14-18	5	4	Medium

* Poor orchard management

From the feedback the following deductions may be made:

- Black cold was highest in container 13 at 6%;
- it was intermediate in container 12 at 2-4%; and
- it was lowest in container 14 at 0-1%.

The temperature recordings for the above containers are shown in Figure 7. The following apply:

- The consignment with the highest black cold scores (container 13) was a door to door container that was loaded at 6.5°C and which remained around this temperature for the duration of the journey.
- The container with intermediate scores was loaded at 6.3°C but the temperature went up to 7°C within a day where it remained for two days. It then briefly returned to 6.3°C before steadily climbing to 7.4°C and ending at 6.5°C.
- The best container was loaded at 7°C. It then went up to 7.5-8°C for four days after which it steadily reduced to reach a minimum of around 5.7°C on day 21.

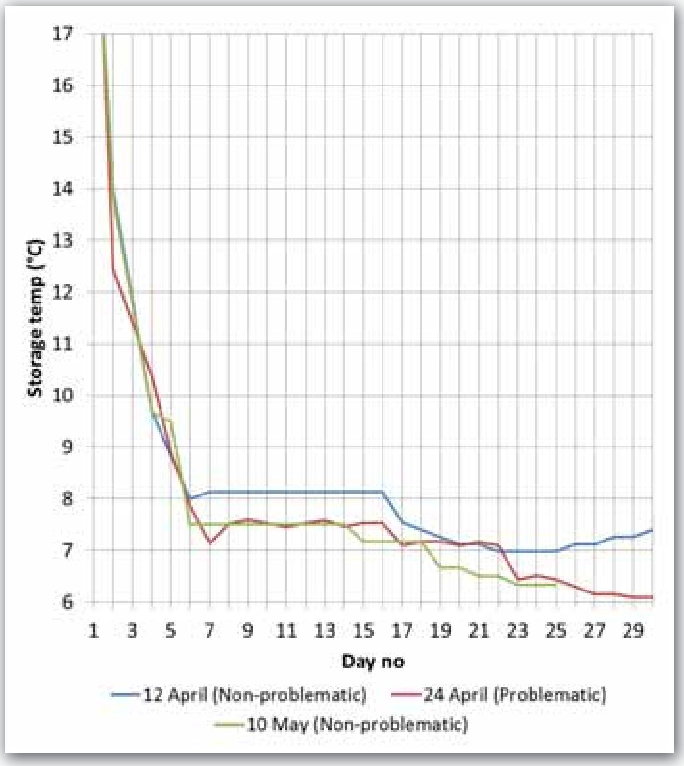

Figure 5. Storage temperatures logged for one problematic and two non-problematic consignments by Exporter 1.

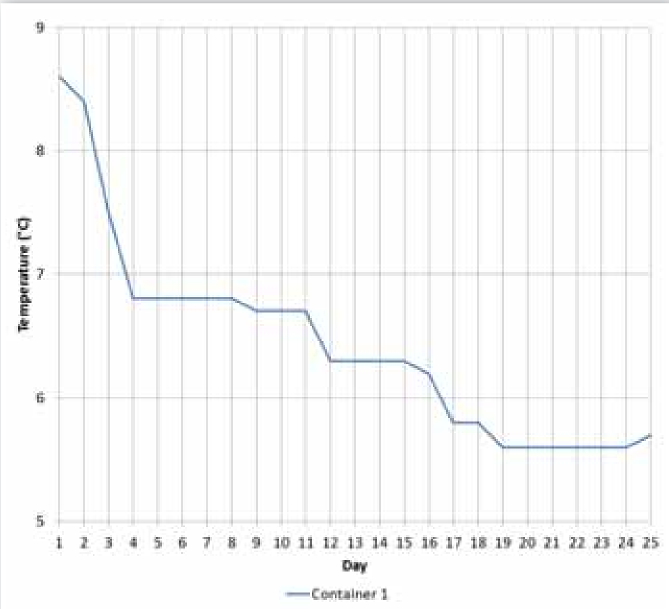

Figure 6. Temperatures logged for container 1 by Exporter 2.

The third set of containers of interest is numbers 17 and 18. The following similarities occurred:

- The two containers were packed on the same date.

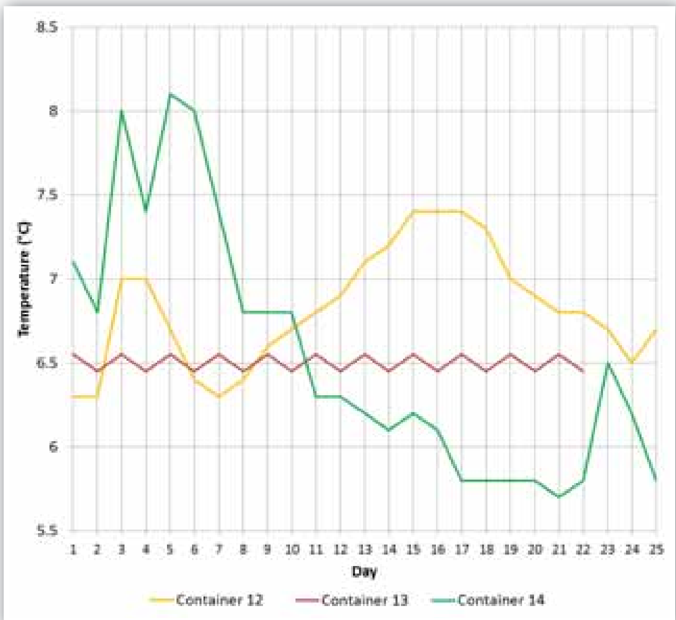

Figure 7. Temperatures logged for containers 12, 13 & 14 by Exporter 2.

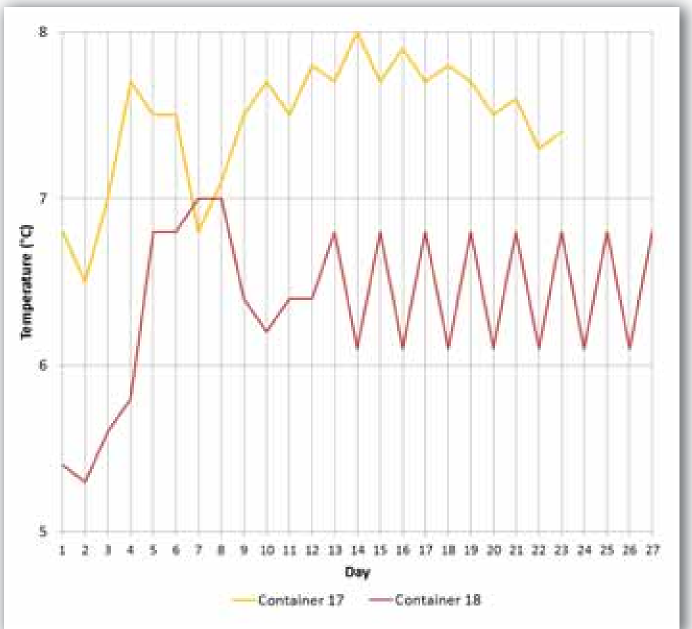

Figure 8. Temperatures logged for containers 17 & 18 by Exporter 2.

- Two producers (Producer F and Producer I) contributed to both containers.
- Feedback received from the importers regarding the two producers were for bigger as well as smaller counts for container 17 and for bigger counts only in the case of container 18.

From the feedback the following deductions may be made:

- Black cold was highest (8-10%) for bigger count fruits from both producers packed in container 18.
- Black cold was lowest (1-4%) for bigger count fruit from both producers packed in container 17.

The temperature recordings for the above containers are shown in Figure 8. The following apply:

- The consignment with a high incidence black cold (container 18) was loaded at around 5.3°C. It then went up to 7°C by day 7 after which it decreased to around 6.4°C for the remainder of the period.
- The container with a low incidence of black cold was loaded at 7°C. It then went up to 7.5-8°C for four days after which it steadily reduced to reach a minimum around 5.7°C on day 21.

From the last two examples it is clear that Exporter 2 used too low loading temperatures.

Determining the effect of set specific differential fruit growth rates

It well known that bigger 'Pinkerton' fruit (counts 8, 10 & 12) are most susceptible to black cold damage. The article by Kruger *et al*. (2014) deals with distortions caused by the fact that later fruit sets grow faster than earlier fruit sets, causing the later set fruit to be larger but less mature than the earlier set by the time of harvest. The aim of the present study was to determine if the above trend was observable when comparing the size to maturity ratio of the fruit from the 19 orchards they surveyed.

By way of illustration, the relationship between the fruit mass and moisture content of fruit from two orchards are shown in Figure 9. In the first orchard there was a linear relationship between fruit mass and moisture content. This was true for both the first (Fig. 9a) and second (Fig. 9b) sampling dates. However, the slope of the linear regression line more than doubled

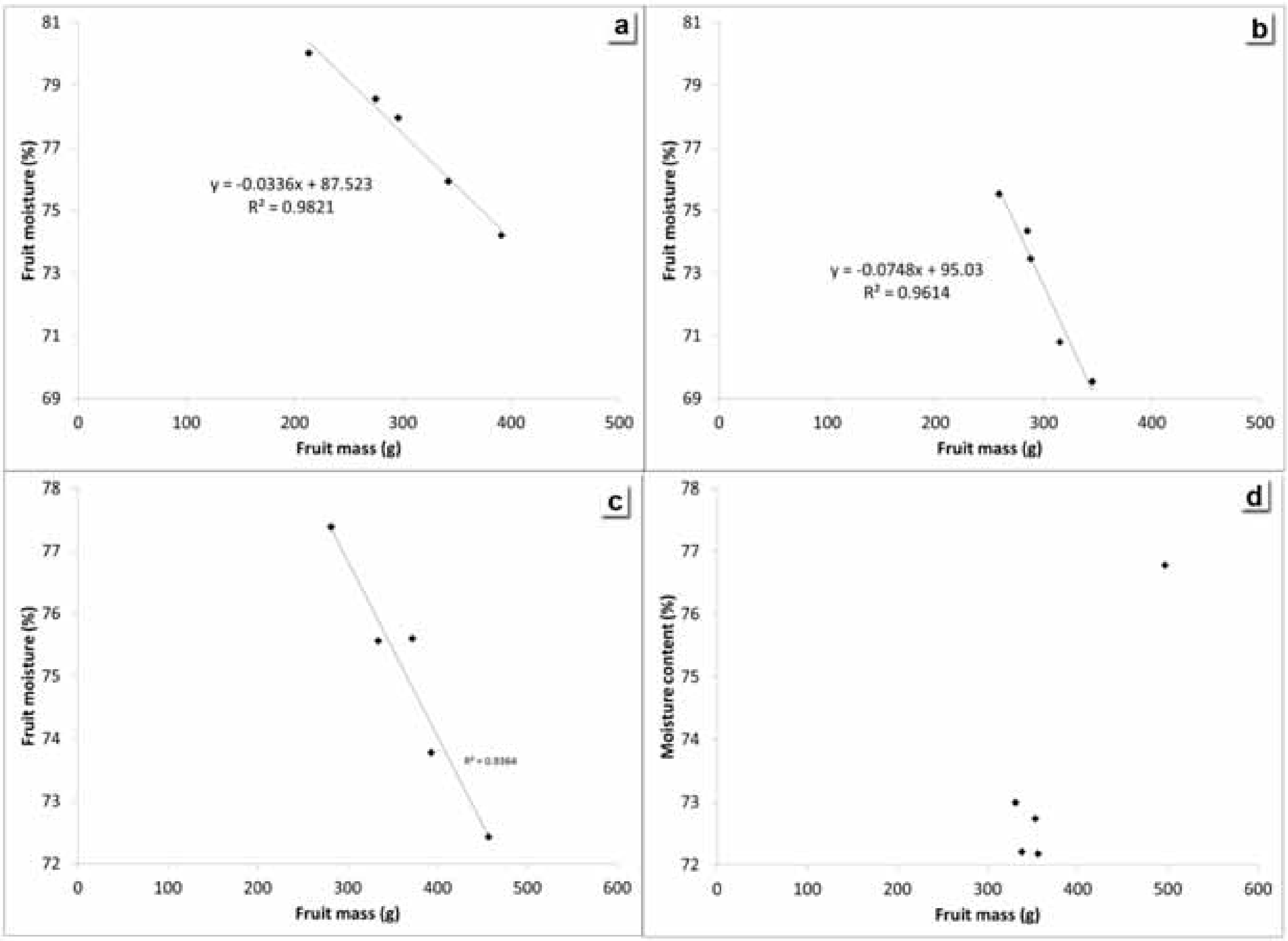

Figure 9. Relationship between the mass and moisture content of fruit from from two 'Pinkerton' orchards in the Schagen area during the 2013 season.

from the first to the second sampling date (-0.0336 vs -0.0748). This is an indication that the less mature fruit grew at a faster rate than the more mature fruit.

The second example (Figs. 9c and 9d) clearly demonstrates the large size/low maturity phenomenon. As was the case with the first example, a linear relationship existed between fruit mass and maturity on the first sampling date. However, on the second date, four of the fruit were between 300 g and 400 g and had moisture contents between 72% and 73%. However, the fifth fruit had a mass close to 500 g and a moisture content close to 77%. This is clearly a late set fruit that grew at an exceptionally fast rate and will most probably be more susceptible to chilling injury than the other four fruit.

CONCLUSIONS

The black cold problems that re-emerged when exporting the Pinkerton cultivar during the latter half of the last decade are due to the combination of a number of causative factors:

- The most important is the large number of new plantings that were established. Due to good overseas marketing opportunities, exporters did not follow the recommendation to market the first number of the season's fruit locally and they exported fruit from very young trees.
- Certain exporters also started to export the fruit at lower than the recommended temperature regimes during the early and mid-season. They got away with this during most seasons. However, climatically induced phenological differences between seasons resulted in increased levels of black cold during high risk seasons.
- Certain exporters started to significantly stretch the season, due to excellent prices realised during the late season. To do this, they made use of low temperature settings, particularly towards the end of the shipping period.
- Interestingly, although certain young orchards on high potential soils did show signs of grey pulp, the disorder was far less problematic than during the late nineties. This is most probably due to the fact that the producers' nitrogen management was considerably better than during the nineties. The introduction of controlled atmosphere and SmartFresh also significantly contributed towards controlling this disorder.
- The fungal infection associated rind senescence symptoms observed by Kruger (2012) were also successfully dealt with by more effective prochloraz applications.
- It is recommended that the current project be continued as a service project and that the researchers retain a hands-on approach to ensure that a healthy balance is struck between the basic recommendations formulated at the turn of the century and marketing considerations.

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