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Evaluation of avocados exported to Europe and the UK during the 1999 season

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ABSTRACT

Although prices achieved on the export markets during the 1999 season were generally high, this was more a result of the markets being under-supplied with avocados, than because South African avocados were of superior quality this past season. The incidence of severe quality defects was alarmingly high during 1999, with black cold injury, grey pulp and soft arrivals being the most common problems. Fortunately, market conditions allowed overseas agents to move stock quickly and to sell enough better quality fruit for high prices so that poorer quality fruit did not, in general, have a major impact on average market prices or returns to growers.

1999 was both a low-cropping year and a high rainfall year for the majority of the production areas. These two factors are the most likely explanation for the higher incidence of quality problems. There are, however, strong indications that the grey pulp problems were exacerbated by fruit often having been over mature at the time of harvest. Fruit physiological maturity needs to be regularly monitored throughout the export season and the industry is warned of the dangers in hanging fruit late — a maximum maturity standard with respect to harvesting for export, is called for.

The European Union is rigorously applying the regulations covering the minimum acceptable standards for importation of avocados. South African Pinkerton exports were particularly severely affected by the application of these standards in Belgium and Holland during the 1999 season, since a high percentage of Pinkerton exports were severely affected by black cold and grey pulp. European officials ordered the destruction of numerous pallets of Pinkerton on the grounds that this fruit was unfit for human consumption. The image of Pinkerton in Europe has become severely tarnished and the industry will be obliged to ensure that Pinkerton exports are of an acceptable standard if consumer resistance to the cultivar is to be overcome.

INTRODUCTION

Evaluation of the quality of South African avocados on arrival in Europe and the UK has been part the South African Avocado Growers' Association's technical activities since

1988. Data collected over the years have allowed the industry to manage the shipment of avocados more effectively. The following trends have become evident:

1) Decreasing fruit firmness on arrival with increased time from packing to arrival in Europe.
2) External chilling injury (e.g. "Black Cold injury" refer to definitions given below) tends to be more common for less mature fruit and larger fruit tends to be more prone to such injury. The transport temperature regime selected has a direct influence on the incidence of external chilling injury.
3) Internal disorders ("Grey Pulp" and "Pulp Spot" refer to definitions given below) are positively correlated with fruit physiological maturity. The incidence and severity of such disorders can be exacerbated by incorrect transport temperature regimes and extended refrigeration.
4) The industry has been making extensive use of Controlled Atmosphere ("CA") shipment since the 1996 export season. Use of CA has consistently given better results in terms of fruit quality and shelf life upon arrival in Europe in comparison with conventional Regular Atmosphere ("RA") "porthole" container shipments.
5) "Off-years" (in terms of crop yield) tend to result in poorer quality fruit being delivered to the export markets than is the case during "on-years". 1999 was an "off year" for the majority of production areas.
6) Heavy rainfalls during or shortly before fruit harvest have an adverse affect on fruit quality. Rainfall figures were extremely high in many of the production areas during the 1999 season.
7) The Pinkerton cultivar is especially prone to severe quality defects after sea-transport to Europe. This is resulting in increasing resistance to South African Pinkerton as European buyers become more discerning.

The 1999 season confirmed many of the quality trends listed above and, in particular, highlighted the benefits of the use of CA transport. This paper presents and discusses the results obtained from quality data collected in Europe by the SAAGA Overseas Technical Officer ("OTO") during the 1999 export season. The discussion is primarily focussed on the issues which caused the most severe marketing difficulties in Europe during the past season, namely soft arrivals, external chilling injury, and grey pulp. Fuerte, Hass and Pinkerton quality are discussed in detail. Insufficient samples of Ryan, Edranol and Rinton were collected to permit meaningful analyses of quality data for these cultivars.

DEFINITIONS

Firmness: fruit firmness as an indication of ripeness, measured using a densimeter:

Densimeter Reading Fuerte	Category	Densimeter Reading Hass
>90	Very Hard	>96
85-89	Hard	92-95
82-84	Firm	90-91
77-81	Breaking	86-89
61-76	Soft	74-85
49-60	Very Soft	65-73
<48	Eat-ripe	<64

(Merensky Technological Services, pers. comm.)

Black Cold Injury: "Cold injury" as defined by Swarts (1984): Black or brown, irregularly shaped discoloration of the skin. The affected area is clearly defined and there is definite depression of the skin at the edges. The flesh directly adjacent to the lesion is not affected.

Dusky Cold Injury: "Dusky Cold" / "Bolverkleuring" / "Bulb discoloration" / "Distal-end browning" as defined by Kaiser *et al*.(1995), Leclercq (1989). A light to hazy brown coloration of the skin which usually affects the distal portion of the fruit. Affected fruit often display internal disorders such as pulp-spot, grey pulp, vascular browning.

Brown Cold Injury: A light brown hue to or discoloration of the skin. Lenticels tend to remain alive and healthy within the affected area. The edge of the affected area is less well defined than for black cold and is not sunken. The flesh of fruit exhibiting brown cold injury sometimes displays internal disorders.

Grey Pulp: A grey / brown / black discoloration of the mesocarp. For the purposes of this report, both "Internal browning" and "Grey pulp" as defined by Swarts (1984) have been classified as grey pulp. The OTO has observed that pulp discolorations are greyer in appearance when the unaffected flesh is more watery and whiter (less physiologically mature); and browner in appearance when the unaffected flesh is oilier and yellower (more physiologically mature). From a commercial perspective in Europe, the differences between grey pulp and internal browning are irrelevant — fruit with "internal browning" and fruit which "cut black" are equally unacceptable.

Vascular browning: Any discoloration of the vascular bundles and adjacent mesocarp tissue.

Pulp spot: brown / grey / black spots in the mesocarp which are either immediately visible when the fruit is cut, or which develop within a few minutes after cutting.

Lentidamage: External discoloration of the lenticels.

Sample: a standard sized export carton of avocados (370 mm x 285 mm x 90 mm external dimensions) sea-freighted to Europe.

COMMENTS ON MARKETING DIFFICULTIES

Although the focus of this paper is on fruit quality rather than marketing, the quality of the fruit delivered to the European market can have a major impact on market selling prices. It is thus important to discuss quality issues from the perspective of the overseas buyer, since it is ultimately the ability to deliver what the client wants that will determine the long-term survival of the South African avocado industry.

The 1999 season was characterised by extremely good prices being realised on the European market. It would, therefore, be logical to assume that the avocados that were exported during 1999 were of superior quality and deserving of good prices. The opposite was in fact true. Quality problems were often extremely severe (details provided below), and it was only because the European market was so under-supplied that prices remained at such a high level. Compare this with the 1998 export season, where the quality of most cultivars was extremely high, yet the European market was oversupplied. This meant that stock turnovers were often slow and fruit sometimes deteriorated as a result of extended cold-storage in Europe. Secondly, any soft arrivals (of which there were many instances as a result of logistical and shipping difficulties) or poor quality fruit had a very poor chance of being sold for an acceptable price. The end result was extremely poor returns to many growers during the 1998 season. Despite the more favourable returns during the 1999 season, quality and logistical problems did have an influence on market prices — average returns would no doubt have been even more favourable had these problems not existed. Put simply, a high percentage of poor quality fruit on one or more consecutive vessels, impacts negatively on market prices — even if a particular agent has received superior quality fruit, his ability to command a better price will be influenced by the average market price.

Soft arrivals of fruit cause immediate marketing difficulties, since shelf-life of softer fruit is limited and the agent may be forced to accept a lower selling price. The situation is exacerbated by the fact that in much of continental Europe, supermarkets demand hard avocados. The situation differs somewhat in the United Kingdom, which now ripens a large percentage of avocados prior to sale. The UK market is thus in a better position to handle softer arrivals, but here too there are problems. Fruit can either be too soft for sale to the UK supermarkets, or fruit will not be of uniform ripeness and additional labour costs will be necessary to select fruit of acceptable firmness. Most European importers regard a soft arrival as a quality problem, in reality it is more of a marketing problem since softer avocados are often of acceptable eating quality. Riper fruit are also more likely to have developed fungal infections than are fruit that arrive in a hard

condition — diseased fruit are completely unacceptable.

External chilling injury, in particular the "black cold" symptom to which South African avocados are often prone, is the second most severe quality problem after fruit firmness. Black cold is rarely seen on avocados from other origins and is often confused with Anthracnose infection, especially at the supermarket or wholesaler level.

Eating quality of avocados is naturally an important factor — poor quality fruit (e.g. exhibiting grey pulp or pulp spot) undermine consumer confidence and damage the reputation of South African avocados. European buyers are quick to refuse South African avocados once internal defects become common, preferring to switch to (what are perceived to be) "more reliable" sources. Over-mature fruit exhibiting grey pulps often cause such difficulties, pointing towards a need for a maximum picking maturity standard.

Although lentidamage is purely a cosmetic defect, acknowledged by the European trade not to affect the internal quality of the fruit, severe lentidamage can result in marketing difficulties. Hass and Fuerte are the two export cultivars most severely affected by lentidamage. In France in particular, lentidamage on Hass can be problematic even though this is not visible when the fruit ripen, since hard, green Hass are sold to the public — lentidamage is therefore still visible and the fruit cosmetically unappealing. In the UK, where Hass fruit are ripened prior to sale, Hass lentidamage is not a significant marketing problem.

SAMPLING PROCEDURES

The OTO was based in Rungis, France from mid March until mid September 1999. The majority of samples were collected from importers' warehouses on the Rungis Market on the day of delivery of sea-freighted containers from the Belgian port of Zeebrugge. In addition, during the 1999 season the OTO made five visits to warehouses in Antwerp and Rotterdam and four visits to warehouses in England in order to sample sea-freighted avocados delivered to these centres. It was considered necessary to undertake such trips in order to inspect different cultivars and count sizes sent preferentially to different markets (primary location for sample collection influences the count / cultivar spread of the samples). The OTO was instructed during the 1999 season to concentrate on Pinkerton where possible — this necessitated a number of Benelux trips, since very little Pinkerton tends to be delivered to the French market. Distances and travel times between the various centres in Benelux and England meant that in some cases fruit were sampled a day or two after delivery of the containers to the warehouses, rather than on the day of delivery itself as is usually possible in Rungis. Because containers from Zeebrugge are generally delivered to warehouses in Antwerp and Rotterdam within a few hours of container deliveries to Rungis, it was not possible to inspect fruit from the same vessel in both Benelux and Rungis — the majority of samples were therefore collected from either Benelux or Rungis. Delivery of fruit to English warehouses tends to be a day or two later than European deliveries — it was thus possible to sample fruit from English warehouses in addition to the samples from the same vessel collected from warehouses in either Benelux or Rungis. English samples were used to supplement sampling data from European deliveries.

Approximately 25 standard avocado cartons were selected for detailed arrival and ripe fruit analysis per vessel consignment delivered to Europe. Sample cartons were invariably selected from the uppermost layer of cartons in a pallet stack, and a different pallet was used for each sample carton. Practical difficulties make it impossible that the samples selected per vessel will be truly representative of the overall arrival quality of the fruit from that vessel. However the data provide sufficient information to allow trends to be seen and highlight quality problems over the season.

Evaluations:

Irrespective of the number of fruit ("count size") within a sample carton, 10 fruit were randomly selected for detailed arrival and ripe analysis. These sample fruit were individually numbered with a felt-tipped pen so that arrival and ripe quality of individual fruit could be recorded. The following information was recorded per sample fruit:

A: On arrival:

1) Fruit age from date of packing (days).
2) Fruit firmness using a densimeter.
3) Presence or absence (1 or 0) of black cold, dusky cold, brown cold, lentidamage. If Hass fruit were ripening upon arrival, lentidamage and black cold were difficult to distinguish, this should be borne in mind when interpreting the Hass lentidamage and black cold injury data presented below. Dusky and brown cold data were not recorded for Hass, these defects being difficult to distinguish from the normal ripening coloration.
4) Cosmetic defects (e.g. wind damage, picking injuries, insect damage).
5) Presence of infection (sooty mould, Anthracnose, stem-end rot).

B: When ripe (Hand-test — approximately equivalent to "Breaking" to "Soft" according to the densimeter scale):

1) External quality defects as listed above (point A3). The colouring of ripe Hass makes analysis of external chilling injury and lentidamage impossible.
2) Internal defects: Grey pulp, pulp spot, vascular browning. Fruit were cut open into two equal halves along the longitudinal (proximal to distal ends) axes.
3) Presence of Anthracnose, stem-end rot, sooty mould.

This report concentrates on the three problems which caused the major marketing difficulties in Europe during the 1999 season, namely fruit firmness, black cold and grey pulp.

RESULTS AND DISCUSSION

FUERTE

Figures 1 and 2 show averages per vessel sampled for fruit age, firmness, black cold and grey pulp for RA Fuerte and CA Fuerte respectively.

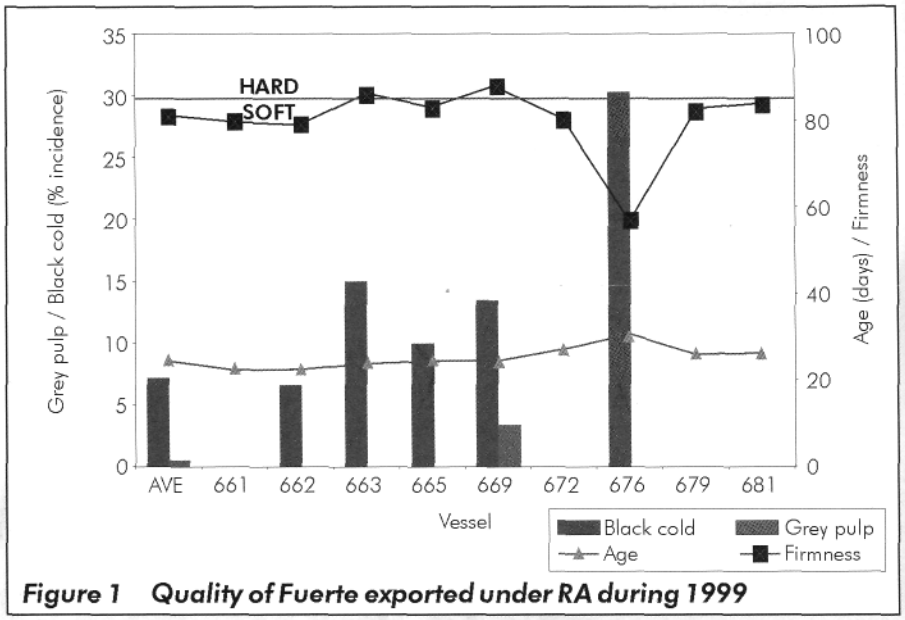

Figure 1 Quality of Fuerte exported under RA during 1999

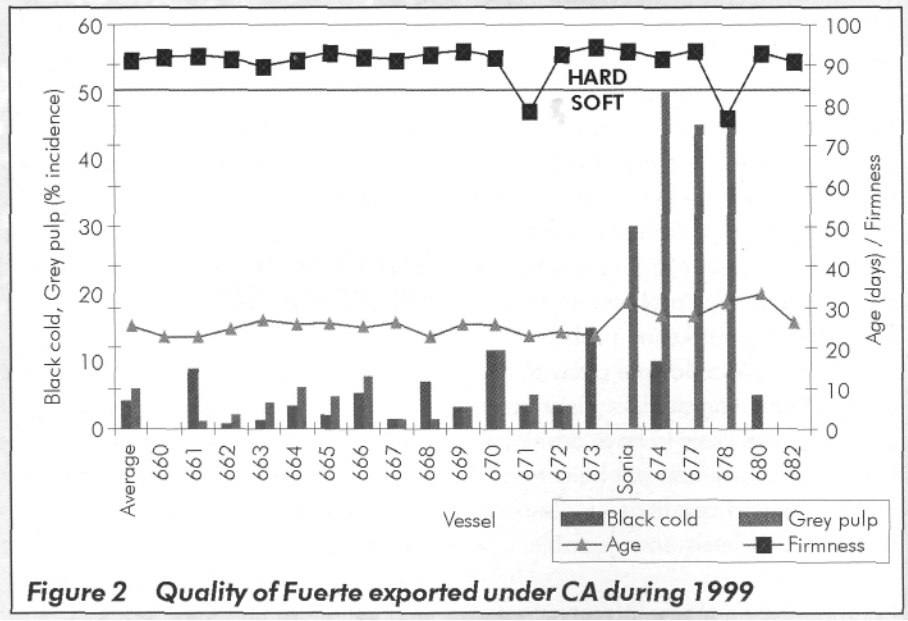

Figure 2 Quality of Fuerte exported under CA during 1999

Sample size for **RA Fuerte** was small – only 210 fruit were sampled over the 1999 season. The reason for the limited sample was that very few RA containers of Fuerte

were exported to Europe during 1999. Regardless, Figure 1 shows the poor results for RA shipments of Fuerte — most fruit were breaking to soft upon arrival in Europe. Average fruit ages upon arrival were 25.29 days 24.29 days for CA and RA samples respectively thus RA fruit was on average one full day younger upon arrival in Europe than was the case for CA samples. It is clear that the benefit of landing younger RA fruit did not result in improved fruit firmness.

Black cold incidence was high, with average incidence for the industry being 7.14%. It is interesting to note that the oldest fruit sampled 30 days old from vessel 676, were also the softest fruit sampled and had the highest incidence of black cold (30%).

This again confirms the strong correlation between fruit age and firmness and fruit quality for RA Fuerte shipments. With the exception of the mid-season sample from vessel 676, it is clear that black cold injury was confined to the early part of season — confirming that more mature fruit are less sensitive to cold injury. In view of the apparently low incidence of grey pulp for RA Fuerte (0.48%), it might at first glance appear that CA shipment result in poorer internal quality. In the light of the small sample size for RA Fuerte, it is difficult to make accurate comparisons however — soft fruit causes a greater immediate marketing problem than does internal quality.

The sample size for **CA Fuerte** (Figure 2) was considerably more representative — 1578 fruit were sampled. Table 1 provides quality data for different production areas for CA Fuerte samples (sample size for RA Fuerte was too small to allow for meaningful comparisons between different production areas). The number of fruit sampled ("**n**") must be taken into consideration when interpreting the regional results.

It can be seen from Figure 2 that except for two vessels, average fruit firmness upon arrival was always firm to very hard.

Black cold was an important quality defect throughout the season, with the industry average being 3.99%. This is in apparent contrast to the normal trend of fruit being more sensitive to black cold earlier in the season when oil levels are lower, and points to the extreme sensitivity of the fruit during a wet season. Incidence of black cold was considerably higher for fruit from the Kiepersol production area and noticeably higher for the Tzaneen production area than was the case for the remaining production areas.

The industry average for Grey Pulp was 5.89%, being present throughout the season. However, the graph shows a large increase in grey pulp incidence towards the end of the season, with between 30 and 50 percent of the sample fruit per vessel being affected. Grey pulp is generally accepted to be a "late-season" symptom — i.e. an indication of physiological over-maturity. This clearly points to a need to ensure that fruit are picked at the correct physiological maturity, rather than hanging fruit for marketing reasons. It must also be pointed out that fruit age on arrival was on average considerably older for vessels "Sonia" through 680 than was the case for earlier vessels sampled — the extended refrigeration time may have further contributed to the development of grey pulp in physiologically over-mature fruit. It will also be noted that the last two vessels sampled, vessels 680 and 682, showed no grey pulp. These sample fruit were of Natal origin, and are presumed to have been picked at the correct physiological maturity, thus being less prone to developing grey pulp. Also, in contrast to the situation for the northern production areas, it was an on-year in Natal, and

production was higher— internal fruit quality tends to be better during on-years (Donkin *et al.,* 1995). Table 1 shows an unacceptably high incidence of grey pulp for all production areas during the 1999 season.

Table 1 ***Incidence of various disorders in Fuerte fruit exported under CA during the 1999 season*** *(Percentage of fruit affected)*

Area	n	Age	Firmness	Grey Pulp	Black Cold	Lenticel damage	Stem-end rot	Anthracnose	Pulp spot
Levubu	519	25.29	91.51	4.0	2.7	14.3	6.4	6.2	4.2
Tzaneen	640	24,72	92.26	5.6	4.7	6.4	5.5	4.5	4.8
Kiepersol	230	25.04	91.76	7.4	9.6	10.0	3.5	5.2	0.9
Nelspruit	129	26.57	93.11	6.2	2.3	12.4	9.3	7.8	0.8
Natal	60	29.83	93.00	20.0	1.7	6.7	28.3	31.7	1.7
Industry	1578	25.3	91.47	6.0	4.0	10.0	6.7	6.5	4.1

The extremely high incidence recorded for Natal (20%) should not be interpreted as meaning that Natal fruit was of considerably inferior quality than was the case for the rest of the industry. Sample size for Natal fruit was small (60 fruit) and the high average incidence was caused by the inclusion of two sample cartons (i.e. 20 fruit) from vessel 677 which were of very poor ripe quality — these fruit also influenced the Anthracnose and stem-end rot data for Natal.

Table 1 records a relatively high percentage of CA fruit affected by lentidamage — this was however rarely severe enough to have caused marketing difficulties. Pulp spot incidence was considerably more common for fruit from Tzaneen and Levubu than for the other production areas. The industry average for pulp spot was 4.1 % for CA Fuerte and 8.57% for RA Fuerte.

It is interesting to note that during the 1996 export season, brown cold injury was considered to have been the most important quality defect in Fuerte (Eksteen *et al.,* 1997). Like 1999, 1996 was an extremely wet year and overall fruit quality was very poor. However, brown cold injury was not a significant quality defect during 1999. One major difference between 1999 and 1996, is that the overwhelming majority of Fuerte were exported under CA conditions during 1999, whereas during the 1996 season most Fuerte was exported in RA containers. During 1999, RA deliveries of Fuerte were more prone to brown cold (5.28%) than were CA deliveries (1.39%), in addition to being softer upon arrival. CA Fuerte affected by brown cold were primarily confined to a few early season samples originating from specific packhouses.

HASS

Sample sizes for CA and RA Hass were adequate, 695 and 928 fruit respectively. Figures 3 and 4 present vessel averages of fruit age, fruit firmness, grey pulp and black cold for RA Hass and CA Hass samples respectively.

Tables 2 and 3 present quality data for the various production regions for RA and CA Hass samples respectively. The number of fruit sampled ("**n**") must be taken into consideration when interpreting the regional results.

Table 2 ***Incidence of various disorders in Hass fruit exported under RA during the 1999 season*** *(Percentage of fruit affected)*

Area	n	Age	Firmness	Black Cold	Lenticel damage	Anthracnose	Stem-end rot	Grey pulp	Pulp spot
Levubu	220	25.55	90.27	0.0	24.5	14.5	12.7	16.3	0.0
Kiepersol	311	26.29	86.61	8.4	20.9	8.7	7.1	15.8	1.3
Natal	60	25.83	93.00	3.3	10.0	1.7	8.3	20.0	1.7
Nelspruit	118	24.29	92.51	0.0	19.5	11.9	3.4	11.0	0.0
Tzaneen	328	25.13	90.74	0.1	36.9	6.7	6.1	13.4	1.2
Industry	928	25.52	89.69	1.1	26.0	8.6	7.0	14.6	0.9

Table 3 ***Incidence of various disorders in Hass fruit exported under CA during the 1999 season*** *(Percentage of fruit affected)*

Area	n	Age	Firmness	Black Cold	Lenticel damage	Anthracnose	Stem-end rot	Grey pulp	Pulp spot
Levubu	130	25.31	94.32	0.8	43.1	14.6	8.5	19.2	4.6
Kiepersol	170	25.53	93.98	5.8	38.2	2.4	1.7	3.5	0
Natal	40	23.75	94.95	0	7.5	2.5	7.5	7.5	0
Nelspruit	100	24.70	94.93	0	17	9	6	14	1
Tzaneen	260	25.00	94.40	4.2	34.2	1.9	3.1	6.5	0
Industry	695	25.08	94.37	3.2	32.5	5.5	4.5	9.4	1

It can be seen in Figures 3 and 4 that fruit firmness on arrival was far more variable for RA fruit than for CA fruit — several arrivals of RA Hass were breaking to soft, whereas all CA Hass fruit sampled were hard upon arrival.

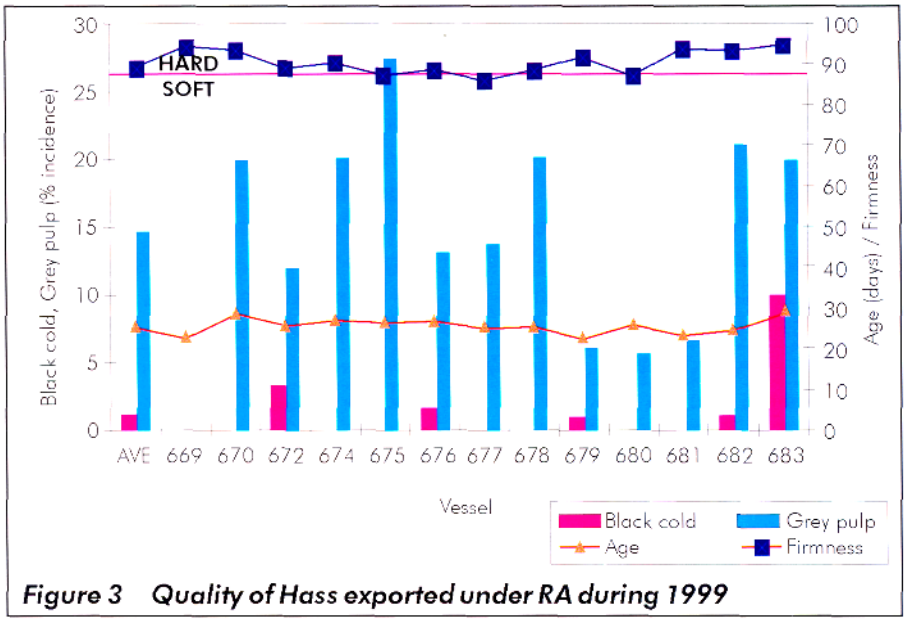

Figure 3 Quality of Hass exported under RA during 1999

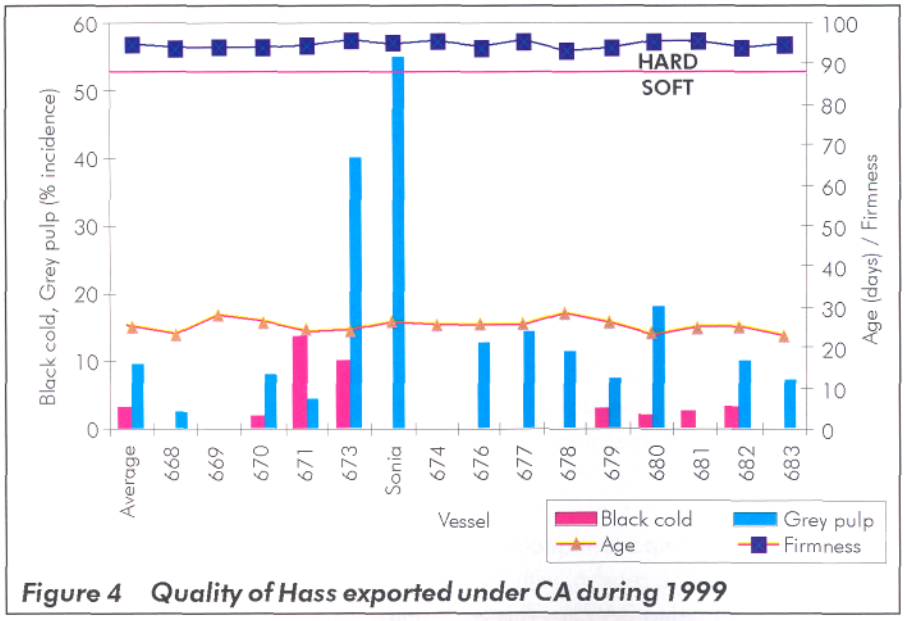

Figure 4 Quality of Hass exported under CA during 1999

Average ages of fruit samples were 25.52 days and 25.09 days for RA and CA samples respectively. It would appear that the incidence of black cold was higher for CA Hass (seasonal industry average = 3.17%) than was the case for RA Hass (seasonal average = 1.19%). However, many of the RA samples were already ripening (and hence colouring) upon arrival, making the cold damage less easy to see than would have been the case for harder, and green fruit. It is thus difficult to make meaningful comparisons between the incidence of black cold for RA and CA Hass samples. No seasonal trends in black cold incidence were discernible.

Incidence of Hass lentidamage was high during the 1999 season. This trend was not

unexpected, given the high rainfall, which makes fruit far more prone to lentidamage during the picking and packing process. Further, a general dispensation for an increased tolerance on Class 2 export quality Hass was granted during 1999. Despite the foregoing, it is important to note that while lentidamage was common, it was rarely severe and few complaints about lentidamage were received from European importing agents. This again highlights the influence market conditions can have upon the perception of "acceptable quality avocados" by the European Trade. The OTO's observations in Europe during the previous high rainfall year, 1997, indicated that lentidamage was somewhat more prevalent but not significantly more severe than was the case for 1999. However, 1997 was a more difficult marketing year as there was more competition from other avocado exporting countries than was the case during 1999. It is interesting to note that the French importers considered lentidamage on Hass to have been one of the quality defects causing the most severe marketing difficulties during 1997 (Minutes of French importers' meeting held on 13 June 1997).

Grey pulp incidence was high for both CA and RA Hass samples. Average incidence of grey pulp was higher for RA than for CA — 14.67% as opposed to 9.35%. This indicates that controlled atmosphere resulted in less grey pulp although the average incidence was unacceptably high for both CA and RA shipments. There is no discernible seasonal trend in grey pulp incidence for RA Hass. It must be noted that many of the RA Hass that were soft upon arrival often displayed severe grey pulp. For CA Hass samples, there was likewise no seasonal trend in grey pulp incidence discernible.

PINKERTON

There is a common belief within the industry that the quality problems being experienced in Pinkerton are a recent development, and that prior to the 1998 export season there were few quality problems with this cultivar. A probable reason for this misconception is that the European market is becoming more discerning and is providing more detailed feedback on quality to the industry. Further, it is only during the past two seasons that European officials have been inspecting imported avocados and rejecting fruit not meeting the European Standards. South African Pinkerton consignments have been subjected to rigorous inspections as the officials have become aware of the severe quality defects associated with this cultivar. Numerous complete pallets of Pinkerton were destroyed on the orders of E.U. inspectors during the 1999 season. The message is clear — avocados must be of acceptable quality or sale within the European Union will not be permitted. It should be noted that as far back as 1989, Hubert Leclercq reported on " …an alarmingly high incidence of cold injury" and " …very high incidences of grey pulp" in Pinkerton inspected in Europe during the 1988 export season (Leclercq, 1989). He also recommended that " …no new plantings (*of Pinkerton)* should take place until clarity (*as to the suitability of the cultivar for export*) has been obtained". It is unfortunate that the industry did not heed his warning.

During the 1999 seasons, black cold and severe internal grey pulp were common among Pinkerton samples inspected in Europe. A total of 570 fruit were analysed. With the exception of the two first Pinkerton consignments sampled, originating from vessels 669 and 670 (which were RA porthole and RA integral consignments respectively) all

fruit sampled were transported under CA conditions. The majority of the fruit sampled originated from vessels 672, 673, 674 and "Sonia" Maersk, which all docked in Belgium in a two-week period from the end of June to early July. This corresponds to the peak period of Pinkerton exports during 1999, when fruit from most of the production areas was present and could be sampled by the OTO. Since there was an indication during the 1998 season that certain production regions experienced a higher incidence of quality problems, samples collected by the OTO were divided into regions of origin: a) "Levubu" i.e. Levubu / Soutpansberg; b) "Kiepersol" i.e. Kiepersol / Hazyview; c) "Nelspruit" i.e. Nelspruit / Schagen; d) "Tzaneen" i.e. Greater Letaba production area (too few samples were collected from other production areas to allow meaningful data comparisons). It is acknowledged that such categorisation of the sampled fruit is problematic, since within the areas there are in may instances significant differences both in terms of soil nutrient content and climate. Further, the bias towards samples from specific vessels meant that fruit from the northern production areas would have been more physiologically mature than fruit from the southern production areas. Regardless, some interesting trends were seen:

Figure 5 shows seasonal comparisons of percentage incidence of grey pulp (Figure 6) and black cold (Figure 7) for the aforementioned production areas and the industry as a whole.

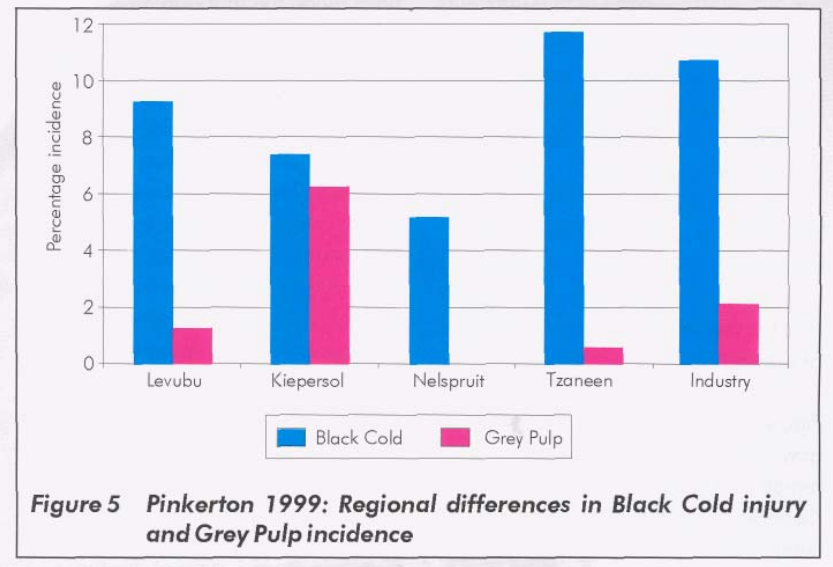

Figure 5 Pinkerton 1999: Regional differences in Black Cold injury and Grey Pulp incidence

Figure 6 Grey pulp in Pinkerton

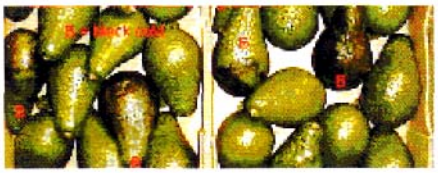

Figure 7 Black Cold in Pinkerton

It can be seen that black cold was common throughout the industry, lowest incidence (5.2%) being for Nelspruit and highest incidence (11.7%) being for Tzaneen. The industry average of 10.7% black cold highlights the severity of the problem during the 1999 season. However, far more severe than the external quality defects, are the severe internal defects of grey pulp.

Figure 5 shows a marked difference in grey pulp incidence according to region. Grey pulp incidence for Kiepersol Pinkerton was almost three times higher (6.2%) than the industry average (2.1%), low to non-existent for the Pinkerton samples from the other production areas. It is important to emphasise that many of the samples having grey pulp, did **not** show black cold injuries — this means that simply discarding all fruit exhibiting black cold will not guarantee that the remaining ("apparently healthy") fruit will be of acceptable internal quality. It is also important to note that the data only reflect percentage incidence as a presence or absence of grey pulp, not the severity of the problem. Thus at first glance the incidence of grey pulp for Pinkerton seems to have been less of a problem than was the case for either Fuerte (CA average = 5.89%) or Hass (RA average 14.7%, CA average 9.4%) during 1999. However, when Pinkerton suffers from grey pulp, it is not uncommon for 60 to 100% of the flesh to have turned virtually black (Figure 6). In contrast, the grey pulp in affected Fuerte or Hass is rarely so severe, more commonly it is merely a slight greying of a small portion of the mesocarp.

CONCLUSIONS AND RECOMMENDATIONS

Black cold injury was a common problem for Hass and Fuerte during 1999 — the wet season is likely to have made the fruit extremely sensitive to external chilling injury. It is important to emphasise, however, that fruit from specific packhouses were far more

prone to black cold. When reports of black cold injury are received from Europe, there is a tendency within the industry to assume that incorrect temperature management during the voyage was the cause of the black cold symptoms. There were several cases during the 1999 season when fruit from one packhouse were affected by black cold, while fruit from a different packhouse within the **same** container were free from cold damage. The same situation was often noted for soft arrivals — soft fruit from one packhouse and hard fruit from another packhouse within the same container. Soft arrivals are also often blamed upon a too warm temperature regime during the voyage. Clearly, if one gets both soft fruit and hard fruit or cold-damaged and non-cold-damaged fruit from different origins within the same container, the cause of the problems has to be more complex than incorrect temperature manage during the voyage. It is important to examine the **whole** cold chain (i.e. from harvest until arrival at the overseas warehouse) before one can identify a weak link in that chain. It is the opinion of the authors that a high percentage of the soft arrivals and cold-damage seen during the past season, are attributable to the affected fruit having arrived in the ports of containerisation with pulp temperatures higher than the maximum permissible deviations from requested shipping temperatures. Warm-loaded fruit are more likely to ripen in transit. Ten years ago Eksteen (1990) recommended that there was a need for the industry to develop systems to ensure that a higher percentage of (export) fruit arrived in Cape Town at *(designated)* shipping temperature. During 1999, regular reports were received from Cape Town of a high percentage of avocado consignments arriving in the port with pulp temperatures above the maximum permissible temperature deviations (weekly reports from Martin Oosthuizen, Cape Town Technical Officer). High priority should be given to addressing this matter.

The benefits of CA shipment for Hass and Fuerte avocados are clear— fruit arrive in hard condition and have a longer shelf life than is the case for RA porthole shipments. While many within the industry remain skeptical about the use of CA because of the extra cost that this involves, such costs must be brought into perspective. Soft arrivals either have to be sold very quickly (meaning that the European agent is not in a strong position to negotiate a better price) or (worst case scenario) sometimes have to be destroyed as no buyer will accept them. The losses incurred as a result are far higher than the additional cost of the CA. Fruit older than about 27 days have a high chance of arriving in a breaking to soft condition if transported under RA conditions, even when the product has been properly cooled and there have been no breaks in the cold chain. Although it is not advisable to refrigerate avocados longer than absolutely necessary, sometimes situations beyond one's control (e.g. shipping delays) make this impossible to avoid. During the 1999 season there were a number of occasions when CA containers were inadvertently "short-shipped" and were only transported on a subsequent vessel (a week or two later in some instances). This meant that some fruit were older than 35 days by the time they reached the European markets. Despite this, those CA fruit arrived in a hard condition, which would not have been the case had they been transported in RA containers.

The 1999 season was characterised by a high incidence of grey pulp, the cause of which can only partially be blamed on extended transport times — the primary cause is most likely to have been over-maturity. Grey pulp has long been a serious problem for the industry, to the extent that recommendations have often been made to address this

issue as a matter of urgency. For example, according to Leclercq (1990): "Grey pulp remains the single most important internal physiological disorder affecting avocados on the overseas markets. The complex nature of grey pulp requires a multidisciplinary research approach to the problem. Export losses, probably amounting to millions of Rands, are incurred". Considering that Mr Leclercq made this statement ten years ago when the overseas markets were less discerning, it is not unreasonable to assume that today's losses as a result of grey pulp are considerably higher. Fruit maturity needs to be carefully and regularly monitored, and the Temperature Committee recommends that a maximum permissible maturity standard be established for the various cultivars.

Since the majority of the Pinkerton fruit sampled during the 1999 export season were transported to the overseas markets under CA conditions, yet quality problems remained extremely severe, the authors are unable to conclude that CA shipment has resulted in a significant improvement in Pinkerton quality. This should not be interpreted to mean than the controlled atmosphere system itself is in any way responsible for the poor quality of Pinkerton. The primary benefit of CA to avocados is to increase the likelihood of hard fruit being delivered to the European markets, thus extending shelf life. The results have shown that this works very effectively for Fuerte and Hass, and Pinkerton sent under CA also usually arrives in a hard condition. There were many cases during the 1999 season of Pinkerton arriving in a hard condition and showing neither black cold on arrival nor grey pulp on ripening. This clearly indicates that the "Pinkerton problem" needs to be traced back to its source — e.g. climatic variations, incorrect orchard practices, incorrect temperature management prior to or during shipment. The industry has to ensure that all Pinkerton exported by sea will arrive and ripen with quality defects — otherwise, the future of this variety on the European market is bleak.

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