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Further refinement of 'Pinkerton' export parameters

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ABSTRACT

The quality management research conducted on 'Pinkerton' during the last three years has rendered good results. In general, the internal quality of export 'Pinkerton' was found to be considerably better than in the past. Fruit maturity has been identified as the most important quality-determining parameter, but at the same time aspects related to orchard condition and tree management have also been noted as important. In this respect, fruit Ca and N levels have been correlated with the two main disorders, grey pulp and black cold injury. During the past season, the recommended N and Ca norms were further refined. In addition, surveys were conducted on the effects of tree age, fruit set and rootstock on fruit quality. Tree age was found to be of particular importance and the grey pulp problem was found to diminish in (correctly fertilized) older trees. The fruit set study revealed some interesting trends. More mature earlier sets were found to be more susceptible to grey pulp and less susceptible to black cold injury, while the reverse was true for later sets. The fruit set distribution was spread in younger trees but it considerably improved in older trees where 96% of the fruit were found to be from a single set. Our initial results indicate rootstock not to be of particular importance, but additional research is required on this aspect.

INTRODUCTION

During the last four years, considerable work has been done aimed at improving the storage potential of the Pinkerton cultivar. The earliest results on grey pulp (Kruger *et al.,* 2000) indicated the susceptibility of fruit from different production regions to vary. Fruit from warmer areas with high potential soils were shown to be more susceptible to this disorder than fruit from cooler areas with poorer soils. It was further shown that adherence to strict maturity specifications is the single most important intervention strategy. Recommendations were also made regarding appropriate fruit nitrogen and calcium content specifications. The above recommendations were further updated during the 2000 season Kruger *et al.* (2001). The maturity specifications were more closely specified, taking into account the production region (high or low risk) and season (on or off). Specific postharvest recommendations were also made pertaining to storage temperature, the use of controlled atmosphere (CA) and 1 methyl cyclopropene (1-MCP). The present paper aims to further refine the above specifications. The following aspects are dealt with:

- The multiple fruit set pattern of this cultivar.
- The effect that tree age has on fruit quality and storage potential.
- The effect that rootstock has on fruit quality and storage potential.
- Further refinement of the Ca and N specifications.

Table 1. Fruit set recorded in 2 and 7 year old 'Pinkerton' trees located in two orchards in the Kiepersol area.

Set period	Percentage of total yield	
	2 year old trees	7 year old trees
June	32.1	-
July	22.6	96.6
August	26.4	-
September	-	1.5
October	18.9	1.5
January	-	0.4

FRUIT SET PATTERN

This trial was conducted in two orchards located in the Kiepersol area. The first was only two years old, while the second was seven years of age. In both orchards, individual inflorescences were marked as the first flowers opened. This was continued throughout the season. Chemical analysis was conducted and at the end of the season the fruit was harvested and stored for 28 days at 7°C and evaluated.

The yield distribution is shown in Table 1 while the incidence of grey pulp and black cold injury is shown in Figs. 1 and 2.

The results are interesting and enable the formulation of useful recommendations. In younger trees the fruit set is spread out over five months making it impossible to export these fruit due to the enormous difference that exists with regard to maturity. However, in older trees 96.6% of the fruit harvested were from the first set. The implication of this result is clear: If the fruit are harvested within the correct maturity range, 96.6% of the avocados ought to be free of grey pulp. The possibility exists that the remaining 3.4% may not ripen properly, but this is less of a problem than grey pulp.

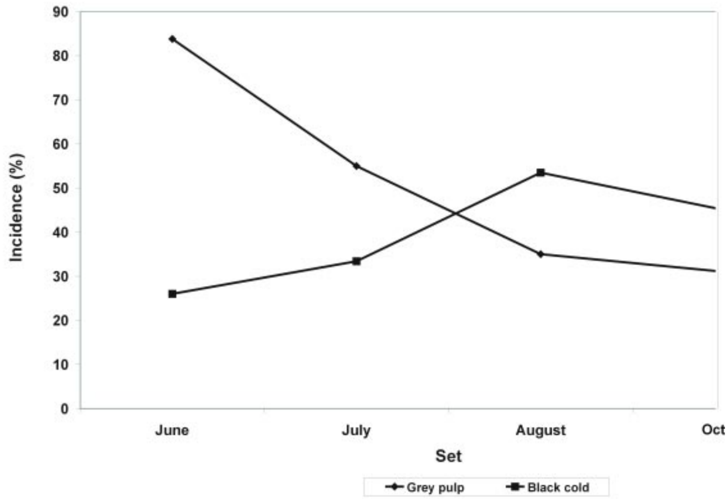

Figure 1. Incidence of grey pulp and black cold injury in 4 different sets of fruit from 2 year old Pinkerton trees. Note that only the incidence is plotted and not the intensity of the disorder. In most affected fruit the disorders were faint and the fruit were marketable.

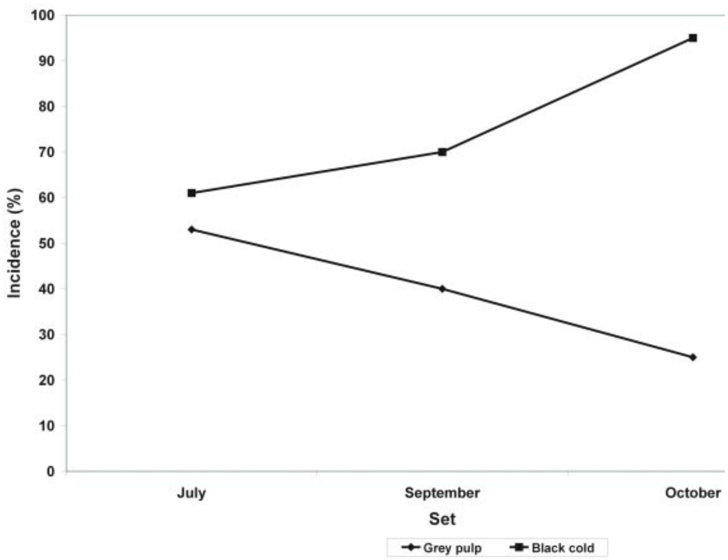

Figure 2. Incidence of grey pulp and black cold injury in 3 different sets of fruit from 7 year old Pinkerton trees. Note that only the incidence is plotted and not the intensity of the disorder. In most affected fruit the disorders were faint and the fruit were marketable.

The grey pulp statistics plotted in Figs. 1 and 2 reflect incidence and not intensity. A large proportion of the fruit recorded as having grey pulp, only showed slight symptoms and were therefore still marketable. In any event, it clearly demonstrates that the more mature fruit from the first set is considerably more prone to contracting grey pulp than the fruit from the later sets.

A similar but reverse situation exists with regard to black cold injury (Figs. 1 and 2). The data is again expressed as incidence and not intensity. In most cases, only small lesions occurred on marketable fruit and the results appear worse than it really was. Nevertheless, the results show that less mature fruit from the later sets are more susceptible to black cold injury than more mature fruit from earlier sets. In contrast with grey pulp, however, the management of black cold injury is more complex and can not be achieved by carefully controlling the maturity of the fruit. The black cold problem is therefore more comprehensively addressed elsewhere (Kruger *et al.*, 2002).

EFFECT OF TREE AGE

In this trial, four orchards located on the same farm in the Kiepersol area were monitored. The oldest orchard was seven years of age while the youngest was two years old. Two five year orchards were also studied. The first of these was a high density orchard (1 666 trees per hectare), while the second was a standard density orchard (607 trees per hectare). Fruit was regularly sampled and at harvest the avocados were stored at 7°C for 28 days before being ripened and evaluated.

The results attained in the tree age survey are displayed in Table 2. Again, the results make for very interesting reading. Unfortunately, the samples were not exactly of the same maturity at harvest. The fruit from the older trees were slightly less mature than those from the younger trees. This can, however, not account for the drastic reduction in the incidence of grey pulp in fruit from the older trees. It would therefore appear that the danger of contracting grey pulp during storage is considerably lower in older trees than in younger trees harvested at the correct maturity. This is a particularly welcome observation as it infers that it can only go better in future, as existing Pinkerton orchards become older.

The calcium and nitrogen content analysis of the above fruit is shown in Table 3. The results clearly illustrate that the fruit from the older trees have a lower nitrogen and higher calcium content than the younger trees. These observations corroborate the above findings and the previously formulated fruit mineral content parameters.

Again, the interpretation of the black cold injury results is more complex and is dealt with elsewhere (Kruger *et al.*, 2002).

Table 2. Influence of tree age on the fruit quality of 'Pinkerton' avocados.

Tree age	Maturity (% moisture)	Grey pulp		Black cold injury	
		Incidence (%)	Severity index	Incidence (%)	Severity index
2 year	75.4	60	34	80	13.5
5 year hd	76.3	10	80	60	10.3
5 year sd	76.0	10	30	60	7
7 year	77.1	0	0	70	11.1

Hd = high density orchard (1666 trees/ha) and sd = standard density orchard (607 trees/ha)

Table 3. Nitrogen and calcium content of Pinkerton fruit from four orchards of differently ages.

Tree age	N (%)			Ca (%)		
	Dec	Feb	May	Dec	Feb	May
2 year	1.34	1.07	0.89	791	371	170
5 year hd	1.32	1.02	0.68	721	363	245
5 year sd	1.21	1.07	0.67	802	369	243
7 year	1.08	0.95	0.62	900	481	255

Hd = high density orchard (1666 trees/ha) and sd = standard density orchard (607 trees/ha)

Table 4. Effect of rootstock on 'Pinkerton' avocado fruit quality.

Rootstock	Tree age (years)	Maturity (%)	Grey pulp		Black cold injury	
			Incidence (%)	Severity index	Incidence (%)	Severity index
D 7	8	76.3	40	80	70	20
D 7	5	76.5	10	70	50	9.8
Thomas	5	76.8	30	15.6	50	12.1
Martin Grande	5	75.7	20	36	60	11.1

Table 5. Physiological disorder and nutritional content statistics of Pinkerton orchards located in the Nelspruit and Kiepersol production areas.

Production area / Parameter	Nelspruit mean (9 orchards)	Kiepersol mean (18 orchards)	Best* orchard	Worst** orchards
Tree age	7.6	6.6	10	5.8
Maturity @ harvest	77.8	76.6	78.1	76.9
Grey pulp incidence	13.3	28.4	0	38
Black cold incidence	65.6	64.1	0	84
N November	1.48	1.43	1.52	1.51
N January	1.30	1.44	1.02	1.5
N March	1.19	1.14	1	1.23
N April	0.98	0.99	0.77	1.08
Ca November	1259	851	1200	848
Ca January	726	581	812	592
Ca March	430	380	583	380
Ca April	317	294	483	261
Ca/N November	851	595	789	561
Ca/N January	558	403	796	392
Ca/N March	361	333	530	308
Ca/N April	324	297	627	241

* Only one of the 27 orchards surveyed in the two production areas was free of both grey pulp and black cold injury. This orchard was located in the Kiepersol area.
** This value reflects the mean of 5 of the worst orchards, 4 from the Kiepersol area and one from in the Nelspruit area.

EFFECT OF ROOTSTOCK

In this part of the study, three adjacent Nelspruit orchards grafted on either Duke 7, Martin Grande or Thomas rootstocks, were monitored. The fruit was harvested, stored and evaluated as above.

The results are shown in Table 4. No significant difference existed between the different rootstocks. It would therefore seem that rootstock does not play an overriding role with regard to Pinkerton fruit quality. The role of tree age, however, came to the fore again.

REFINING THE FRUIT CALCIUM AND NITROGEN LEVELS

In this part of the study, fruit from 18 orchards belonging to six growers in the Kiepersol area, considered to be a high risk area, and nine orchards belonging to three growers in the greater Nelspruit area, considered to be a low risk area, were studied. Fruit samples were drawn on a monthly basis from November 2000 until March 2001 and subjected to N and Ca analyses. At harvest, the fruit were stored at 7°C for 28 days, ripened on the shelf, and evaluated.

The results are summarized in Table 5. The incidence and intensity of black cold injury did not differ between the two production areas. The intensity of grey pulp did not differ either. However, the incidence of grey pulp was twice as high in the Kiepersol area than in the Nelspruit area. (The mean moisture content of the Kiepersol fruit was 1% lower at harvest.) The nitrogen content of the fruit from the two areas was fairly similar during November but the rate at which it reduced from November to January was faster in the Nelspruit area. The Nelspruit area also had significantly higher fruit calcium levels at the beginning of the season. This trend was also reflected in the Ca : N ratio. The importance of retaining as high as possible Ca : N ratio throughout the season is clear when comparing the latter ratio in the best and worse Kiepersol samples as shown in the table.

RECOMMENDATIONS

One of the most important results emanating from the study concerns tree age. Fruit from older trees were shown to be considerably less susceptible to grey pulp than fruit from younger trees. The fruit from older trees were also found to have lower N and higher Ca levels.

Older trees were also found to be superior in terms of fruit set period. The set was considerably more concentrated in older trees, while it was spread out in younger trees.

Based on the information in hand, it is recommended that Pinkerton fruit should not be exported from trees that are younger than five years of age.

After taking the data accrued during the present study into account, it is suggested that the maturity recommendations suggested by Kruger *et al.* (2000) and Kruger *et al.* (2001) be retained. These state that fruit from a low risk area should fall within the 80% to 73% moisture range during an on-season and between 80% and 75% during an off-season. Fruit from a high risk area must be between 80% and 75% during an on-season and between 80% and 77% during an off-season. Maturity remains the most important parameter to be taken into account when controlling grey pulp.

The results of the present study confirmed that our previous mineral content recommendations (Kruger *et al.*, 2000 & Kruger *et al.*, 2001) are appropraite. It should, however, be emphasized these were primarily formulated with the control of grey pulp in mind. It is suggested that a nitrogen content of below 1% by March be promulgated. This ought to ensure the absence of grey pulp should the fruit be harvested within the correct maturity ranges. However, if black cold injury is to be reduced, the 1% mark will have to be reached by January.

A similar situation exist with regard to the Ca content of the fruit. The present results suggest that the 1000 ppm fruit Ca level during November is correct in terms of the control of grey pulp. However, in terms of black cold injury this value should be increased to 1200 ppm. However, the present results suggest that it is doubtful whether a Ca content-related decrease in black cold injury is to be attained between the 1000 and 1200 ppm levels. An effect was only noticed when the 1200 ppm threshold was topped. What is more, the rate at which the calcium decreases as the fruit grows was also found to be slower in black cold injury free fruit. These fruit were found to still be above 880 ppm by January and above 600 ppm by March.

In terms of grey pulp, the Ca : N ratio of above 500 ppm/% need probably only remain over 500 ppm/% until January and then not decrease by more than 100 ppm/% per month. However, in terms of grey pulp the 500 ppm/% during March is probably correct.

Although storage temperature was not addressed in the present study, it remains important and is dealt with by Kruger *et al.* (2002). It is suggested that all Pinkerton, regardless of fruit set, maturity or origin be exported at a higher temperature than is presently used.

This temperature should approach 10ºC and new ethylene inhibition technology (Lemmer *et al.*, 2002) should be employed to reduce the chances of fruit softening during transport.

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