Effects of harvest maturity, storage temperature, controlled atmosphere and SmartFresh on the post-harvest vascular staining disorder of 'Maluma' avocado fruit

SD Mhlophe and FJ Kruger

Agricultural Research Council – Institute for Tropical and Subtropical Crops
Private Bag X11208, Nelspruit 1200, South Africa

Tel: +27 13 753 7000; Fax: +27 13 752 3854; E-mail: fransk@arc.agric.za

ABSTRACT

Vascular staining (VS) is a physiological disorder that afflicts the fruit of the 'Maluma' avocado cultivar. The present study aimed to establish what effect harvest maturity, storage temperature, controlled atmosphere and SmartFresh (SF) have on the incidence and intensity of the disorder. The results indicated that the incidence and intensity of VS decreases as the fruit matures. Based on the present results it is recommended that the fruit be harvested between 23% and 26% dry matter contents (77-74% moisture content). It is further recommended that a SF application be performed at 300 ppb.

INTRODUCTION

'Maluma' is a 'Hass'-like avocado cultivar originating from the Limpopo Province. It is notable for being precocious and having a high yield. 'Maluma' fruit are larger and slightly more pear-shaped than 'Hass' fruit and are less prone to skin blemishes. 'Maluma' was released with full export cultivar status in South Africa from the breeding and selection programme of Allesbeste Nursery. A substantial number of hectares have been planted to the cultivar and exports have been taking place since 2006. A number of problems have arisen during export, the most important being soft landings, grey pulp and a reddish stain of the vascular bundles (vascular staining) that develops during ripening.

The vascular staining occurs in the flesh as dark red speckles (Figure 1). It is usually more prevalent in the outer laying vascular bundles than in the vascular bundles that are closer to the seed (Figure 2). The South African Avocado Growers' Association

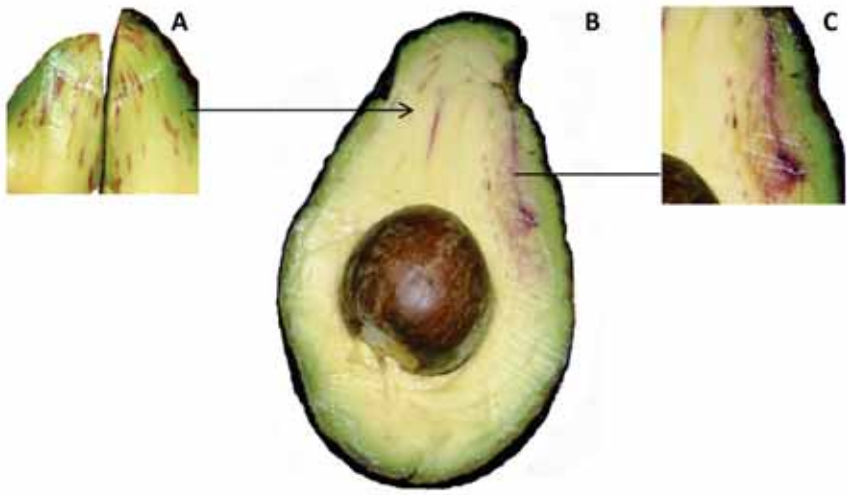

Figure 1. Vascular stains in the mesocarp (A) and diffusion of the red vascular stain into the pulp (B & C) of ripened 'Maluma' avocado fruit.

Figure 2. Vascular staining is usually more prominent in the outer ring of vascular bundles and less obvious in the inner ring of vascular bundles.

(SAAGA) commissioned the Post-harvest Technologies Division of the Agricultural Research Council's Institute for Tropical and Subtropical Crops (ARC-ITSC) to investigate the post-harvest problems of the 'Maluma' cultivar and to formulate appropriate remedial recommendations. Preliminary investigations indicated that, of the above three disorders, vascular staining is the most important. A study was therefore designed to establish the causes of the vascular staining, and to formulate appropriate harvest and storage protocols to reduce the incidence and intensity of the disorder. The study consisted of two parts: an orchard based survey and a laboratory based mitigation trial. The aim of the orchard survey was to establish what role harvest maturity plays. The aim of the laboratory trial was to determine if the disorder can be inhibited by storage at a specific temperature; a SmartFresh (SF) application or through the use of controlled atmosphere (CA).

MATERIALS AND METHODS

Experiment 1: Effect of fruit maturity on vascular staining

Three 'Maluma' and 'Hass' orchards each were selected on three farms (Bergendal Trust, Avocado Valley and Hokaai Boerdery, Schagen - referred to as Schagen hereunder) in the Nelspruit region. Thirty fruit were randomly collected from two sample plots in each of the orchards on a two weekly basis as from March 2011 to June 2011. On each sampling date, ten fruit were used for moisture content analysis and the remainder ripened. Upon reaching the ready to eat stage, each fruit was cut longitudinally into halves and the intensity of VS rated on a scale between 0 and 5 (Figure 3).

Experiment 2: Effect of storage temperature, CA and SF applications on vascular staining

Four replicate cartons of commercially packed count 18 'Maluma' fruit were used for this study. Three treatments were applied, namely, regular atmosphere (RA), SF (300 ppb) and CA (4% O_2 & 6% CO_2). The fruit were stored for 30 days at respectively 4, 6 and 8°C followed by ripening at 20°C. Upon reaching the ready to eat stage, each fruit was assessed as above.

RESULTS AND DISCUSSION

Experiment 1: Effect of fruit maturity on vascular staining

The maturation rates (mean of three orchards) of the 'Maluma' and 'Hass' orchards are shown in Figure 4. As may be deduced from the graph, on any given date the maturity stage of 'Hass' was approximately one month ahead of that of 'Maluma'.

The maturation rates of the three 'Maluma' orchards are shown in Figure 5. The Schagen orchard was at a slightly more advanced maturity stage dur-

Figure 3. Vascular staining intensity scale used in the study.

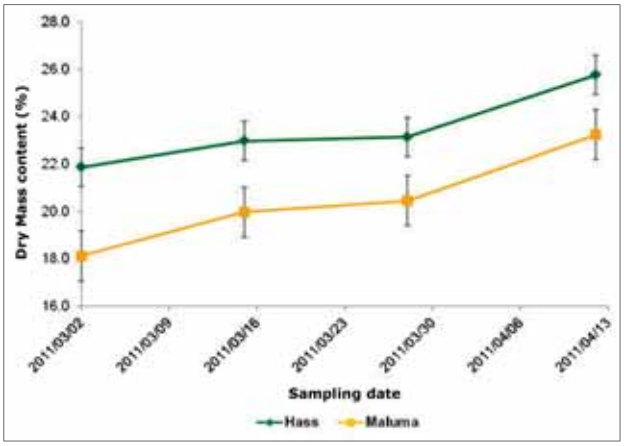

Figure 4. Mean maturation rates of fruit from, respectively, three 'Hass' and three 'Maluma' orchards in the Nelspruit region.

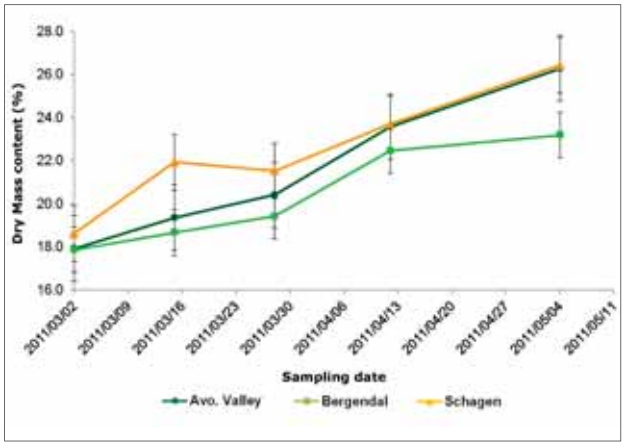

Figure 5. Maturation rate of avocado fruit from three 'Maluma' orchards in the Nelspruit region.

ing the first phase of the sampling period. Towards the end of the period it was at a similar maturity stage as the Avo Valley samples which matured at the fastest rate when viewed over the whole period. The Bergendal fruit matured at the slowest rate.

The incidence and intensity of vascular staining is shown in Figure 6. At Avo Valley both the incidence and intensity was high at the beginning of the season, but it significantly decreased in a curvilinear fashion throughout the season. Although the initial incidence and intensity was lower at Bergendal, the seasonal reduction rate was lower than that of Avo Valley. The incidence trend of Schagen was less clear while the intensity trend was also curvilinear. Closer scrutiny of the results revealed that the data is generally in sync with the maturation stage/rate results depicted in Figure 5. In terms of a practical recommendation, it is suggested that a harvest window between 23% and 26% dry matter (77-74% moisture content) be considered.

Experiment 2: Effect of storage temperature, CA and SF applications on vascular staining

The incidence and intensity of VS is shown in Table 1. A number of deductions can be made from the table. It is firstly clear that storage temperature does not

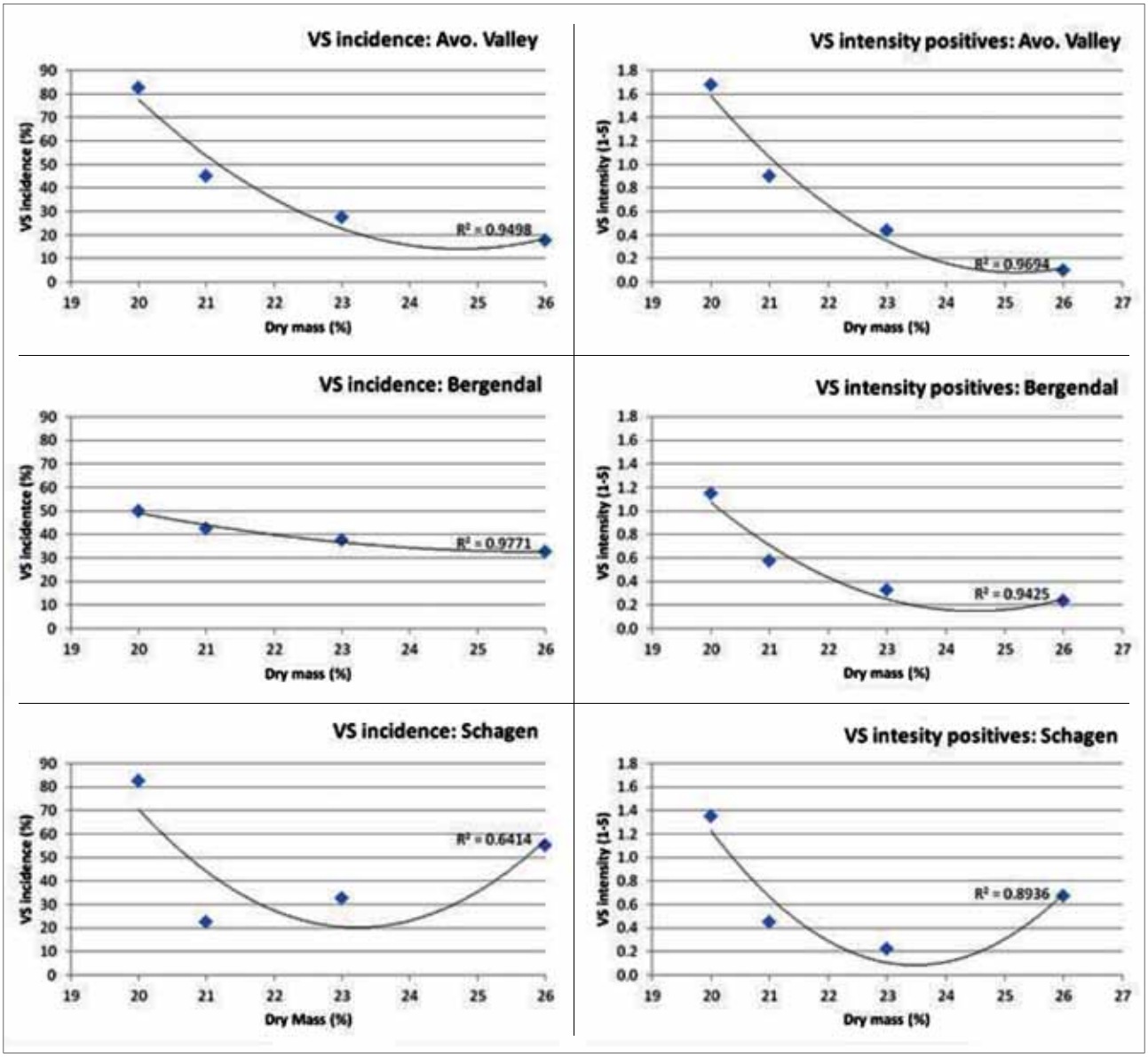

Figure 6. Relationship between the dry mass content and vascular staining incidence/intensity of 'Maluma' avocado fruit from three orchards in the Nelspruit region.

Table 1. Effect of 1-MCP (300 ppb) and controlled atmosphere on the vascular staining incidence and intensity of stored 'Maluma' avocado fruit.

Treatment	Storage temperature (%)	Incidence (%)	Intensity all (1-5)	Intensity positives (1-5)
RA	4	65.3 a[(x)]	1.3 a	2.0 ab
CA	4	34.7 b	0.5 ab	1.4 abc
SF	4	23.6 c	0.3 b	1.1 c
RA	6	58.3 a	1.1 a	1.8 ab
CA	6	33.3 b	0.5 ab	1.4 abc
SF	6	22.2 c	0.2 b	1.0 c
RA	8	69.4 a	1.5 a	2.2 a
CA	8	43.1 b	0.8 ab	1.8 abc
SF	8	30.6 c	0.4 b	1.2 bc

[x] Means in columns followed by the same letters are not significantly different at 5% level of significance.

play a role. The results further indicated that both the SF and CA applications reduced the incidence and intensity of the disorder. Of the two applications SF was more effective.

CONCLUSIONS

The incidence and intensity of VS in the 'Maluma' cultivar decrease as the fruit matures. Based on the present results it is recommended that the fruit be harvested between 23% and 26% dry matter content (77-74% moisture content). It is further recommended that a SF application be performed at 300 ppb directly after the target pulp storage temperature is reached.

ACKNOWLEDGEMENTS

The authors wish to thank SAAGA and the ARC-ITSC for their financial contributions. Special thanks also to the avocado producers (Bergendal Trust, Avocado Valley and Hokaai Boerdery) for a consistent supply of fruit.