**South African Avocado Growers' Association Research Report for 1978. 2:39-41**

# PHYSIOLOGICAL AND BIOCHEMICAL FACTORS ASSOCIATED WITH THE FUERTE AVOCADO FRUIT DEVELOPMENT

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*C.S.F.R.I. NELSPRUIT*

## PHYSIOLOGICAL MATURITY

This investigation was carried out over the period 26/1/1978 to 15/5/1978.

**Fruit length.** Although fruit length increased throughout the period of investigation it was variable (Table 1). This may be attributed to the peculiar shape of the cultivar. No correlation, however, could be established between fruit length and fruit maturity.

**Fruit diameter.** With maturity the increase in fruit diameter was constant and much more stable than fruit length (Table 1). No correlation could be established between fruit diameter and fruit maturity. There was, however, one important conclusion that could be drawn regarding fruit diameter. When fruit samples are taken in the field it is difficult to judge whether the fruit are more mature than previous samples. This can be avoided when it is ensured that the fruit diameter of the present sample is not less than the average of the previous sample.

**Storage loss in fruit length and diameter.** Storage of fruit at 25°C resulted in an increasing loss in fruit length and diameter with increased time of storage (Table 1). This is important when packing methods and materials are considered to avoid a loose pack with resultant bruising.

**Mass/volume ratio.** Preliminary work on the mass/volume ratio showed promising results which could possibly be coupled with fruit maturity. The fresh fruit mass and volume both increased at *a* similar rate for a limited period. At a certain stage the volume increase exceeded the mass increase resulting in a reversed mass/volume ratio graph (Figure 1). The significance of this "turning point" lies in the correlation with the fruit oil content. In this study the oil content of the fruit was between 12% and 13%, the standard used in Australia for maturity.

**Storage loss in mass and volume,** at 25°C, increased with increasing time of storage. It appears, however, (Table 1) that this loss is greater in immature fruit than mature fruit. The average loss in volume, over the complete period of investigation, was greater than the loss in mass, which must be as a result of the slower increase in mass in mature

fruit. Both these factors are important when packing methods are considered to avoid a loose pack and resultant bruising of the fruit during transportation.

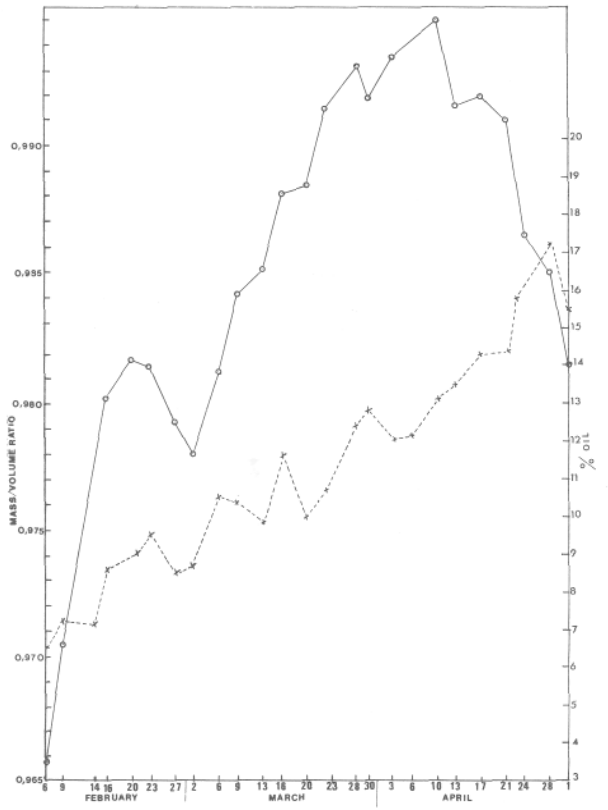


FIG. 1: Mass/volume ratio (o—o) and percentage oil (x—x) during maturation of the Fuerto avocado fruit

## BIOCHEMICAL INVESTIGATION

**Pectin methyl esterase (PME) activity** was regarded by some investigators as an indicator for tomato and banana maturity. It was shown by de Swardt and Maxie, however, that these tests can be affected by the interference of phenolic substances in banana fruit. In our present investigation we could likewise not establish any correlation between PME activity and maturity. There was, however, a sharp drop in fruit ripening, and a further drop with the appearance of pulp spot.

**Polyphenol oxidase (PPO)** has been established by many workers as the browning enzyme in plant tissue. In the present investigation PPO activity in fresh fruit was higher during January and early February compared with a drop through March and early April after which there was a slight rise during May. This enzyme can, therefore, not be associated with fruit maturity or for that matter with the period of pulp spot appearance where it can cause browning of the fruit tissue.

With ripening at room temperature there is an increase in PPO activity and except for the early fruits (January) this increase does not vary greatly to an extent where it may be associated with pulp spot. It is known; that pulp spot does not appear in fruit stored at room temperature, and the possibility still exists that low temperature storage may activate the enzyme. Analysis of pulp spot affected fruit (Table 3) did not show a significant increase in PPO activity. The only remaining possibility is that this activation (through possible low temperature injury as was shown with cucumbers) is restricted to the vascular bundles. This is now under investigation.

**TABLE 1: Measurements for the determination of the physiological maturity of Fuerte avocado fruit**

| Picking date | Mass loss (%) during storage at 25°C | | Volume loss (%) during storage at 25°C | | Average fresh fruit length (mm) | Average fresh fruit diameter (mm) | Loss (mm) in fruit length on storage at 25°C | | Loss (mm) in fruit diameter on storage at 25°C | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 week | 2 weeks | 1 week | 2 weeks | | | 1 week | 2 weeks | 1 week | 2 weeks |
| 14/2/78 | 10,21 | 18,15 | 9,4 | 17,18 | 108,0 | 65,2 | 6,67 | 9,40 | 2,50 | 5,83 |
| 16/2/78 | 10,42 | 19,59 | 10,20 | 20,03 | 103,0 | 66,2 | 6,67 | 9,67 | 3,50 | 5,17 |
| 20/2/78 | 10,36 | 19,60 | 10,67 | 20,21 | 104,7 | 68,5 | 7,83 | 11,40 | 2,83 | 5,80 |
| 23/2/78 | 12,50 | 16,12 | 12,43 | 16,02 | 108,6 | 68,9 | 6,17 | 10,00 | 1,67 | 6,17 |
| 27/2/78 | 8,11 | 12,58 | 9,79 | 13,78 | 113,6 | 69,1 | 5,67 | 9,34 | 2,17 | 5,83 |
| 2/3/78 | 8,31 | 17,29 | 8,02 | 19,41 | 108,3 | 68,3 | 5,16 | 7,83 | 3,16 | 6,00 |
| 6/3/78 | 9,69 | 15,82 | 9,37 | 17,18 | 111,8 | 70,8 | 6,16 | 9,50 | 3,17 | 5,17 |
| 9/3/78 | 10,19 | 18,24 | 10,98 | 19,19 | 102,9 | 69,9 | 5,00 | 10,00 | 3,00 | 5,16 |
| 13/3/78 | 12,30 | 13,56 | 12,48 | 15,33 | 113,7 | 69,8 | 6,50 | 8,84 | 4,67 | 5,17 |
| 16/3/78 | 10,63 | 17,53 | 11,86 | 18,77 | 112,0 | 72,3 | 6,18 | 9,67 | 2,33 | 6,34 |
| 20/3/78 | 12,81 | 17,28 | 13,56 | 18,53 | 112,9 | 70,7 | 7,00 | 9,16 | 4,50 | 5,33 |
| 23/3/78 | 11,00 | 14,74 | 11,53 | 15,76 | 112,8 | 72,4 | 6,34 | 8,16 | 4,00 | 5,50 |
| 28/3/78 | 7,48 | 10,95 | 7,60 | 11,77 | 109,4 | 67,3 | 3,67 | 5,00 | 2,16 | 3,50 |
| 30/3/78 | 7,76 | 12,75 | 7,26 | 13,70 | 109,7 | 71,8 | 4,17 | 6,83 | 1,17 | 3,50 |
| 3/4/78 | 9,42 | 12,67 | 9,30 | 12,89 | 117,3 | 73,6 | 5,00 | 7,50 | 3,00 | 3,50 |
| 6/4/78 | 8,41 | 12,42 | 8,95 | 13,71 | 111,3 | 73,5 | 4,33 | 8,33 | 2,16 | 3,67 |
| 10/4/78 | 7,72 | 11,50 | 8,53 | 12,57 | 111,1 | 73,6 | 4,50 | 6,84 | 2,00 | 3,17 |
| 13/4/78 | 7,98 | 13,40 | 8,72 | 13,84 | 116,4 | 72,8 | 4,17 | 4,83 | 2,50 | 4,50 |
| 17/4/78 | 8,08 | 11,68 | 7,40 | 12,25 | 110,9 | 73,8 | 4,83 | 5,83 | 2,83 | 3,67 |
| 21/4/78 | 8,38 | 11,40 | 10,80 | 11,95 | 122,3 | 75,5 | 5,66 | 7,50 | 3,34 | 4,33 |
| 24/4/78 | 7,08 | 8,76 | 7,20 | 9,54 | 125,0 | 79,2 | 2,60 | 5,00 | 2,00 | 3,50 |
| 28/4/78 | 9,59 | 12,55 | 10,52 | 13,63 | 129,7 | 79,00 | 4,87 | 6,20 | 2,67 | 4,67 |
| 1/5/78 | 8,62 | 11,80 | 10,77 | 12,11 | 132,8 | 79,89 | 6,50 | 8,16 | 2,83 | 4,33 |
| 8/5/78 | 9,69 | 12,05 | 7,69 | 12,11 | 128,1 | 80,28 | 7,67 | 7,50 | 3,50 | 5,83 |
| 15/5/78 | 7,15 | 10,86 | 8,93 | 13,43 | 131,9 | 82,22 | 5,00 | 8,67 | 4,00 | 4,00 |
| AVERAGE | 9,36 | 14,13 | 9,76 | 15,00 | | | 5,53 | 7,64 | 2,87 | 4,79 |

**TABLE 2: Polyphenol Oxidase, Peroxidase and Pectin Methyl Esterase in Fuerte avocado fruit during maturation and with ripening at 25°C**

| Picking date | PPO activity: Change in *A* by enzyme from 0,01 g fresh tissue in 1 minute at 25° C | | PO activity (U/liter) x $10^3$ | | PME activity (PEu) g x $10^4$ | |
|---|---|---|---|---|---|---|
| | Fresh green fruit | Soft ripe fruit | Fresh green fruit | Soft ripe fruit | Fresh green fruit | Soft ripe fruit |
| 26/1/78 | 6,5 | 11,7 | 2,131 | 48,685 | 58,84 | 14,67 |
| 30/1/78 | 5,5 | 11,9 | 1,807 | 44,032 | 52,44 | 9,60 |
| 2/2/78 | 5,4 | 12,5 | 0,917 | 30,478 | 62,34 | 6,40 |
| 6/2/78 | 4,8 | 8,4 | 1,416 | 24,612 | 52,98 | 8,80 |
| 9/2/78 | 3,4 | 4,7 | 2,468 | 26,129 | 50,40 | 7,38 |
| 14/2/78 | 1,9 | 5,3 | 1,214 | 22,151 | 51,47 | 11,73 |
| 16/2/78 | 2,2 | 4,9 | 0,809 | 29,872 | 53,33 | 11,20 |
| 20/2/78 | 2,9 | 3,9 | 3,345 | 20,512 | 81,16 | 12,27 |
| 23/2/78 | 3,3 | 4,4 | 2,822 | 13,419 | 82,58 | 8,89 |
| 27/2/78 | 2,0 | 4,0 | 0,937 | 12,205 | 55,91 | 10,874 |
| 2/3/78 | 2,4 | 4,5 | 0,985 | 15,172 | 84,00 | 10,76 |
| 6/3/78 | 2,2 | 4,4 | 1,481 | 13,464 | 82,76 | 8,71 |
| 9/3/78 | 3,5 | 4,5 | 1,784 | 8,496 | 85,60 | 14,19 |
| 13/3/78 | 2,3 | 4,2 | 1,851 | 10,272 | 55,02 | 12,00 |
| 16/3/78 | 3,2 | 4,0 | 2,485 | 11,377 | 69,87 | 11,31 |
| 20/3/78 | 4,4 | 5,1 | 0,792 | 13,661 | 88,71 | 7,11 |
| 23/3/78 | 4,5 | 6,4 | 1,096 | 8,550 | 62,40 | 13,96 |
| 28/3/78 | 3,4 | 6,6 | 0,991 | 11,800 | 73,78 | 12,09 |
| 30/3/78 | 3,5 | 5,3 | 2,117 | 10,503 | 50,37 | 14,49 |
| 3/4/78 | 5,4 | 5,4 | 1,871 | 8,480 | 78,40 | 14,49 |
| 6/4/78 | 3,8 | 5,2 | 0,705 | 7,889 | 71,11 | 13,42 |
| 10/4/78 | 2,5 | 4,0 | 1,001 | 6,568 | 71,20 | 12,05 |
| 13/4/78 | 4,8 | 6,5 | 0,604 | 8,438 | 80,80 | 10,40 |
| 17/4/78 | 4,1 | 5,4 | 1,156 | 15,673 | 101,42 | 8,62 |
| 21/4/78 | 5,0 | 5,4 | 1,841 | 14,273 | 86,13 | 11,29 |
| 24/4/78 | 4,7 | 5,0 | 1,536 | 18,718 | 74,13 | 13,69 |
| 28/4/78 | 5,6 | 5,3 | 2,502 | 18,925 | 89,60 | 8,80 |
| 1/5/78 | 5,4 | 7,0 | 3,827 | 18,226 | 81,16 | 7,04 |
| 8/5/78 | 6,5 | 7,4 | 4,747 | 18,677 | 50,76 | 7,38 |
| 15/5/78 | 6,3 | 5,6 | 6,567 | 20,161 | 68,27 | 5,51 |

**TABLE 3: Enzyme activities in fruits with pulp spot after low temperature storage**

| Picking date | Fruit number | PPO activity: Change in *A* by enzyme from 0,01 g fresh tissue in 1 minute at 25°C | PO activity (U/liter) x $10^3$ | PME activity (PEu) g x $10^4$ |
|---|---|---|---|---|
| 9/3/78 | 1 | 3,5 | 8,496 | 10,67 |
| 9/3/78 | 2 | 3,4 | 8,900 | 23,47 |
| 9/3/78 | 3 | 2,9 | 8,900 | 14,93 |
| 9/3/78 | 4 | 1,2 | 13,220 | 22,40 |
| 9/3/78 | 5 | 2,4 | 11,730 | 16,00 |
| 9/3/78 | 6 | 2,1 | 13,620 | 12,80 |
| 9/3/78 | 7 | 2,6 | 13,220 | 13,33 |
| Average | | 2,6 | 11,155 | 16,23 |
| 13/3/78 | 1 | 2,9 | 10,92 | 22,400 |
| 13/3/78 | 2 | 3,5 | 11,19 | 18,666 |
| 13/3/78 | 3 | 3,15 | 19,42 | 28,800 |
| 13/3/78 | 4 | 3,7 | 13,22 | 10,666 |
| Average | | 3,3 | 13,69 | 20,133 |
| 17/4/78 | 1 | 3,2 | 20,90 | 3,200 |
| 17/4/78 | 2 | 3,5 | 18,88 | 7,466 |
| 17/4/78 | 3 | 3,7 | 12,14 | 7,466 |
| 17/4/78 | 4 | 3,9 | 19,02 | 9,600 |
| 17/4/78 | 5 | 3,5 | 22,66 | 3,200 |
| 17/4/78 | 6 | 3,9 | 15,78 | 12,800 |
| Average | | 3,6 | 18,23 | 7,289 |
| 20/4/78 | 1 | 4,1 | 16,99 | 7,466 |
| 20/4/78 | 2 | 4,0 | 20,36 | 6,933 |
| 20/4/78 | 3 | 4,0 | 16,99 | 6,400 |
| 20/4/78 | 4 | 1,8 | 17,94 | 9,600 |
| 20/4/78 | 5 | 3,3 | 17,80 | 7,466 |
| Average | | 3,4 | 18,02 | 7,573 |

**Peroxidase (PO) activity** is not generally associated with the browning reaction in plant tissue but in the present study gave very positive results.

In fresh firm avocado fruit PO activity does not vary much during maturation except for a slight increase in May. With storage at 25°C, however, there is a significant increase in soft fruit. The PO activity in soft fruit was highest during January and February dropping through March and early April with a slight rise during late April and May. Here again there does not seem to be any association with the appearance of pulp spot. In fact at this time PO was at its lowest. What does seem important is that in fruit affected with pulp spot (Table 3) there was an increase in PO activity, compared with fruit ripened at 25°C. This enzyme has often been shown to be associated with ethylene evolution and both of these factors are in turn as-associated with stress physiology.

At this stage there is no evidence that pulp spot can be associated with fruit maturity and the enzymes involved in fruit discolouration. It is of interest, therefore, that stress physiology such as high orchard temperatures during harvesting and also soil water stress which may give us further guidelines as to the appearance of pulp spot, particularly in view of its association with PO activity and ethylene evolution, be investigated.