

Proceedings from Conference '97: Searching for Quality. Joint Meeting of the Australian Avocado Grower's Federation, Inc. and NZ Avocado Growers Association, Inc., 23-26 September 1997. J. G. Cutting (Ed.). Pages 76-82.

## **AVOCADO FRUIT SAMPLING PROCEDURES AFFECT THE ACCURACY OF THE DRY MATTER MATURITY TEST**

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**Keywords:** avocado, percent dry matter, maturity index, ripening

### **Abstract**

The current dry matter (DM) test for avocado harvest maturity in Australia (21 % DM) occasionally does not prevent the marketing of fruit which do not ripen to acceptable quality. To test the effects of fruit sampling procedures on the maturity test, 'Hass' fruit were harvested four times at fortnightly intervals from four aspects (north, south, east and west) of sample trees, in three size categories (small, medium and large) from the northern aspect, and undamaged and "damaged" fruit (with ring neck or with sunburn) at one harvest. Fruit were also stored at 40, 60, 80 and 98% relative humidity (RH) at 20°C for four days. The % DM and days to ripe (DTK) were measured.

Aspect had no effect on the % DM or DTK in this trial, although fruit from the eastern side of the tree were larger. Smaller fruit and damaged fruit had higher % DM and ripened more quickly, suggesting they were more mature. Damaged fruit were also smaller. Storage of fruit under RH conditions of 60% and lower for four days increased the % DM by almost 1%. Differences in the % DM between healthy, medium size fruit within the same tree was as great as 5%, and differences between trees, up to 2.5%.

These results indicate that the fruit sampling procedures for the DM test, and the inherent variation in fruit % DM within and between trees, can have an important impact on the commercial relevance of the result. It is recommended that at least 10 fruit (one fruit per tree from across the block) be used for the test, and that these fruit be representative of the fruit to be harvested. Fruit should be analysed as soon as possible after harvest, or stored under conditions which minimise moisture loss from the fruit.

### **Introduction**

Avocado fruit reach a stage during their growth when they can ripen to acceptable quality after harvest. The fruit is then said to have reached harvest or horticultural maturity. Fruit harvested immature can have unacceptable eating quality, can shrivel while softening, or soften unevenly. Therefore, it is important to identify the minimum maturity that ensures acceptable quality when ripe.

Research has focused on identifying fruit characteristics which indicate the point of earliest acceptable harvest. These characteristics (often called maturity standards) should be easy to measure, and are generally developed by correlating the fruit characteristic with quality when ripe. However, because of fruit variability and the influence of growing conditions, the fruit characteristic will not always be a reliable indicator of maturity. The challenge is to obtain a balance between speed and cost of measuring the fruit characteristic, and its accuracy as an indicator of final fruit quality.

Avocado fruit oil content is a good and reliable indicator of maturity, and is still the best one available today (Kaiser, 1994). However, traditional techniques for measuring oil content are expensive. The amount of moisture in the flesh (also indicated as the percentage of dry matter or % DM) is cheaper to measure, and has been adopted by a number of producing countries as a harvest maturity standard. It has the disadvantage of being less reliable than oil content, and is influenced more by growing conditions (Lee *et al.*, 1983; Coggins, 1984).

The Australian avocado industry has expressed some concern about the current dry matter maturity standard, particularly whether the standard is accurate enough to minimise the risk of immature fruit being marketed. This research investigated the effect of fruit sampling procedures on the accuracy of the maturity standard.

## **Materials and methods**

### Trees

The trials were conducted on a typical commercial 18-20 year old avocado orchard at Glasshouse Mountains (south east Queensland). The 'Hass' trees were approximately 9 m high, with 9 m between rows and 4.5 m between trees within rows. There was little inter-row contact between trees, and moderate light reached the orchard floor. Experimental trees were selected for uniformity in fruit yield and canopy appearance. Either 10 or 20 individual tree replications were used, depending on the trial. Fruit were transported to the laboratory within 1 hour of harvest, weighed, dipped in Sportak® (0.05% v/v) for 1 minute and ripened in single layer trays at 20°C.

### Fruit aspect

Avocado fruit (three fruit per aspect per tree per harvest), of average size for each aspect of each tree, were harvested from the north, south, east and west aspect of the canopy of 10 trees at fortnightly intervals for six weeks, commencing 29 April 1996.

### Fruit size

Small, medium and large fruit (three for each size category per tree per harvest) were harvested from the northern aspect of each of the same 10 trees, and at the same times as the above trial. The fruit in each size category were representative of that category for each of the trees at the time of harvest.

### Fruit damage

Two fruit per tree per damage category from 20 trees were harvested for each of three "damage" categories in June. Fruit were undamaged, or had either ring neck of the

pedicel, or sunburn on the fruit itself. Fruit were of average size for each of the damage categories on each tree.

### Storage conditions after harvest

Sixteen fruit of average size were harvested from each of 10 trees. Four fruit per tree were stored at 22°C in 30-litre plastic barrels ventilated with air. The air for each barrel was humidified to either 40%, 60%, 80% or 98% relative humidity (RH) by bubbling the required volume of air through water. The fruit were individually weighed daily, and after four days removed to a standard controlled temperature room at 20°C and 80% RH, until eating soft.

### Fruit quality assessment

Fruit were examined daily by gentle hand pressure, and the days to ripe (DTR) determined as the days from harvest to the eating soft stage.

At eating soft, a subsample of the flesh from the middle of the fruit was weighed, dried at 65°C for 2 days, re-weighed, and the % DM at harvest calculated.

## **Results**

### Aspect

Figure 1 shows that aspect did not affect the % DM or ripening of the fruit. However, fruit from the east side were larger. Fruit size increased with each harvest, and more mature fruit ripened more quickly.

### Fruit size

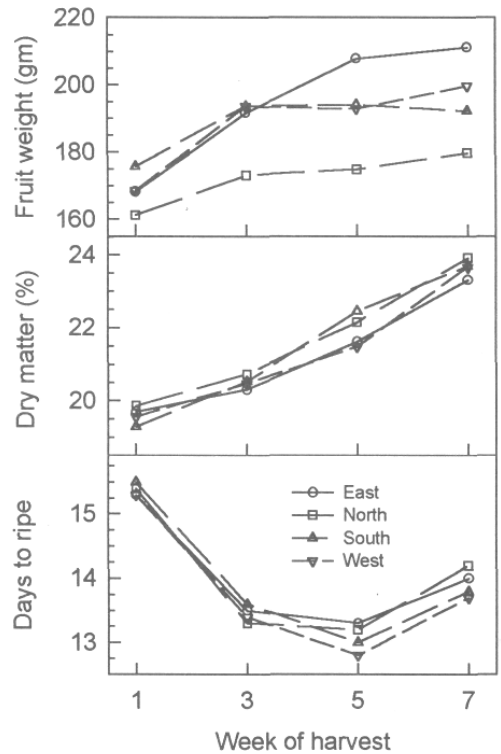
Fruit averaged about 100, 170 and 210 grams for small, medium and large fruit respectively, over the four harvests. Small fruit had higher % DM at all harvests (Figure 2). The smaller fruit also ripened more quickly.

### Fruit damage

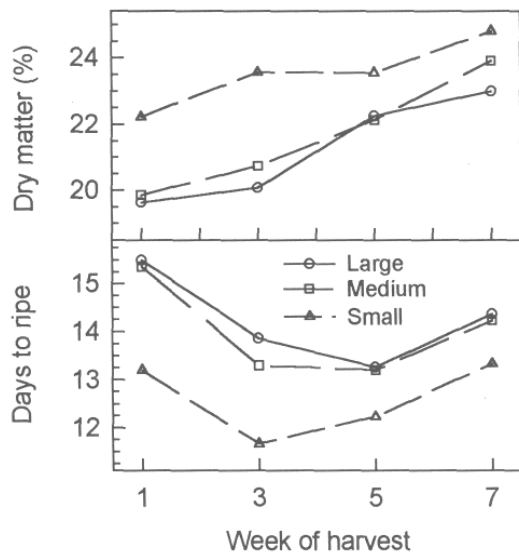
Table 1 shows that fruit with ring neck or sunburn were smaller, had a higher % DM and ripened more quickly than apparently healthy fruit. Fruit with sunburn symptoms had a higher % DM and ripened more quickly than those with ring neck.

**Table 1** The effect of fruit injury on fruit weight, % dry matter, and the number of days from harvest to ripe, of 'Hass' avocados

Characteristic	Damage symptom		
	Undamaged	Ring neck	Sunburn
Weight (grams)	182	129	158
% Dry matter	21.3	22.6	22.9
Days to ripe	12.9	11.6	10.3



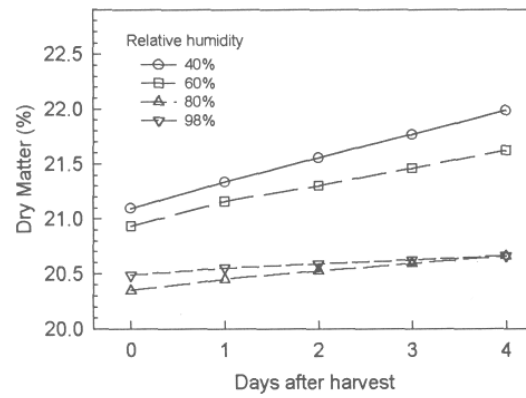
**Figure 1** The fruit weight, % dry matter and days to ripe of 'Hass' avocado fruit harvested at fortnightly intervals, from the east, north, south and west sides of 10 trees



**Figure 2** The % dry matter and the days to ripe of small, medium and large size 'Hass' avocado fruit harvested at fortnightly intervals from the north side of 10 trees

### Conditions after harvest

Figure 3 indicates that storing fruits under RH of 80-98% for up to four days before the dry matter test did not affect the % DM result significantly. However, storage at 60% RH or lower caused an increase in the % DM measured at the end of the storage period.



**Figure 3** The % dry matter of 'Hass' avocado fruit stored for up to four days at 40, 60, 80 and 98 % RH before the dry matter test

### Variability between fruit and between trees

In all of the above experiments, the trees from which the fruit were harvested had a significant effect on the % DM of the fruit, and the rate at which the fruit ripened. For example, at the last harvest of the aspect trial, fruit from one tree had an average of 22.2 % DM, and fruit from a similar tree in the same block, an average of 24.6 % DM. Also, at the same harvest, medium size fruit from one tree had dry matter ranging from 20.6 to 25.2%.

### **Discussion**

The side of the tree on which the fruit were growing had no effect on % DM or days to ripe in this experiment. Similar results have been obtained in SE Queensland in other 'Hass' avocado trials (Vuthapanich, unpublished results). However, aspect had an important effect on the % DM and days to ripe of mango (Hofman *et al.* 1995), and the colour and quality of lychee (Tyas *et al.*, 1997). The size and spacing of the trees in this experiment resulted in only small differences in the amount of light being received by the fruit. Uneven distribution of light around the canopy would be greater in an orchard with smaller trees or wider tree spacing, and under these conditions aspect influences on the % DM may be greater.

The effect of fruit size on % DM and ripening were somewhat surprising, and suggests that the smaller fruit were more mature. Similar results from South Africa also indicate that smaller 'Pinkerton' fruit have a higher % DM because of earlier flowering and slower growth during the colder part of the spring. Later flowers set fruit during warmer conditions, and these fruit grow faster and are larger but less mature at commercial

harvest, than early set fruit (Sippel *et al*, 1992). These results are contrary to the general belief that larger fruit are more mature, and therefore are often harvested first in the season. This practice may need reviewing in light of the current results.

The results of the damage trial also indicate that small fruit are more mature at commercial harvest. In this trial, it was difficult to identify if the damage caused the smaller fruit size, or whether the smaller size pre-disposed the fruit to more damage. Never-the-less, using damaged fruit in the dry matter test will result in an artificially high % DM result. Storing fruit under low RH resulted in a higher % DM because the dryer conditions increased the rate of water loss from the fruit before analysis. The results suggest that storage conditions below 80% RH can affect the final % DM result. Typical RH in the field is 60-80%, so holding the fruit under field conditions for several days could result in a higher % DM being measured. Higher temperatures or more air movement would increase the fruit moisture loss, and increase the % DM result more. Thus, fruit should be analysed as soon as possible after harvest. If this is difficult, fruit should be stored in a plastic bag in the refrigerator to prevent moisture loss.

In conclusion, adequate sampling of fruit from a number of trees across the orchard is very important because of the variation in fruit % DM between trees and between fruit. The lower the number of fruit used in the test, or if damaged fruit, or fruit of other sizes are included in the sample, the more likely the result obtained will be very different from the mean % DM of the average fruit. Therefore, it is suggested that a total of at least 10 fruit per orchard be used in the maturity test, and that these fruit are taken from each aspect from 10 trees (one fruit per tree) throughout the orchard. The more fruit used in the test, the more accurate the result will be. The fruit used should be representative of the fruit intended for harvest. Damaged fruit should be excluded. If an estimate of the lowest % DM of fruit in the orchard is desired, then larger, healthy fruit should be tested.

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