EARLY SEASON FRUIT MATURITY

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ABSTRACT

Early season fruit were assessed as part of a longer-term study to determine the influence of early season maturity on ripe fruit quality, the robustness of the maturity standards to seasonal variation and to identify those factors that influence maturity. In the 2000-2001 and 2001-2002 seasons samples of early season fruit were collected from several orchards up to 6 weeks prior to the start of commercial harvesting. Dry matter content influenced fruit quality in both seasons. There was considerable variation in dry matter content within each region. Aspect and sampling height were identified as factors contributing to this variation. No relationship was observed between fruit size and dry matter content for either season.

Keywords: dry matter content, vascular browning, body rots, checker boarding

INTRODUCTION

A major quality problem experienced in the USA market in the 1999/2000 season was checkerboard arrivals. This is a result of uneven rates of ripening and is indicative of fruit harvested at low maturity. Immature fruit not only have a greater incidence of checker boarding but they are also more prone to chilling injury, uneven ripening resulting in flesh adhering to the stone, and vascular browning may be prevalent. Other symptoms include red colouration of the peel on ripening, vascular strands may be stringy, and in extreme cases the fruit may shrivel. The eating quality is also inferior with a distinct watery taste.

It is therefore necessary to ensure that fruit entering the market early in the season have attained a maturity that allows fruit to ripen uniformly to a consistently high quality. Maturity in avocados is generally measured either by dry matter or oil content. Dry matter is the commercial maturity index used for Hass in New Zealand, Australia, South Africa, Israel and the USA because of the ease with which it can be determined, and because it is highly correlated with oil content (Hofman and Jobin-Decor, 1999). Ranney (1991) showed that for a range of cultivars including Hass there is a measurable relationship between dry matter content and physiological maturity, and that this relationship appears to be constant from season to season.

Under New Zealand conditions, higher dry matters are required to achieve acceptable quality on ripening given the long storage times taken to reach the major export markets. Commercial maturity standards in New Zealand are based on a 20-fruit sample whereby average dry matter content must exceed 24%, and 90% of the sample must exceed 20.8% dry matter.

These experiments are part of a longer-term study to determine the influence of early season maturity on ripe fruit quality of Hass and the robustness of the maturity standards to seasonal and regional variation. As part of these studies the influence of several factors, which have been reported to influence maturity, have been examined. These include fruit size, aspect on the tree (Hofman and Jobin-Decor, 1991) as well as height within the canopy.

METHODS

<u>2000-2001 season</u>

Fruit were sampled at random from 3 orchards in the Far North (8th August 2000) and 2 orchards in Whangarei (3rd August 2000). Dry matter content was determined on a 20-fruit sample. The remaining fruit were placed into coolstorage at 5-7 ºC for periods of either 2, 3 or 6 weeks. A sample of fruit from each of the Far North orchards (50 per orchard) was removed from coolstorage after 2 weeks and treated with 100 ppm ethylene at 15 ºC for 24 hours and allowed to ripen at ambient temperature. Fruit coolstored for either 3 (50 fruit per orchard) or 6 weeks (100 fruit per orchard) was allowed to ripen naturally at ambient temperature after removal from coolstorage. Fruit quality was assessed after fruit had reached a firmness of 85 based on a firmometer using a 300g weight. Fruit was assessed in accordance with the AIC Fruit Assessment Manual (AIC, 2000).

The influence of aspect on fruit dry matter content was investigated by collecting a twenty fruit sample at random within each compass quadrant (NE, NW, SE, SW) on 5 individual Hass trees in a Katikati orchard. The trees were seven years old, with light exposure on all sides of each tree. Average dry matter content was assessed for each sample and the results analysed using ANOVA (Minitab).

Effect of height within canopy on fruit dry matter content was assessed by collecting a twenty fruit sample at random from the top 2.5 metres of canopy and from the bottom 2.5 meters of canopy on four individual Hass trees in a Te Puke orchard. The trees were over 20 years old and approximately 10 metres in height. Average dry matter content was assessed for each sample and the results analysed using ANOVA (Minitab).

<u>2001-2002 season</u>

Samples of 120 fruit were drawn at regular intervals from two orchards each in the Far North and Whangarei. Fruit were sampled from the Far North on 9th July, 29th July, 12th August, 27th August and 14th September 2001. Fruit were sampled from Whangarei on 12th July, 23rd July, 8th August, 3rd September, and 1st October 2001. Dry matter content was determined on a 20-fruit sample from each orchard and the remaining fruit placed in coolstorage at 5-7 ºC for 4 weeks. The fruit were ripened at 20ºC and fruit quality assessed in accordance with the AIC Fruit Assessment Manual (AIC, 2000).

RESULTS & DISCUSSION

Fruit Quality

2000-2001 season

Vascular browning was the quality parameter most affected by fruit maturity. The longer the coolstorage period the more pronounced the effect on both severity and incidence of vascular browning after 3 or 6 weeks coolstorage (Table 1). Body rot severity was highest after 6 weeks coolstorage, although incidence was greatest after 3 weeks in coolstorage. Stem-end rot incidence and severity was greatest for fruit that had been coolstored for 6 weeks. Analysis of variance of the data indicates that while both coolstorage and dry matter content significantly influenced ripe fruit quality, coolstorage had the greater influence.

Table 1. Incidence (%) and severity (% area affected) of stem-end rots, body rots and vascular browning of fruit sampled from 3 Far North orchards on 8 August 2000. Fruit were either coolstored for 2 weeks followed by ethylene preripening (n=50), or coolstored for either 3 (n=50) or 6 weeks (n=100) followed by natural ripening at ambient.

Dry matter	Weeks in	Stem-end rots		Vascular browning		Body rots	
content (%)	coolstore	Severity	Incidence	Severity	Incidence	Severity	Incidence
23.6	2	0.39	16.3	1.63	46.9	1.41	10.2
24.6	2	0.02	2.0	0.05	4.0	0.15	4.0
26.5	2	0.54	12.5	0.75	33.3	0.42	8.3
23.6	3	0.17	15.4	0.37	13.5	1.75	30.8
24.6	3	0.16	7.8	0.25	9.8	1.63	47.1
26.5	3	0.09	6.4	0.04	4.3	2.32	34.0
23.6	6	0.56	40.0	8.26	72.6	12.92	10.5
24.6	6	0.54	26.3	4.68	54.5	10.82	10.1
26.5	6	0.57	27.5	1.87	33.0	7.42	15.4

2001-2002 season

In the 2001-2002 season a significant ($P < 0.001$) relationship was observed between incidence of body rots and the minimum dry matter content recorded in the 20-fruit maturity sample (Fig. 1). Both the overall level and variance in body rot incidence decreased as the minimum dry matter content in the sample increased. The relationship was stronger for minimum dry matter content than either average dry matter or sampling date.

As fruit maturity increased, fruit ripened more evenly as indicated by the checkerboard rating of fruit 48 hours after removal of fruit from coolstorage

(Fig. 2). In both seasons of this study, the higher the minimum dry matter content in the 20-fruit maturity sample, the more even the rate of ripening.

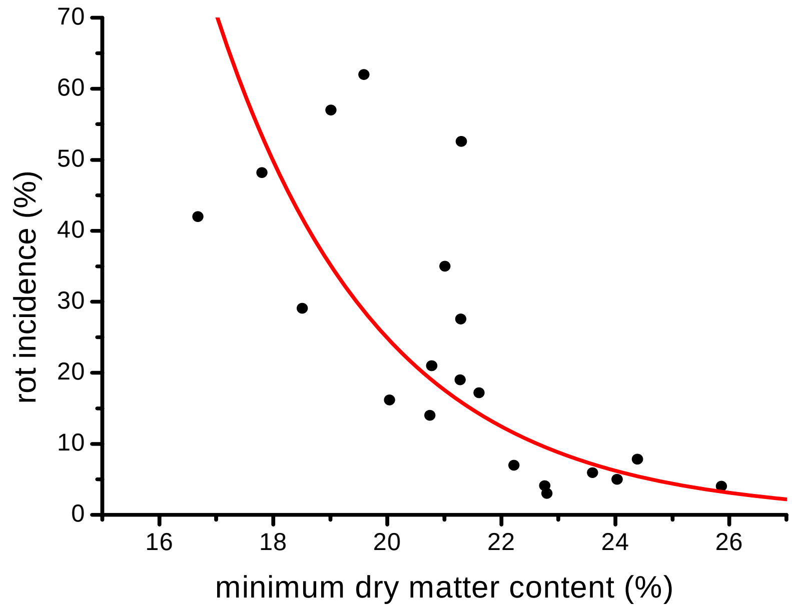

Figure 1. Relationship between body rot incidence (%) and minimum dry matter content recorded in a 20-fruit maturity sample. (Y=25658*exp(-0.3469X), $R^2 = 0.65$, P<0.001)

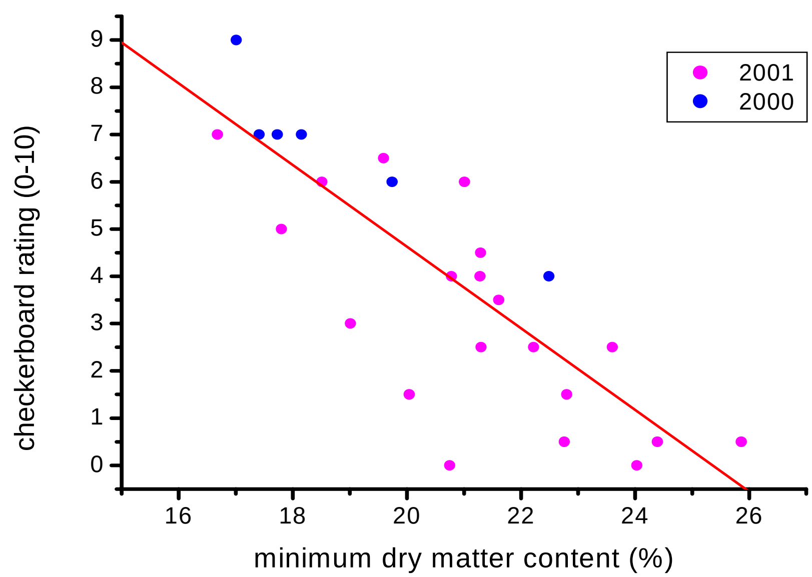

Figure 2. Evenness of ripening as measured by checker-board rating in relation to minimum dry matter content recorded in a 20-fruit maturity sample. Combined data from the 2000-2001 and 2001-2002 seasons was submitted to regression analysis (Y=21.9 – 0.86X, $R^2 = 0.66$, P<0.001)

Fruit size

In both years of this study there was no relationship between fruit dry matter content and fruit size as measured by fresh weight (Figs 3,4). This applied to all three regions in both seasons. This is in contrast to Australia, where dry matter was related to fruit size (Hofman and Jobin-Decor, 1991). Figures 3 and 4 also provide a graphic illustration of the extent of the variation in dry matter for each of the three regions for orchards sampled on a single date.

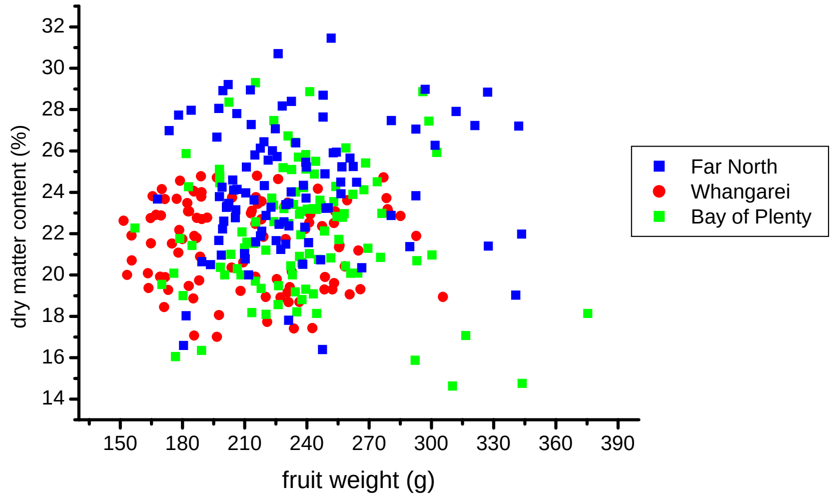

Figure 3. Dry matter content (%) in relation to fruit weight (g) for fruit collected over the period 27th July to 4th August 2000 from the Far North, Whangarei and the Bay of Plenty. Samples of 20 fruit were taken at random from 5 orchards in each region.

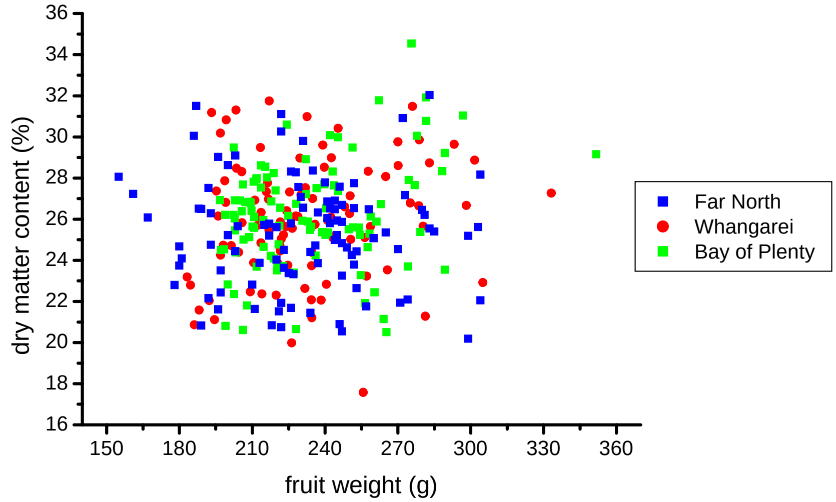

Figure 4. Dry matter content (%) in relation to fruit weight (g) for fruit collected over the period 10th –14th September 2001 from the Far North, Whangarei and the Bay of Plenty. Samples of 20 fruit were taken at random from 5 orchards in each region.

Aspect

Although aspect significantly (P<0.001) influenced dry matter content, this was not consistent from tree to tree, as evidenced by the significant (P<0.001) interaction between aspect and tree (Table 2). There is also considerable variation between trees in the overall level of dry matter. In general, fruit with the lowest dry matter where located in the South-West quadrant (Table 3).

Table 2. Summary of treatment effects (aspect and tree) from two-way ANOVA on fruit dry matter content based on a 20 fruit sample.

Source	Significance
Aspect	P<0.001
Tree	P<0.001
Aspect * Tree	P<0.001

Table 3. Table of means (± standard errors) comparing effect of aspect on dry matter content within and between trees.

	Aspect			
Tree	NE	NW	SE	SW
1	23.47 ± 0.48	21.82 ± 0.29	22.24 ± 0.40	21.64 ± 0.41
2	22.64 ± 0.37	23.81 ± 0.34	26.15 ± 0.25	22.40 ± 0.65
3	22.93 ± 0.29	24.07 ± 0.26	22.93 ± 0.40	22.70 ± 0.29
4	21.56 ± 0.33	24.57 ± 0.27	23.62 ± 0.36	21.37 ± 0.48
5	20.68 ± 0.37	23.20 ± 0.23	22.28 ± 0.31	22.84 ± 0.26

Height in canopy

The height within the canopy at which the fruit were sampled significantly (P<0.001) influenced the average dry matter content of the sample (Table 4). However there was also significant (P<0.001) variation between trees and a significant (P<0.001) interaction between height and tree. For one tree there was no significant difference between top and bottom of the tree (Table 5). However, on other trees the difference in dry matter content between top and lower portions of the tree exceeded 4%.

Table 4. Summary of treatment effects (height and tree) from two-way ANOVA on fruit dry matter content based on a 20 fruit sample.

Source	Significance
Height	P<0.001
Tree	P<0.001
Height * Tree	P<0.001

Table 5. Table of means (± standard errors) comparing effect of sampling height within canopy (upper 2.5 m versus lower 2.5 m) on dry matter content within and between trees.

	Height	
Tree	Lower	Upper
1	22.66 ± 0.23	25.52 ± 0.56
2	25.71 ± 0.42	29.78 ± 0.35
3	26.52 ± 0.27	26.28 ± 0.47
4	24.99 ± 0.38	29.60 ± 0.49

CONCLUSION

Considerable variation in the dry matter content of early season fruit was observed in this study. Fruit quality was related to dry matter content in both seasons. The lower the maturity the greater the prevalence or severity of disorders including vascular browning, body rots and checker boarding. Maturity standards were revised to account for the degree of variation in early season fruit dry matter content. Two factors, aspect and sampling height, were identified which contributed to this variation. There was no relationship between fruit dry matter content and fruit size as determined by weight.

REFERENCES

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