Seasonal changes on chemical and physical parameters in six avocado (*Persea americana* Mill) cultivars grown in Chile

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SYNOPSIS
The avocado fruit parameters - moisture content, volume, polar and equatorial diameters and seed coat colour - were correlated with oil content and subjected to simple and multiple regression analyses, in order to find a faster way to estimate the oil content, in six avocado cultivars grown in Chile. The best oil content estimator was the moisture content, based on simple regression equations. The minimum moisture content to harvest avocado cultivars was 80,5 per cent for Negra de la Cruz; 78,7 per cent for Bacon; 79,4 per cent for Zutano; 82,3 per cent for Fuerte; 77,1 per cent for Edranol and 73,9 per cent for Hass.

INTRODUCTION
Avocado oil content relates closely to its palatability (Hatton & Campbell, 1959; Olaeta, Gardiazabal & Martinez, 1986), and is used as a maturity index.

The soxhlet standard method (Lee, 1981) to analyse the oil content is expensive and slow. For these reasons, it is necessary to look for a simple essay that permits an easy relation to the oil content of its maturity level.

Harkness (1954), Mazliak (1971), Lee (1981) and Swarts (1976), reported that in avocado, as the oil content increases, the moisture decreases. On the other hand, it has been observed that there is a close correlation between the weight, diameter and seed coat colour of the fruit and its maturity (Harding, 1954; Harkness, 1954; Hatton & Campbell, 1959; Soule & Harding, 1955; Hatton, 1964; Valmayer, 1967; Erickson, 1966).

A model to determine the oil content in the analysed cultivars, in a simple way, was drafted.

MATERIALS AND METHODS
The fruits of Negra de la Cruz, Zutano, Bacon, Fuerte, Edranol and Hass cultivars were harvested in La Palma Experimental Station, Quillota, Chile during the 1981-1982 season.

The oil content (AOAC, 1980), moisture (AOAC, 1980), weight, volume, equatorial and polar diameter of the fruits and seed coat colour (Munsell, 1976) were measured in each cultivar every 15 days from the anthesis up to the maturity, which is defined as the state of the fruit growth, in which its oil content does not increase.

These parameters were correlated with each other and subjected to several simple and multiple regression analyses, in order to determine the existing relations and find out a faster value of the oil content.

RESULTS

In all analysed cultivars as the fruit develops, there is an increase in the oil content (Figure 1).
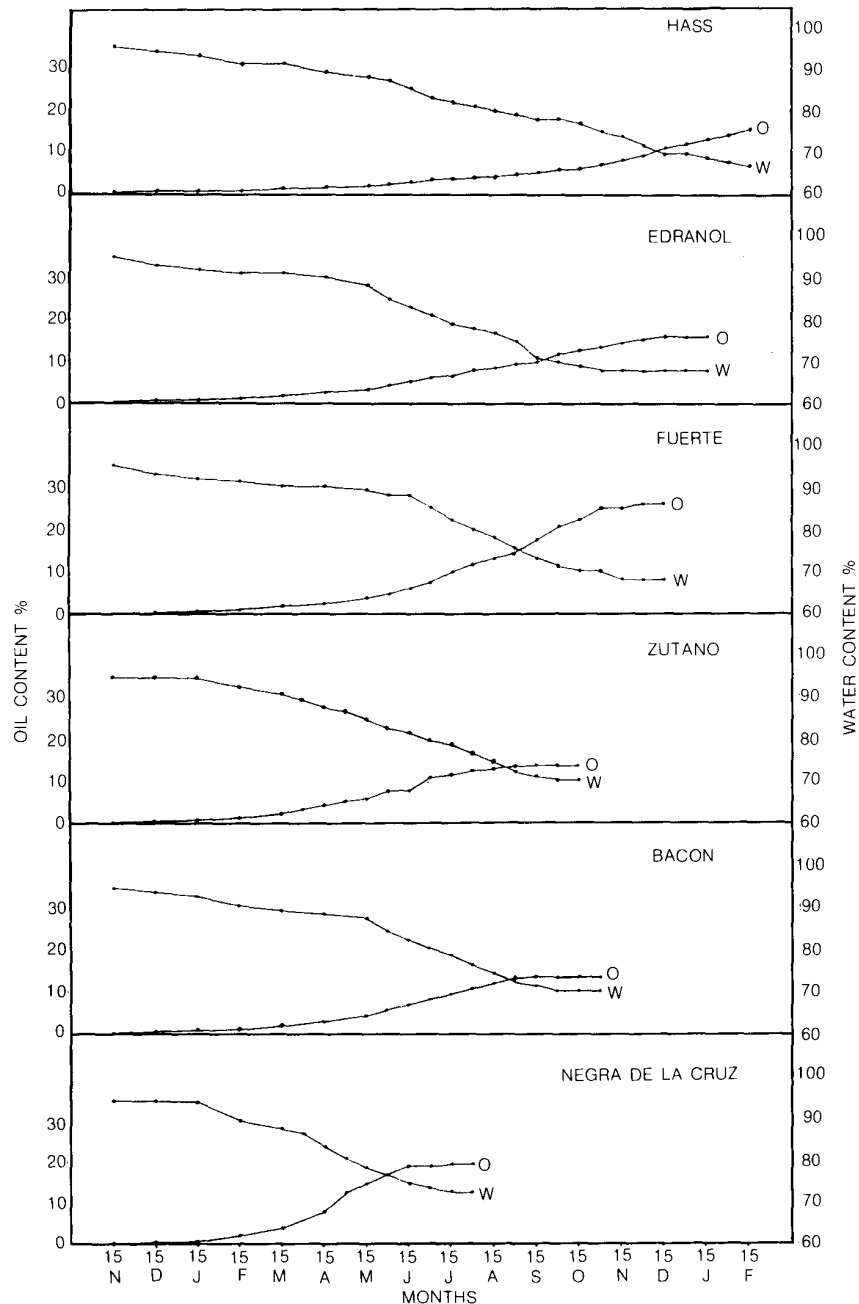

Fig 1   Seasonal changes in oil and water content of fruit of avocado (*Persea americana* Mill).

The growth of fruits expressed in weight, volume, polar and equatorial diameter (Figures 2 and 3), was adapted to a single sigmoid curve.

High correlations were found between oil content and moisture (Table 1). These correlations were higher in all cases than the ones found among the oil content and amongst analysed growth parameters (Table 2).

When applying multiple regression models with all possible combinations to the analysed parameters, it was found that the oil content values of higher accuracy, were simple regression equations, based on the moisture content, under the following model:

$$Y_i = B_o + B_1 X_i + E_i$$

where
Y_i = oil content in the i-esimal observation
B_o = interceptor of the regression line with the Y axis
B_1 = change in the answer mean when X varies in a unit
X_i = percentage of moisture in the i-esimal observation
E_i = error due to the aleatorisation of the i-esimal observation

In accordance with this model, characteristic equations were obtained for all the analysed cultivars (Table 3).

When comparing the oil content in each cultivar by means of the regression equation and the other determined by the soxhlet method, it was observed that the variations were no higher than 4 per cent.

DISCUSSION
The relations between the oil content and moisture, agrees with what other authors have pointed out, namely Harkness, 1954; Mazliak, 1971; Lee, 1981; Swarts, 1976.

The decrease rates and periods of moisture content coincide with the rates and times when there is a significant increase in the oil content of each cultivar. This situation, which is confirmed by the high correlation, allows that the oil content can be determined with a small variation through the moisture content.

The minimal oil content present in avocado cultivars when harvested in Chile, are with the following moisture levels: 80,5 per cent for Negra de la Cruz; 78,7 per cent for Bacon; 79,4 per cent for Zutano; 82,3 per cent for Fuerte; 77,1 per cent for Edranol, and 73,9 per cent for Hass.
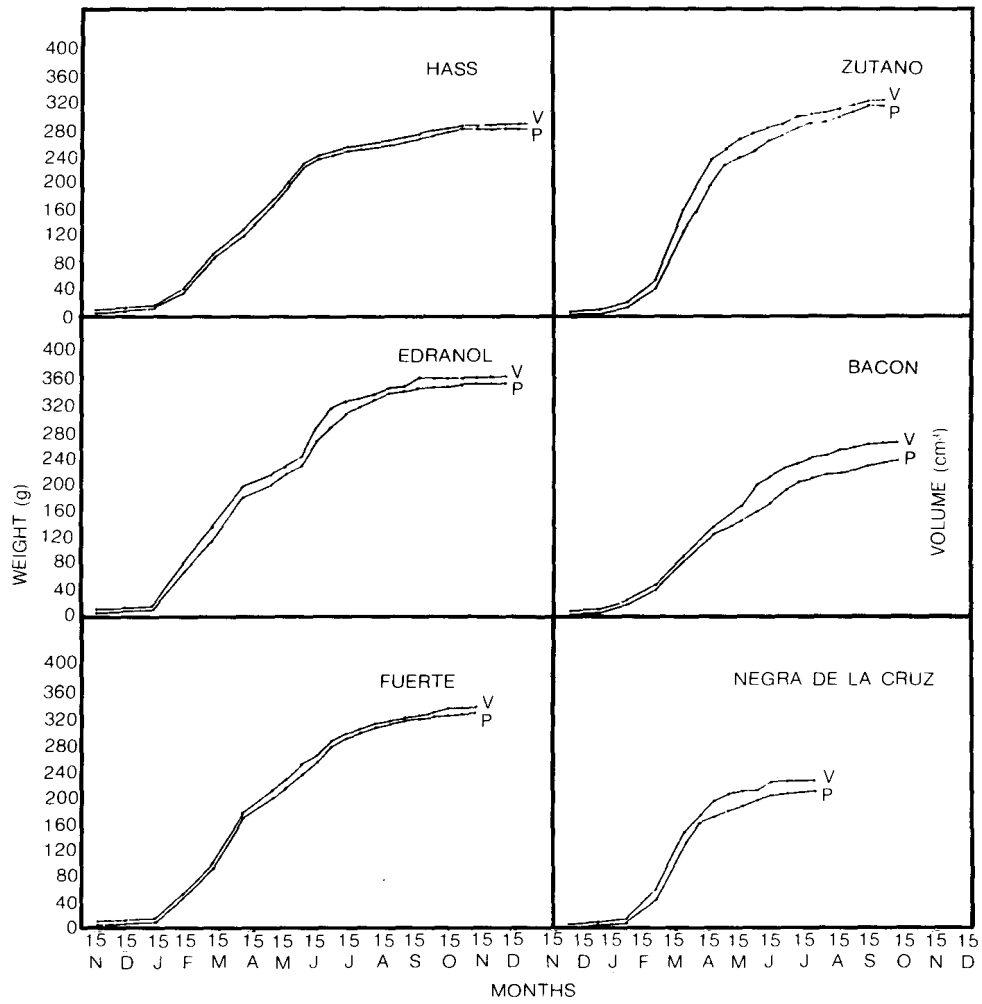
Fig 2 Seasonal changes in base of weight and volume in size of fruit of avocado (*Persea americana* Mill).
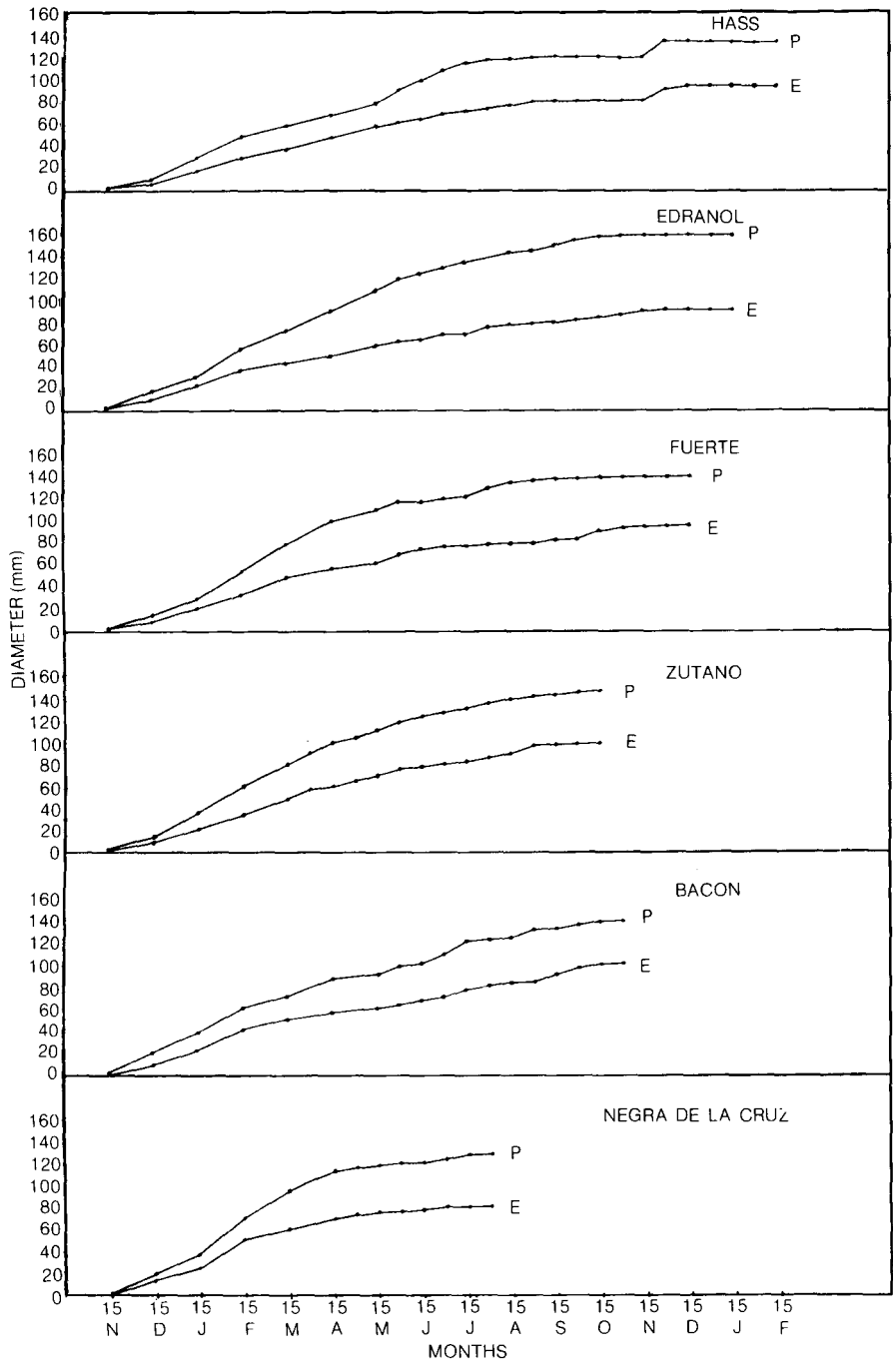
Fig 3 Seasonal changes in polar and equatorial diameter of avocado fruit (*Persea americana* Mill) cultivars.

TABLE 1 Correlation coefficients between the oil content and moisture content of avocado fruit cultivars

Cultivars	Negra de la Cruz	Bacon	Zutano	Fuerte	Edranol	Hass
Correlations	-0,997	-0999	-0,988	-0980	-0,989	-0,980

TABLE 2
Correlation coefficients between the oil content and weight, volume, polar and equatorial diameter in avocado fruit (*Persea americana* Mill) cultivars

Cultivars	Weight	Volume	Equatorial diameter	Polar diameter
Negra de la Cruz	0,911	0,918	0,899	0,870
Bacon	0,943	0,929	0,931	0,930
Zutano	0,922	0,879	0,904	0,905
Fuerte	0,849	0,832	0,738	0,759
Edranol	0,888	0,875	0,859	0,846
Hass	0,752	0,756	0,741	0,773

TABLE 3 Regression equations of the oil content for avocado fruit (*Persea americana* Mill) cultivars			
Negra de la Cruz	: % oil	=	91,141 - 0,971 (% Moisture)
	: R2	=	- 0,9925
Bacon	: % oil	=	57,124 - 0,599 (% Moisture)
	: R2	=	- 0.9974
Zutano	: % oil	=	58,494 - 0,622 (% Moisture)
	: R2	=	- 0,9869
Fuerte	: % oil	=	84,507 - 0,905 (% Moisture)
	: R2	=	- 0,9061
Edranol	: % oil	=	53,246 - 0,561 (% Moisture)
	: R2	=	- 0,9864
Hass	: % oil	=	48,428 - 0,520 (% Moisture)
	: R2	=	- 0,9750

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