SPATIAL DISTRIBUTION OF DRY MATTER IN AVOCADO FRUITS AND ITS RELATIONSHIP WITH FRUIT LOAD

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Abstract

The quality and post-harvest life of avocado fruits is strongly conditioned by their oil content, accumulated before harvest. Oil content can be estimated through the dry matter content of the fruit. Thus, to start the harvest, a minimum of 23% dry matter (DM) must be reached, with an optimum between 23 and 28%, while with a DM above 28% the fruit loses its storage condition.

The spatial variability of the dry matter of avocado fruits was studied in an 8-hectare field. A 20-point grid was stablished. Each sampling point corresponded to a tree. All fruits of each sampled tree were harvested, counted, and individually weighted. A 10-fruit sample was collected at each tree and their dry matter content determined.

An important variability of fruit dry matter was found within the tree and within the field. This variability was related to plant size, fruit size, fruit load, and nutrient content in fruit.

Keywords: Avocado, dry matter, spatial variability, fruit quality, mineral content.

1. INTRODUCTION

Avocado (*Persea americana Mill.*) orchards in Chile occupy approximately 29.105 (year 2021) hectares, where 4,403 hectares (15%) are cultivated in the O'Higgins region (https://paltahass.cl). At the world level, the avocado production reaches ~ 5,5 million tons, where the main producers are Mexico, Perú, Colombia, and Dominican Republic (Odepa, 2018). Chilean production estimation for the 22/23 season was 186,423 tons, of which 103,116 tons were exported. This means that 55.3% of the national production (https://paltahass.cl) will be exported. To export avocados, it is necessary to comply with the harvest indices, as in all fruits, for example in kiwi the indices are 6.2% soluble solids and 16% dry matter. In the case of avocados, the dry matter content is used, which is an indirect measure to estimate oil content of the fruit (Whiley, 2007). With 23% dry matter, an oil level of more than 9% is guaranteed, which allows obtaining fruits of optimal quality for consumption and post-harvest (INIA, 2012.). On the other hand, a high dry matter content, about 28%, although it improves the organoleptic quality of the fruits, decreases the post-harvest life, which limits trips to distant markets, about 30 days of travel. Within the orchard and in the plants, there is high heterogeneity in the dry matter content, partly because flowering lasts 2 months, the load is heterogeneous, the variability of the soil and irrigation etc. (INIA 2012.) Therefore, it is necessary to know the distribution of dry matter in the orchard and the factors affecting it.

MATERIALS AND METHODS

2.1 Location

The study was performed at the Peumo commune (Rapel Valley, Chile) located at the coordinates 34º20'30.42'' South and 71º15'52.74'' West. The study area corresponds to a semi-arid, Mediterranean region, with a temperate climate with temperatures in the range of 5.5 to 27.6 ºC, while precipitation varies between 400 and 420 mm yr^{-1}. The soil belongs to the order Mollisol, which presents a silt loam texture, neutral pH, low organic matter content (~2%), and medium fertility.

2.2 Plant material and growth conditions

The avocado orchard field (*Persea americana mill.*), corresponded to the Hass variety (on mexicola rootstock) established in 2018 in low density (473 plants ha^{-1}), The orchard was drip-irrigated with a double drip line with 6 drippers per plant (0. 8 mm ha^{-1} $hour^{-1}$). Wind machines are used as frost control, which enter operation when the temperature reaches 2.5 Celsius degrees. In addition, this orchard has a second frost control system, that uses water through micro sprinklers of 3 mm ha^{-1} $hour^{-1}$.

2.3 Experimental design

A systematic, non-aligned grid with ~ 20 sampling points (trees)/field was established at selected field, from which all the fruit was removed, counted, and weighed one by one. A sample of 10 fruits was taken from each plant where the nutritional content and dry matter were measured. In addition, 12 fruits of each plant were taken, and dry matter was measured in the laboratory. A high resolution satellite image collected in the middle of the month of January was used to estimate NDVI and, though this, plant vigor.

2.4 Statistical analyses

Maps were produced using kriging interpolation. An omnidirectional linear variogram with all data was used in all cases.

Data were analyzed by descriptive statistics and multiple regression analysis. A step wise procedure was used to select the variables which explain dry matter content of avocado fruits.

3. RESULTS AND DISCUSSION

A large spatial variability in terms of dry matter of fruits, was observed in the studied avocado field (Figure 1). Twenty six percent of the dry matter medians of the tree population had valued lower than the harvest index of 23% DM.

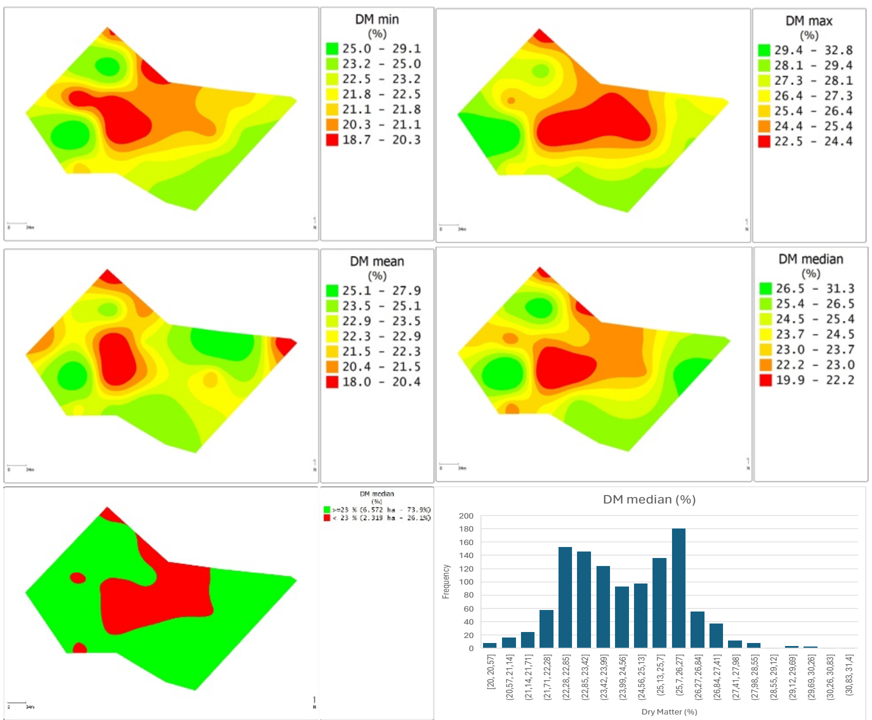

Figure 1. Spatial variability of dry matter of fruits, area under 23% DM, and distribution of DM median values.

Figure 2 shows NDVI values for this orchard and the spatial variability of yield per tree where there is a clear area of low production.

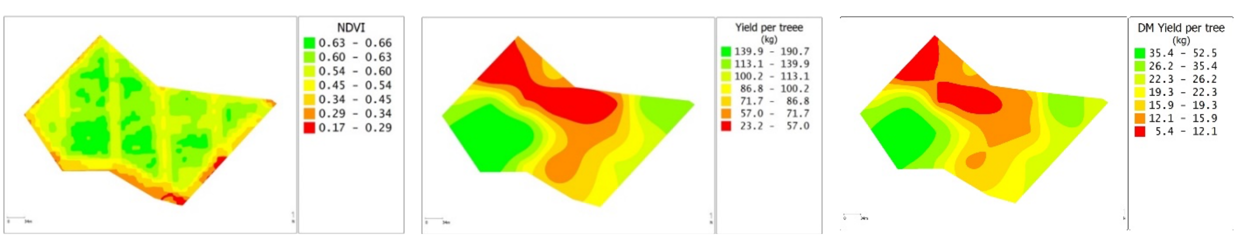

Figure 2. Spatial variability of NDVI (left), yield per tree (right), and DM yield per tree in avocado orchard.

Figure 3 shows the spatial variability of the nutrient contents of avocado fruits. Avocado fruits presented large concentrations (DM basis) of N, P and K, and low Ca contents which were less than half of those of Mg.

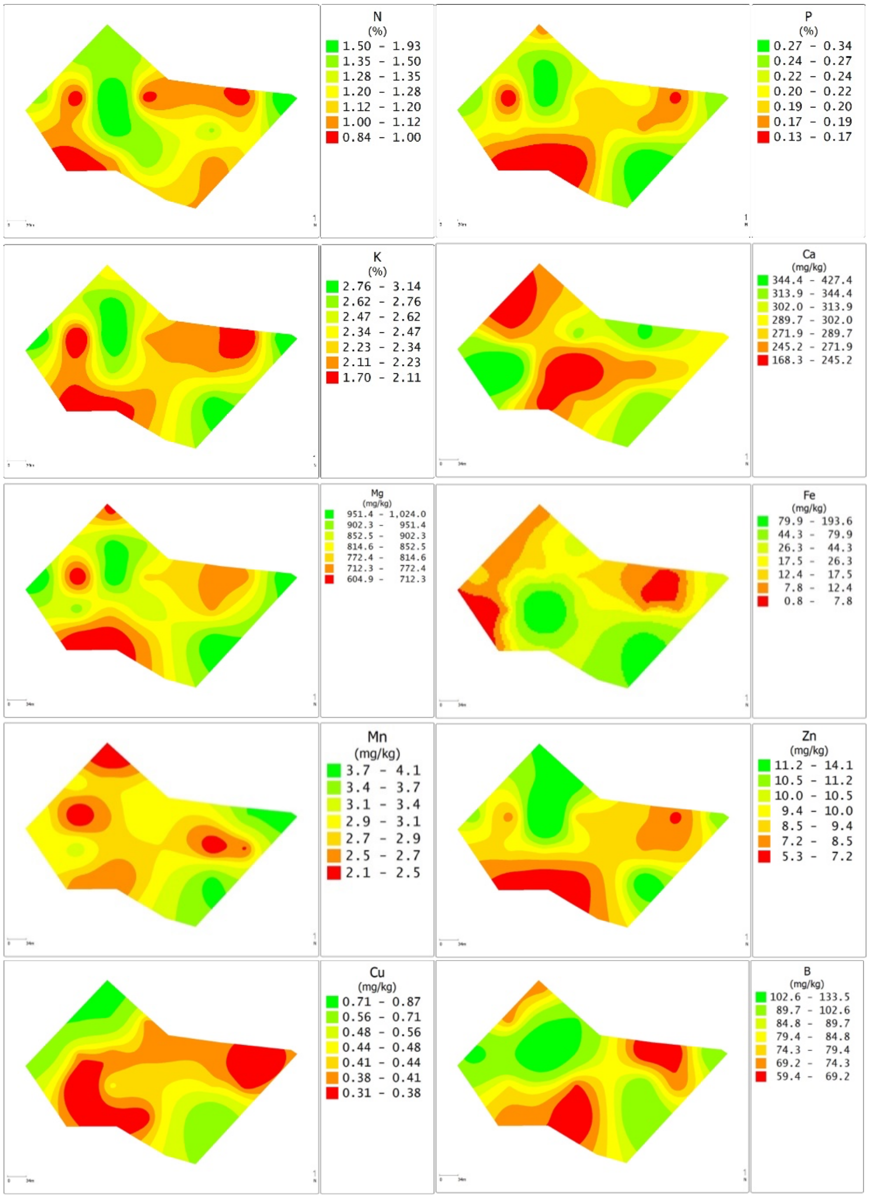

Figure 3. Spatial variability of nutrient content of avocado fruits on DM basis.

Avocado DM yield showed a right-skewed distribution, with a mean of 22 kg of dry fruits/tree (Figure 4)).

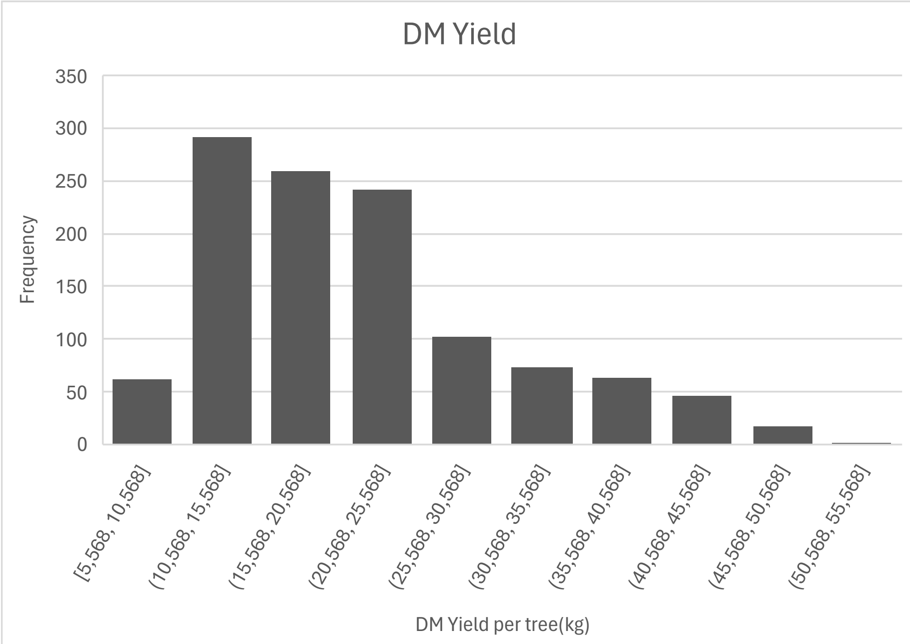

Figure 4: Histogram of Dry Matter Yield

A model selection to explain the maximum fruit DM content was performed using a step wise procedure. Fruit yield, N, P, Ca, Mg, and micronutrient content (except B and Zn) positively impacted median DM content of the fruit, while plant size estimated by NDVI negatively impacted fruit DM (Tabla 1). Potassium concentrations had no effect on DM while P had the largest effect per unit increase (Table 1).

Table 1. Stepwise regression model to explain maximum dry matter content of avocado fruits.

OVERALL FIT

Multiple R	0,91136308
R Square	0,83058266
Adjusted R Square	0,82881329
Standard Error	0,77097088
Observations	1162

AIC	-591,55655
AICc	-591,19037
SBC	-525,80387

ANOVA — Alpha 0,05

	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	12	3348,27393	279,022827	469,42238	0	yes
Residual	1149	682,961108	0,59439609			
Total	1161	4031,23503				

	coeff	std err	t stat	p-value	lower	upper	vif
Intercept	-47639,585	2249,73522	-21,175641	2,7421E-84	-52053,635	-43225,535	
Yield per treee(kg)	0,01718085	0,00093817	18,3131802	6,2497E-66	0,01534014	0,01902157	2,56020274
NDVI	-0,8832464	0,25926767	-3,406697	0,00068029	-1,3919376	-0,3745553	1,45518461
N(%)	2,06937721	0,24294523	8,51787553	5,0294E-17	1,5927112	2,54604322	3,51593306
P(%)	44,7390889	2,73905831	16,3337483	4,3379E-54	39,3649722	50,1132055	24,7779516
Ca(mg/kg)	0,01034466	0,0010615	9,74533451	1,2915E-21	0,00826197	0,01242736	3,59895294
Mg(mg/kg)	0,00436131	0,00087336	4,99369006	6,8408E-07	0,00264774	0,00607487	10,8139578
Zn(mg/kg)	-1,3867356	0,04419893	-31,374865	1,39E-156	-1,4734553	-1,3000159	9,81042924
Fe(mg/kg)	-0,0188653	0,00102136	-18,470679	6,6238E-67	-0,0208692	-0,0168613	1,98333789
Cu(mg/kg)	3,53868523	0,39972705	8,85275392	3,1689E-18	2,75440845	4,322962	4,35160902
Mn(mg/kg)	0,73604492	0,12259155	6,00404283	2,5779E-09	0,49551653	0,97657332	3,87275117
B(mg/kg)	-0,0118458	0,00357233	-3,3159862	0,00094175	-0,0188548	-0,0048368	4,70834012
Longitude	-668,73591	31,5704818	-21,182316	2,4764E-84	-730,67817	-606,79365	3,11255437

4. Preliminary conclusions

- Dry matter of fruits within the orchard is highly variable. It is affected by the mineral content of the fruits, the load, and the vigor of the trees.
- More research is necessary to continue understanding the accumulation of DM in fruits.

5. References

Chilean Avocado Committee (2022). Statistical information on avocado.

Dejean G. et al. (2021). Integración del Procesamiento Imágenes e Internet de las Cosas en la estimación temprana del rendimiento de cultivos frutales. RedUNCI - UNdeC. ISBN: 978-987-24611-3-3 2021

Oficina de Estudios y Políticas Agrarias - Centro de Información de Recursos Naturales (ODEPA-CIREN). (2021). Catastro Frutícola / Principales resultados / Región de O'Higgins.

Ferreyra E., Raúl y Defilippi B., Bruno (eds.). 2012. Factores de precosecha que afectan la postcosecha de palta Hass: Clima , suelo y manejo. 100 p. Boletín INIA Nº 248. Instituto de Investigaciones Agropecuarias,Centro Regional de Investigación La Cruz, La Cruz, Chile.

https://paltahass.cl/wp-content/uploads/2023/01/IQonsulting-Estimacion-Paltas-2022-23-y-proyeccion-5-anos.pdf

Whiley A.W, B. Schaffer y B.N. Wolstenholme El Palto Botánica, Producción y Usos. 2007