FOREST NUTRITION COOPERATIVE

Estimating Soil Water Availability in Forest Nurseries

Rafael Rubilar[1] (speaker), Manuel Acevedo[2], José Hernandez[2], Stefhani Bordones[2]

[1]Cooperativa de Nutrición Forestal -Universidad de Concepción,CHILE- rafaelrubilar@udec.cl

[2]Universidad de Concepción, CHILE

1. ABSTRACT

Irrigation of radiata pine bare root seedlings in forest nurseries of the Central Valley of Chile is usually determined by visual evaluation. Multivariate analyses using soil organic matter, particle size distribution at 0-5 and 5-15 cm depth, and field capacity and wilting point moisture contents were used in conjunction with spatial analyses to develop a spatial soil water availability model used to improve irrigation efficiency of radiata pine bare root seedlings production.

2. OBJECTIVE

To improve irrigation efficiency of bare root radiata pine seedlings grown on sandy soil nurseries of the Central Valley of Chile.

3. METHODS

An airborne multispectral NDVI image with 1m x 1m spatial resolution was obtained one month before seedling harvesting (Fig. 1). Variability in seedling biomass (Figs. 2, 3a and 3b) associated to NDVI was used as a surrogate to select a 50 x 50 m area of higher soil variability. In the selected area soils samples were obtained in intensities of 1mx1m (10 x 10 m square), 2 m x 2m (25 x 25 m square), and 4 x 4 m (50 x 50 m square area) (Fig. 4). Soil samples were obtained at 0-5 cm, and 5-15 cm depth and analyzed for organic matter content (OM) and particle size distribution at >2000um, 2000-1400um, 1400-1000um, 1000-425um, 425-355um, 355-180um, 180-100um and <100um mesh sizes.

Fig 1.- Airbone multispectral image of the forest nursery (real color image).

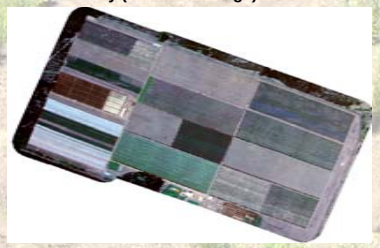


Fig 2.- NDVI image showing biomass variability one month before harvest (in yellow selected area for soil sampling).

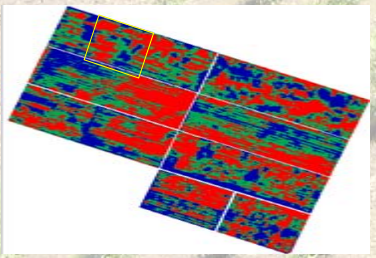


Fig 3.- Biomass variability of seedlings on month before harvesting time a) Low biomass = low NDVI b) High biomass = high biomass.

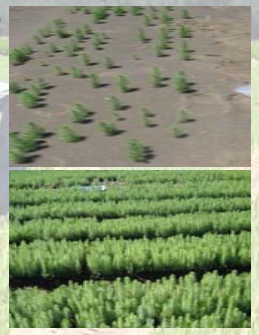


Fig 4.- Soil sampling scheme

Fig 5.- Field capacity and wilting point determinations .

A high correlation was found between surface (0-5 cm) and subsurface (5-15 cm) OM (Fig 6) but not for particle size percentages (Fig 7).

Fig 6.- Organic matter relationship between surface and subsurface horizons.

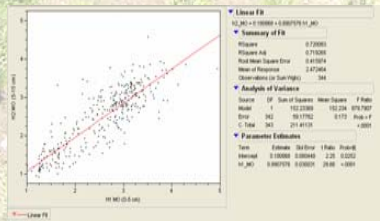
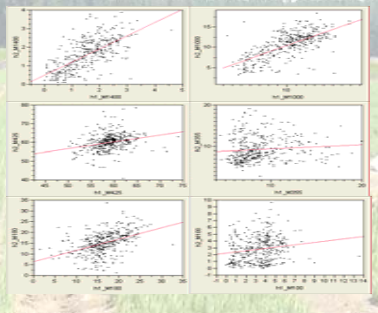


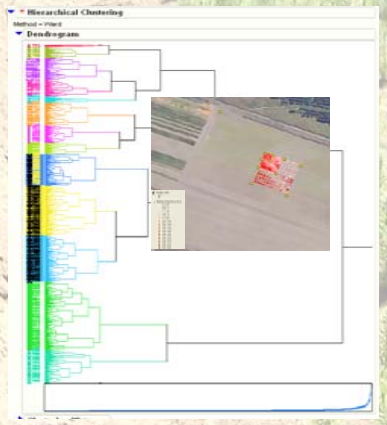
Fig 7.- Correlation between surface (0-5 cm) and subsurface (5-15 cm) particle size percenatges.



Multivariate analyses

Using surface and subsurface horizons Clustering Analysis using the Ward method was applied to separate 13 homogeneous famlies of particle size and OM content for all soil samples collected (Fig 8).

Fig 8.- Hierarchical Cluster.



From each homogeneous soil famiy five samples were randomly selected to determine soil moisture content at Field Capacity at 0.03 Mpa (FC) and Permanent Wilting Point at 1.5 Mpa (PWP), using a moisture pressure plate (Soil Mositure Inc., USA) (Fig 5). Soil moisture content determinations for the 13 families selected ranged from 2.1 to 9.0% for PWP and from 3.3 to 13.9% for FC.

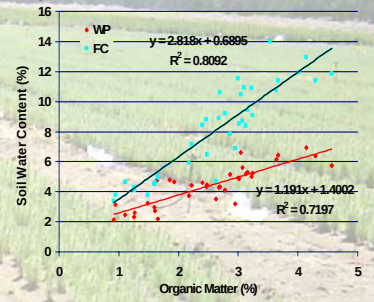
Predicting FC and PWP

Multivariate analyses of variance and stepwise regression analyses were used to select the most important soil measured variables to estimate FC and PWP. Several models were selected based on R^2, MSE and lack of fit to determine FC and PWP.

4.- RESULTS

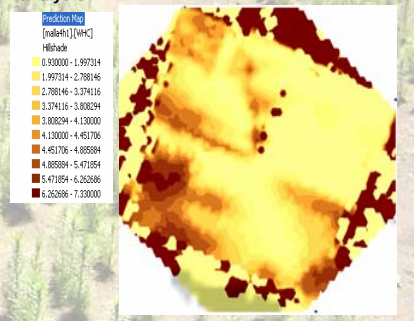
After reviewing several models a simple model using organic matter was selected as the best predictor of FC and PWP (Fig 9).

Fig 9.- Predictive model for FC and PWP.



Universal Kriging analysis was performed on estimates of Water Holding Capacity (WHC) using FC and PWP estimates. An anysotropic model was used to provide estimates of water holding capacity for the area (Fig 10).

Fig 10.- Prediciton Map based on Krigging analysis.



5. CONCLUSIONS & FUTURE STEPS.

- ✓A simple model was able to estimate FC, PWP and WHC based on a single soil parameter for the nursery area.
- ✓Spatial modeling of soil water holding capacity would allow to determine local irrigation needs based on soil OM variability.
- ✓Geostatistical analyses suggest that 10 m sampling of OM would allow to estimate WHC with a differences of 2%.

Future steps

- ✓Biomass estimates from multispectral imagery will be correlated with WHC spatial estimates and may allow to avoid OM sampling to estimate WHC.