Annual Variation of foliar Nitrogen and Chlorophyll Contents in mature Holm Oak Trees as Basis for the Estimation of Canopy Nitrogen in a Mediterranean Wooded Grassland Ecosystem

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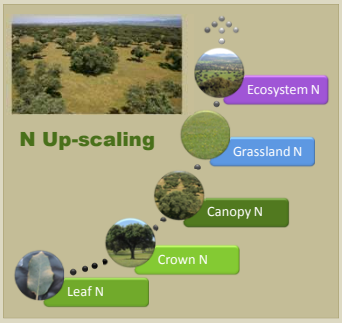


Overview

- Annual foliar chlorophyll and nitrogen variation patterns in mature holm oak trees have been followed during two vegetative periods. Nitrogen concentration is one of the factors that determine the photosynthetic capacity at canopy level and, therefore, the canopy carbon gain ability. Nitrogen is a foliar macronutrient whose foliar concentrations present an annual variation pattern during the vegetative period. In evergreen species like Quercus ilex, foliar nitrogen varies according to leaf age as well . How these patterns affect the estimation of N storage at crown level is the main focus of this study.
- The study area is located West of Spain (Cáceres) at a mean altitude of 258 m ASL. The local climate is Mediterranean, characterized by a mean annual temperature of 16.7 ºC and a mean annual precipitation of 572 mm, with maximum temperatures in summer over 40ºC and a mean summer precipitation of 67 mm (June through September). It is a grazed wooded grassland ecosystem (dehesa) with low tree density (20 % of Quercus ilex trees) which is being monitored by an eddy covariance flux tower (FLUXNET site). Soils are acidic poorly drained stagnic alisols over arkose with low organic matter contents.

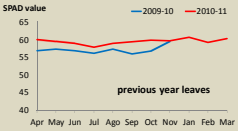
Methodology

Field Sampling	
Number of trees and frequency	• First vegetative period: 10 trees sampled monthly, from March 2009 to March 2010 • Second vegetative period: 5 trees sampled monthly, from April 2010 to March 2011.
Tree sampling	• SPAD measurements: 6 leaves from each of the four tree quadrants (north-south, top-bottom) = 24 leaves/leaf age. Current and previous years leaves were separated measured. A total of 48 leaves/Sampling date/Tree were measured. • N foliar contents: upper third of the crown, shoots from all orientations. More than 100 leaves/Sampling date/Tree were collected.
Leaf selection	• Current year leaves and those of previous years were separated and sampled.

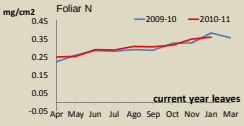
Analysis and Measurements		
Foliar Nitrogen	• Pretreatment: drying at 65ºC + grinding • Dry combustion method: LECO Mod. CN-2000	
Field Chlorophyll	SPAD-502Plus (Konica Minolta): Spad values are means of 5 randomly readings/leaf, avoiding the mid-vein	

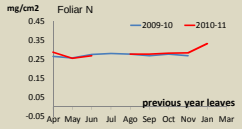
Results

ANNUAL VARIATION PATTERN OF SPAD VALUES FOR MATURE *Q. ilex* TREES

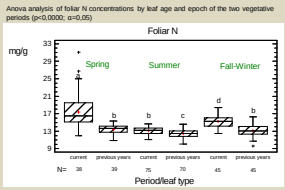


ANNUAL VARIATION PATTERN OF FOLIAR N CONCENTRATIONS PER SURFACE UNIT

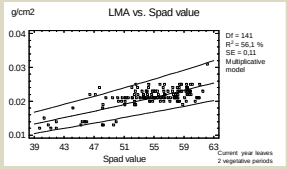


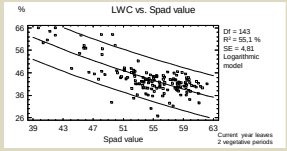


ANNUAL VARIATION OF FOLIAR N CONCENTRATIONS PER MASS UNIT

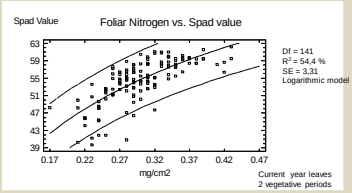


SPAD MEASUREMENTS RELATION WITH LEAF MASS AREA (LMA) AND LEAF WATER CONTENT (LWC)





REGRESSION SPAD vs. FOLIAR NITROGEN CONCENTRATIONS



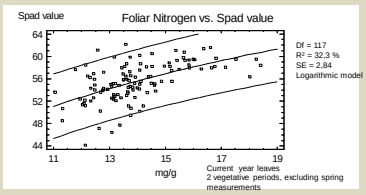


Table 1: Mean , minimum-maximum values of Spad, foliar nitrogen concentration expressed in mass, surface and leaf units, leaf mass area (LMA), leaf water content (LWC) and mass of 100 leaves for two vegetative periods and two leaf ages: current and previous years (all analysis at 65ºC).

Vegetative period	Leaf age	Spad value	N mg/g	N mg/cm²	N mg/Leaf	LMA mg/cm²	LWC %	100 leaves mass (g)
2009-10	Current n=113	54.3 39,7-61,5	14.9 11.1-31.0	0,29 0,17-0,43	0.9 0,3-2,1	0,020 0,012-0,025	43.9 26,8-66,0	6.3 2,0-14,9
	Previous years n=114	56.6 51,8-64,6	13.0 9,7-16,3	0,28 0,21-0,33	1.1 0,4-2,3	0,022 0,017-0,025	42.1 26,8-66,9	8.6 3,5-15,6
2010-11	Current n=45	54.9 40,9-62,1	14.6 12,1-20,9	0,30 0,22-0,43	1,2 0,4-2,7	0,021 0,011-0,031	45.1 38,8-64,9	8.0 1,9-16,8
	Previous years n=40	59,0 53,0-63,9	12.6 10,7-15,3	0,28 0,23-0,35	1.0 0,4-2,9	0,023 0,019-0,025	40.1 26,6-66,9	8.1 3,3-19,1

Conclusions

- **Significant differences between the nitrogen concentrations of the two leaf age classes as well as among the sampling dates. Three main periods were identified whose foliar N concentrations clearly differed : the time between sprouting and leaf elongation, the dry summer period and the winter season. The first is characterized by a maximum of foliar N concentrations (in dry mass units, g/kg), not only related to the foliar chlorophyll contents. Water and thermal stress during the summer produced a stabilization of N foliar concentrations over time and minimized the differences between the leaf age classes (current and previous years). During the fall-winter time the leaves increasingly accumulate N until the following spring.**
- **N estimations at canopy level less dependent of leaf renovation rate during the summer period (for evergreen tree species and Mediterranean climate conditions). The rate of leaf renovation in the crown is a normally unknown parameter. The epoch of the year characterized by less variability overtime and among leaf age classes in the N foliar contents, was the dry summer (June – September).**

Acknowledgments

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