LEAF AREA, DRY MATTER AND GRAIN YIELD OF WHITE LUPINS UNDER RAINFED AND IRRIGATED CONDITIONS

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Summary

Leaf area, dry matter and yield of two white lupin cultivars (Typ Top and Lolita) were evaluated under rainfed and irrigated conditions. Temperature, rainfall and soil moisture were recorded along the crop cycle. Irrigated plots were always kept above 75 % of the soil total available water. Significant differences were found in cultivar responses due to soil moisture conditions, in terms of total biomass and grain yield. Typ Top showed 28 percent and Lolita a 32 percent increase in grain yield in irrigated plots.

Keywords: Leaf area, dry matter production, lupin, soil water content

Resumen

Se analizó la evolución del comportamiento del índice de área foliar, la acumulación de materia seca y el rendimiento en grano de los cultivares de lupino Typ Top y Lolita en condiciones de secano y con riego. La información agrometeorológica registrada durante todo el ciclo del cultivo fueron, temperatura del aire, precipitación mensual y porcentaje del contenido de agua del suelo a diferentes profundidades.

Las parcelas identificadas como tratamiento con riego se las mantuvo constantemente en el nivel de 75 % del contenido total de agua del suelo. Las diferencias en las respuestas de ambos cultivares en términos de biomasa y rendimientos en granos fueron significativas debido a las diferentes condiciones de humedad del suelo. Se observó un incremento en los rendimientos de los cultivare Typ Top y Lolita del 28 % y 32 % respectivamente, en los tratamientos de riego con respecto a secano.

Palabras Claves: Area foliar, producción de materia seca, lupino, contenido de agua del suelo.

Introduction

Leaf area is one of the most important factors on light interception for photosynthesis. Leaf area in lupines reach the highest value at about flowering time or pod filling and then declines toward maturity (Perry et al., 1986). Dry matter production and partitioning of photosynthate are major factors on final lupin yields (Hardy et al., 1997).

Determinate and indeterminate lupin varieties have different patterns of leaf area development and dry matter accumulation (Schwab et al., 1996, Hardy et al., 1997), which are also affected by environmental and management conditions (Faluyi et al., 1997). Research on phenological responses **(**Ravelo & Planchuelo-Ravelo, 1987; Ravelo, *et al*., 1990; Ravelo & Planchuelo, 1996) growth indices (Fuentes *et al*., 1994) and grain yield (Perry *et al*., 1986) show different varietal responses to agroclimatic conditions and soil water balance.

This study is part of a larger project in assessing lupin productivity and soil water supply and management practices in a semi-arid region of Argentina (Ravelo, *et al*., 1997).

Material and Methods

The study was carried out in an experimental farm located in the Santa Maria Department in Córdoba, Argentina (31° 55' S; 64° 23' W; 755 m a.s.l.). The field plots were on sandy loam soil considered suitable for cropping. During crop season (June to December) the average rainfall is 428 mm and the average potential evapotraspiration is 477 mm.

Two white lupin varieties, Typ Top and Lolita (von Baer, 1990) with different plant architecture such us restricted branching and non-restricted branching, respectively were selected for testing. Seed were inoculated within 24 hours of planting with a commercial strain of *Rhizobia* provided by Rizobacter Argentina and using the gum slurry technique.

Two split plots of 15 square meters at a seed density of 17 seeds/m^2 and row spacing of 0.70 meter were sown on 6 July 1998 after a sugnificant rainfall which provided enough water to the soil to reach field capacity. Following emergence on 18 July plants were thinned to establish a final density of 12 plants per square meter.

Soil characteristics such as: pH, field capacity and textural classes were determinated prior to sowing. Soil samples at 20, 40, 60 and 80 cm depth were obtained throughout the cropping season to determine soil water contents by gravimetric method.

Plant samples were randomly taken at ten days intervals from the two plots except for an area of 6 square meters selected for yield evaluation. Leaf area of each plant sample was measured by scanning all previously pressed and flattened leaves. Total leaf area was integrated by an automated image analysis system (van Diest et al, 1989). Dry matter of stems, leaves and roots were recorded for irrigated and rainfed conditions.

Results and Discussion

Soil was classified as sandy-loan with a pH of 6.5 and a field capacity of 14 % of soil dry weight at the 0-20 cm layer and 11 % at the 20-60 cm layer.

The abundant rainfall in early winter (July-August) provided enough moisture to the ground to keep the soil near field capacity during the early stage of the crop cycle; therefore, no much differences was found in soil moisture between irrigated and non irrigated plots. Figure 1 and 2 show the soil moisture variations during the late winter and spring time (September-December) in irrigated and rainfed conditions respectively. The soil moisture for the irrigated plot was always between 10 and 14 % of the soil total available water. On the other hand, rainfed plot shows big differences in soil moisture throughout the crop cycle, reaching the lowest point on December 11 when the cultivar Lolita reached madurity and Typ Top was at pod filling stage.

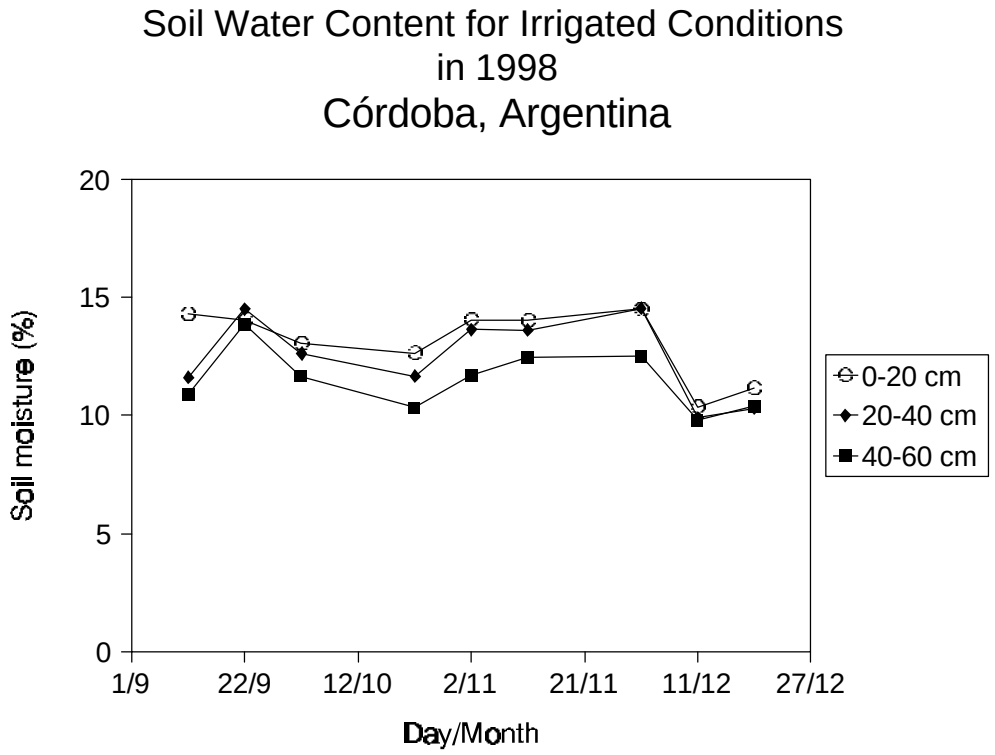

Figure 1. Soil water content (%) in irrigated lupin during 1998 crop season at Córdoba, Argentina

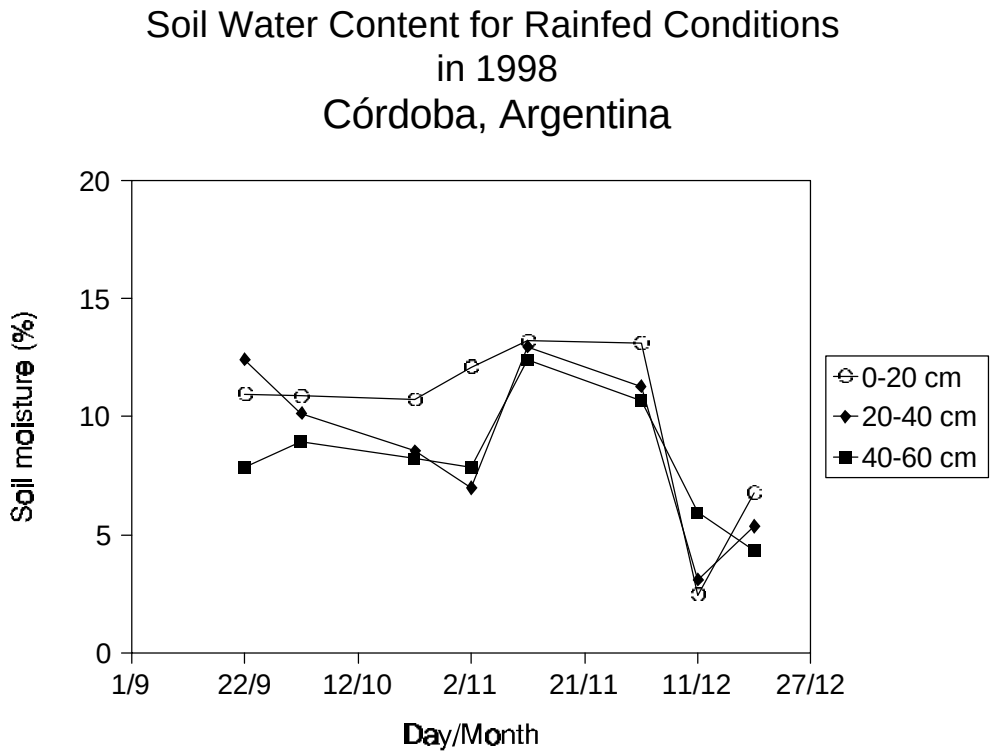

Figure 2. Soil water content (%) in rainfed lupin during 1998 crop season at Córdoba, Argentina

Figures 3 shows accumulated leaf area in both cultivars and treatments. Leaf area measurements for both Lolita and Typ Top indicate a different varietal responses. Lolita has a shorter cycle as compared with Typ Top and it did not develop a large size and number of leaves and no significant differences was found between treatments. On the other hand, Typ Top had a rapid increase in leaf area since early October, particularly under irrigated conditions, and small differences in leaf area was reached at the end of the crop cycle.

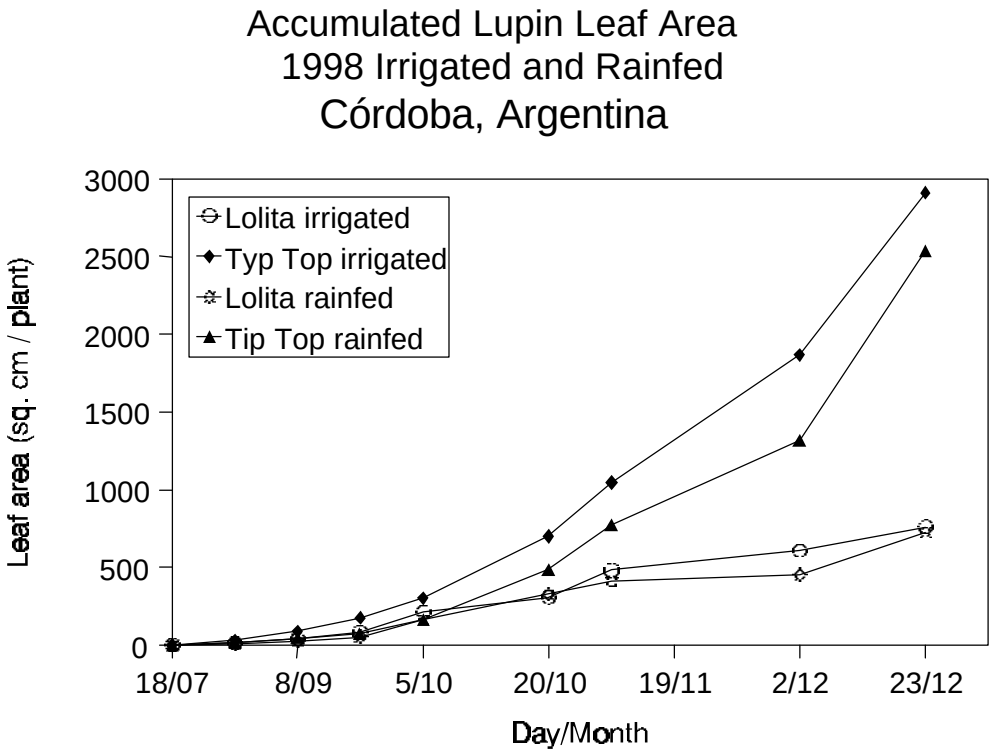

Figure 3. Accumulated leaf area for Lolita and Typ Top varieties in Cordoba, Argentina under irrigated and rainfed conditions.

Accumulated dry matter during the growing season followed a similar pattern for both varieties in both treatments. Dry matter accumulation was larger for cv. Typ Top at harvest time under irrigated and rainfed condition (Figures 4). This represents an average of 1080 g/m^2 and 636 g/m^2, respectively. The results of yield components for Typ Top and Lolita under irrigated and rainfed conditions are showed in Table 1.

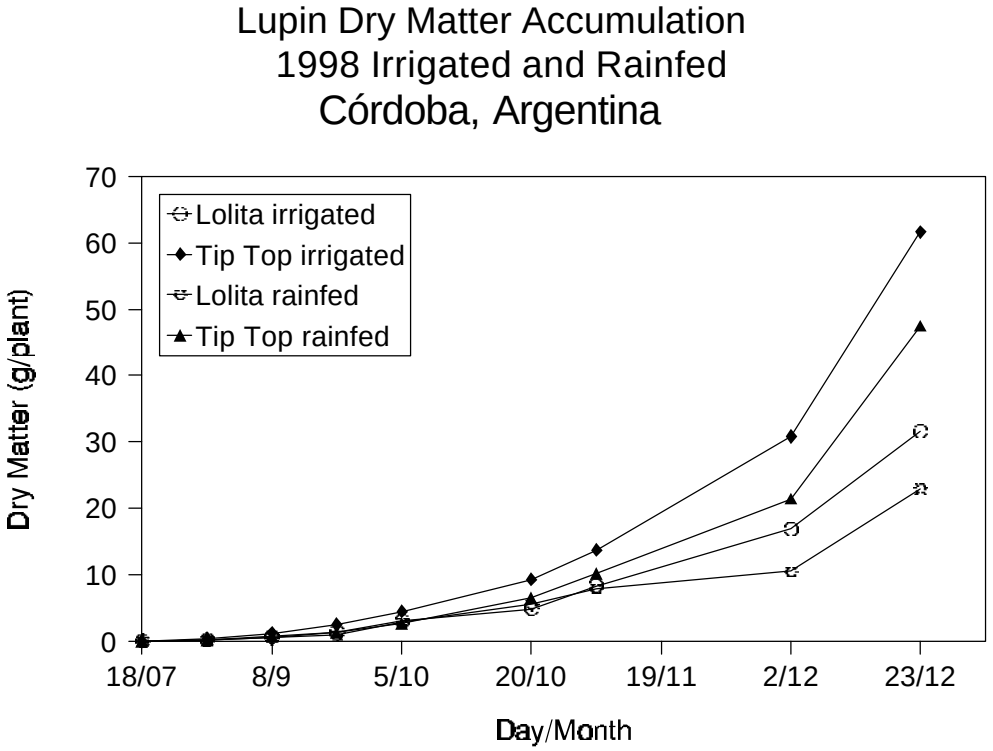

Figure 4. Dry matter accumulation for Lolita and Typ Top varieties in Córdoba, Argentina under irrigated and rainfed conditions

Table 1. Lupin yield components for the varieties of Typ Top and Lolita under irrigated and rainfed conditions in Córdoba, Argentina.

	Typ Top under irrigated cond.	**Typ Top under rainfed cond.**	**Lolita under irrigated cond.**	**Lolita under rainfed cond.**
Grain weight of 1000 grains [gr]	384.9	367.1	373.8	358.4
Num.Grain / m^2	436	355	262	207
Num. Pods / m^2	208	143	84	66
Num. Plants/ m^2	15	13	15	15
Yield ($g/m^{2)}$	167.8	130.3	97.9	74.1

Conclusion

Both lupin cultivars showed a positive response to irrigation, mainly in Lolita with a 32 % increase in yield in the irrigated plot in relation with the rainfed one and Typ Top with 28 % increased in grain yield

References

Faluyi, M.A., F. Zhang, S. Leibovitch and D.L. Smith, 1997. White lupin growth, yield and yield components in Eastern Canada: Influence of management factors. Agron. J. 89:781-788.

Fuentes, M., L. López-Bellido and J.C.B. Lhamby, 1994. Growth Indices and Yield Component Ratios in L. albus (Cv. Multolupa). Advances in Lupin Res. Eds.by J.M. Neves-Martins & M.L. Beirao da Costa. VII Intern. Lupin Conf., Abril 18-23, 1993. Evora, Portugal. pp 381-385.

Hardy, A., C. Huyghe, and J. Papineau, 1997. Dry matter accumulation and partitioning, and seed yield in indeterminate Andean lupin (*Lupinus mutabilis* Sweet).Australian Journal of Agricultural Research. Vol.4 (1):91-101.

Perry, M.W., R.J. Delane, D. Tennant and A.P. Hamblin, 1986. The growth and grain yield of lupins in relation to the soil water balance. Proc. Fourth Intern. Lupin Conference. August 15-22, 1986. Geraldton, Western Australia.

Ravelo, A. C. y A. M. Planchuelo-Ravelo, 1987. Lupifen: Un modelo fenológico para el lupino blanco *(Lupinus albus* L.). III Reun. Argent. Agrometeor.: 75-84.

Ravelo, A. C., A. M. Planchuelo-Ravelo, D. M. Sorlino y M. P. Villariño, 1990. Effects of environment on lupin phenological responses. VI Intern. Lupin Conf. Pucón, Chile: 113.

Ravelo, A. C. y A. M. Planchuelo, 1996. Lupifen II: Un modelo fenológico para el lupino blanco (*Lupinus albus* L.). Revista Fac. Agronomía 16(1-2): 89-97. Buenos Aires.

Ravelo, A.C., A. M. Planchuelo y R. Zanvettor, 1997. Aptitud agroclimática de la provincia de Córdoba para el cultivo de lupino blanco (*Lupinus albus* L.). Actas 7a. Reunión Argentina y 1ra. Latinoamericana de Agrometeorología: 97-98. Buenos Aires, Argentina.

Schwab, R.L., D.W. Reeves, C.M. Peterson and C. Mosjidis, 1996. Dry matter and nutrient accumulation in three diverse white lupin cultivars. Abstract book. Eight Intern. Lupin Conference, 11-16 May 1996. California, U.S.A.

van Diest, P.J., A.W. M. Smeulders, F.B.J.M. Thunnissen and J.P.A.Baak, 1989. Cytomorphometry: A Methodological study in preparation techniques, selection methods and sample size. Analyt Quant Cytol. Histol. 11:225-231.

von Baer, E. 1990. Lupino. Guia de producción y utilización. Asoc. Chilena del Lupino, Temuco, Chile. 19 pags.