# Morphological Acclimatation and Canopy Structure Characteristics of *Arachis pintoi* under Reduced Light and at Full Sun

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## Presenter Information

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## Introduction

The canopy structure is a key variable to determine the adaptive potential of forages and it influences the radiation use efficiency (RUE) under different light conditions. The light extinction coefficient calculated from the Beer-Lambert formula (k) shows the canopy architecture and light interception patterns of plants and thus their potential ability to convert light energy (photosynthetically active radiation-PAR) into plant biomass (Hirose 2005). Under shade, forages may experience changes in plant morphology and canopy structure. Many authors reported those changes and relate them to modifications in light quantity and quality (Varella *et al.* 2010). The magnitude of these morphological changes may be determinant to screen forages for shaded environments such as silvopastoral systems.

The objective of this study was to determine the light interception patterns and extinction coefficients of *Arachis pintoi* under two artificial shading levels (50% and 80%) and in full sunlight and relate them to adaptive potential of this legume for silvopastoral systems.

## Materials and methods

The experiment was conducted at Embrapa South Animal Husbandry and Sheep Research Centre located in Rio Grande do Sul State, Southern Brazil. This study was carried out from October 2009 to April 2011 and aimed to evaluate the effects of two artificial shading levels (50% and 80% black shade cloth) and in full sun on the light interception patterns and extinction coefficient (k) of *Arachis pintoi* (hybrid ecotype AGK12787 vs NC1579 - Embrapa Cenargen) . The experimental design was then a randomized block with 3 replicates. Additional methodological details were described by Barro *et al.* (2012). The leaf area index (LAI) was calculated from destructive samples collected in a 625 $cm^2$ quadrat. Each experimental unit grown with *A. pintoi* measured $2m^2$. The green herbage material was weighed and sub-sampled , followed by morphological separation. Then total leaf area was measured using an optical planimeter (LI-3100, LICOR, Inc.). The leaf area index was estimated using the equation:

$$LAI = LA \times S^{-1} \quad (1)$$

where LA was the green leaf area of the sub-sample ($cm^2$) and S the soil sampled area ($cm^2$).

The photosynthetically active radiation (PAR) was measured with a ceptometer (Decagon model AccuPAR) prior to each cut. To determine both the incident PAR (PARi) and the transmitted PAR (PARt), ceptometer readings were made above and below the legume canopy, respectively. The PAR readings were taken between 11 am and 1 pm local time and under clear sky conditions. The percentage of light interception (LI) was calculated as the amount of the intercepted PAR (PARi - PARt) divided by PARi and this result multiplied by 100. The light measurements were taken monthly over the experimental period.

The relationship between LAI and LI was fitted according to the model of light attenuation within the canopy, described by Monsi and Saeki (Hirose 2005). From the Beer-Lambert formula, k was determined using the regression model:

$$LI = LI\ max\ [1 - \exp(k \times LAI)] \quad (2)$$

where: LI is the amount of PAR intercepted by canopy, LI max is the asymptote of the curve for this exponential relationship and LAI is the leaf area index.

For the relationships between variables (LI and LAI), the data were submitted to a regression analysis at 5% probability level using the PROC REG feature of SAS (Statistical Analysis System, version 9.2.).

## Results and discussion

Forage growth conditions under heay shade (80%) reduced total dry matter yield (DMY) of *A. pintoi*. Under moderate shading (50%), plants showed similar DMY compared to full sunlight (Table 1). Leaf area index (LAI) and DMY data indicated that there was insufficient light energy under 80% shade, which significantly reduced the legume plant growth.

The relationship between LI and LAI was adjusted to different exponential models, according to the shade levels and are shown in Figure 1. The light extinction coefficient (k) was determined from these regressions and based on the interpretation of their biological responses and by examining the confidence intervals generated. Whenever k (slope of equation) was in the same confidence interval, the relationships were expressed by a single regression for

**Table 1. Leaf area index (LAI), specific leaf area (SLA – cm²/g), light interception (LI- %), dry matter yield (DMY g/m$^2$) of *Arachis pintoi* under heavy shade (80% shade cloth), moderate shade (50% shade cloth) and in full sunlight (0% shade). Data are averages of 10 evaluations conducted from November 2009 to April 2011.**

| Shading level | LAI | SE* | SLA | SE | LI | SE | DMY | SE |
|---|---|---|---|---|---|---|---|---|
| 0% | 4.5 ab | 0.48 | 243.3 a | 12.0 | 89 b | 1.7 | 655.4 a | 33.0 |
| 50% | 5.3 a | 0.48 | 255.4 a | 12.0 | 96 a | 1.7 | 613.0 a | 33.3 |
| 80% | 3.5 b | 0.54 | 257.0 a | 13.0 | 92 ab | 1.7 | 394.6 b | 33.0 |

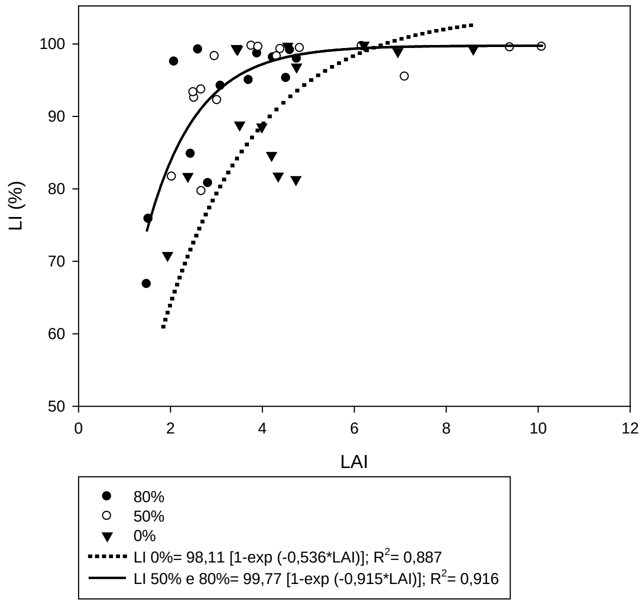


**Figure 1. Relationship between leaf area index (LAI) and light interception (LI) of *Arachis pintoi* growing in full sun (▼), under 50% shade (○) and 80% shade (●) in Bagé, RS.**

different shading levels. In this study, after reaching the critical LAI level (95% LI), *A. pintoi* leaf area continued increasing at constant-maximal levels of LI (Fig. 1). Results indicated similar k values for plants grown under both 50 % and 80% shading levels (Fig. 1), showing that no structural changes occurred in the legume canopy. However, under 80% shading, LAI was the lowest of all treatments and this was probably related to lower forage yields associated with this intense level of shading (Barro *et al.*2012).

Equal values of k (Fig. 1) were obtained for 50 % and 80% shading levels (k= 0.915), which indicated that structural changes occurred on the legume canopy, whereas in full sun k value decreased significantly (0.536). This response confirmed that *A. pintoi* adapted well to shade by reducing leaf angle and by structuring a planophile canopy to intercept more light.

## Conclusions

The light extinction coefficients were changed under shade compared to full sunlight, showing adaptation of *Arachis pintoi* by decreasing canopy angle. Growth of *Arachis pintoi* was strongly reduced under heavy shade (80% sunlight restriction), but it showed potential to grow under moderate shade.

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