Evaluation of the establishment of Leucaena leucocephala *cv. Cunningham in a livestock production farm of the Perico municipality, Matanzas, Cuba*

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ABSTRACT

The objective of this work was to evaluate the establishment of *Leucaena leucocephala* cv. Cunningham in a farm of a cooperative of credits and services (CCS) of the Perico municipality. The work was carried out on a lixiviated Ferralitic Red soil, in a 6-ha area divided into five paddocks. The land preparation was performed in the whole experimental area, making 2-m wide strips with an ADI-3 plow followed by harrowing. Seedling survival after transplant, height, number of branches and floristic composition of the pastureland, as well as the effect of weeding and the damage caused by the animals on plant height, were determined. A variance analysis was applied and the data were processed with the statistical pack SPSS® version 10.0 for Windows XP. Plant survival showed a value of 98 %; the weeding activity had a positive effect on growth, while the plant defoliation by the animals affected establishment. The population of natural pastures (*Dichanthium caricosum* and *D. annulatum*) was maintained around 66 % and the twining legumes (*Teramnus labialis*, *Neonotonia wightii* and *Macroptilium atropurpureum*) decreased from 12 % on the third month after transplant, to 6 % on the fifteenth month. The system was considered established when the plants exceeded 2 m of height. It is concluded that the weeding operation had a positive influence on the performance of height and establishment in *L. leucocephala*, while the defoliations caused by the animals delayed establishment.

Key words: plant establishment, *Leucaena leucocephala* cv. Cunningham

INTRODUCTION

In Cuba, feeding of dairy cattle is mainly based on the use of pastures and forages; although there are long drought periods which oscillate between six and eight months per year, causing a less favorable balance of forage feedstuffs in the dry season. In recent years emphasis has been made on the introduction of legume trees in pasturelands, because of their capacity to provide feed with high nutritional value (Lamela *et al*., 2010; Petit *et al*., 2010), especially during the dry season. In addition, they are used as a source of shade, to preserve and improve soil, recycle nutrients (Sánchez, 2007); and as alternative to reverse the pasture degradation process (Nair, Kumar and Nair, 2009), due to their regrowth capacity after cutting and/or browsing and their ability to be rapidly recovered from biotic or abiotic stresses, among other aspects (Wencomo and Ortiz, 2011).

Leucaena leucocephala (Lam.) de Wit. (leucaena) is excellent for this purpose, because it is among the most used species in association with improved grasses or pastures (Muñoz *et al*., 2004; Alonso *et al*., 2006), an agroforestry practice highly accepted by farmers (Pérez *et al*., 2008; Lamela *et al*., 2010). According to Wencomo (2008) and Barros-Rodríguez *et al*. (2012), the use of leucaena allows to reach weight gains of up to 800 g/animal/day in cattle and an increase of up to two liters of milk per cow per day, in tropical zones.

However, its adoption is still limited; hence it began to be introduced in cooperatives. In this sense, in the Matanzas province it was introduced in more than 20 livestock production farms and about 90 ha were planted in the private sector, during 2009-2011 (Sánchez *et al*., 2011).

For such reason, the objective of this work was to evaluate the establishment of *L. leucocephala*

cv. Cunningham associated to natural pastures in a cooperative farm of the Perico municipality.

MATERIALS AND METHODS

Location of the experimental area. The study was conducted in a livestock production farm belonging to a cooperative of credits and services (CCS), which is located in the San Juan town, in areas of the Perico municipality, Matanzas province, Cuba. This town is located at 22º 58' 38" North latitude and 81º 10'32" West longitude. It limits to the north with the Canaletas community; to the south with Reglita; to the west with La Chucha; and to the east, with El Roque (Ecured, 2013). The study started in June, 2010, and ended in September, 2011.

Climate and soil. The soil on which the study was conducted is classified as lixiviated Ferralitic Red (Hernández *et al*., 2003). The temperature and rainfall values during the establishment of *L. leucocephala* cv. Cunningham are shown in figure 1.

Procedure: The study was conducted in a 6-ha area, divided into five paddocks of 1,2 ha each, which constituted the replications.

The land preparation was performed in the whole experimental area, making 2-m wide strips, with an ADI-3 plow followed by harrowing. The bags with the leucaena seedlings from the nursery were manually transplanted in June. A distance of 3 m between plants and 5 m between rows was used.

The weeding operations were performed with hoe, since 30 days after planting. Afterwards, they were done every time it was necessary, to achieve a high population of the planted species.

After the seventh month of the transplant, until the end of the experimental period, the damaged caused on plant height by the animals that entered the paddocks in an unplanned way was evaluated.

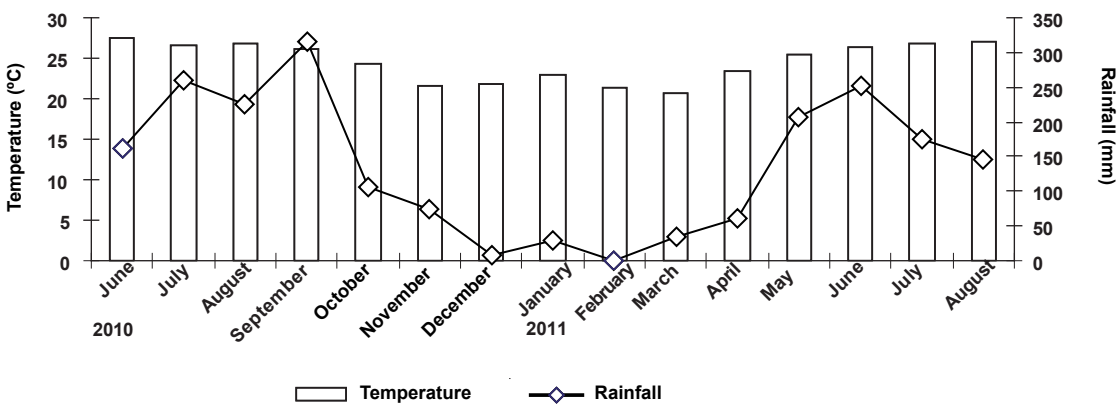
Measurements. Since three months after transplant, until the evaluation concluded in August, 2011, the following indicators were measured:

a. Plant height. Fifty plants were measured per replication (paddock), every two months, with a ruler graduated in centimeters, according to the methodology proposed by Machado *et al*. (1999).
b. Survival. In each replication the number of plants that did not root three months after being planted was counted.
c. Number of primary and secondary branches. The number of branches was determined in 20 plants per replication, at the end of the evaluation (fifteenth month after being transplanted).
d. Floristic composition. The area covered by the accompanying grasses (%) was estimated through the Method of Steps, described by Anon (1980), three and fifteen months after transplant.

Statistical processing. The data of *L. leucocephala* height were processed through a variance analysis, and the following effects were determined: transplant age, weeding operations and damage caused by the animals. The differences among means were found by Duncan´s test, through the statistical pack SPSS® version10.0 for Windows XP.

RESULTS AND DISCUSSION

Although the same planting frame was used in all cases, the quantity of transplanted plants per paddock slightly differed due to the variations in paddock size, which was not representative.



Source: Provincial Meteorological Center (Meteorological Station Indio Hatuey)

Figure 1. Performance of rainfall and temperature during the experimental period.

Table 1 shows the survival of *L. leucocephala* (98 % of rooted plants) three months after transplant. This result could have been influenced by the effective weeding operation of the crop and the rainfall occurred during the first three months of establishment, which guaranteed the appropriate humidity conditions for plant growth (fig. 1).

In general, plant height increased with age (fig. 2) until 15 months after being planted, moment in which they reached an average height of 2,01 m. This result did not differ from the one obtained at 13 months.

A significant variation ($p < 0,001$) of this variable was observed at 13 and 15 months of age, with regards to the other ages. These evaluations coincided with the beginning of the rainy season, when rainfall had an average of 194,85 mm and this influenced such result.

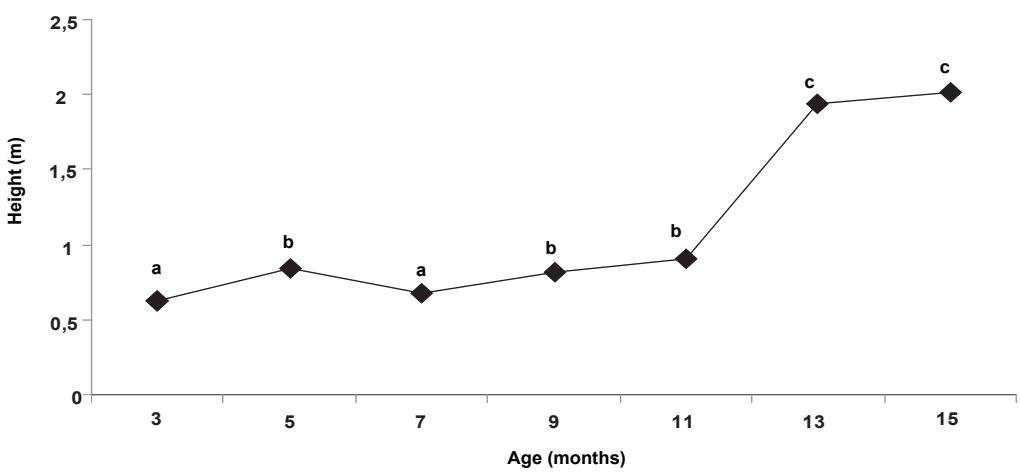
On the seventh month there was a significant decrease of height, due to the unplanned entrance of the animals to the paddock before the establishment height was reached; in this initial stage the plant is very vulnerable to defoliations.

In the first months of establishment this crop grew slowly, which coincides with the report by Toral and Hernández (1997). According to Díaz (cited by Wencomo and Ortiz, 2010), this slow initial growth can be related to the small quantity of leaf area and to the leaf growth and expansion dynamics. Likewise, these authors explain that such problem is also related to biomass partition, which shows certain priority towards the root system during the first weeks.

Egara *et al*. (cited by Ruíz, 1996) stated the slow growth of *L. leucocephala* is due to the negative competition of grasses *Brachiaria decumbens* Stapf. and *Cynodon nlemfuensis* Vanderyst for nutrients. In this sense, Hernández, Carballo and Reyes (1999) obtained similar results and the height of this legume was affected, mainly, by a strong

Table 1. Survival of the leucaena plantation three months after being planted.

Paddock	Plants/ha		Survival (%)
	Transplanted	Rooted	
1	599	589	98,3
2	605	604	99,8
3	601	569	94,6
4	598	580	96,9
5	601	593	98,7
Total	3 004	2 935	97,7



Different letters differ significantly at $p < 0,05$.

Figure 2. Performance of *L. leucocephala* height during the experimental period.

competition with *C. nlemfuensis* and –to a lower extent– with species of the genera *Dichanthium*, *Bothriochloa*, *Brachiaria* and *Digitaria*.

On the other hand, the fortuitous entrance of animals to the paddocks, since the seventh month after transplant, caused defoliations to the plant. This brought about a reduction in the quantity and photosynthetic capacity of the residual leaf area, as well as the mobilization of soluble carbohydrates and other remnant reserves after defoliation, which coincides with the report by Stür, Shelton and Gutteridge (1994); it also decreased the recovery capacity.

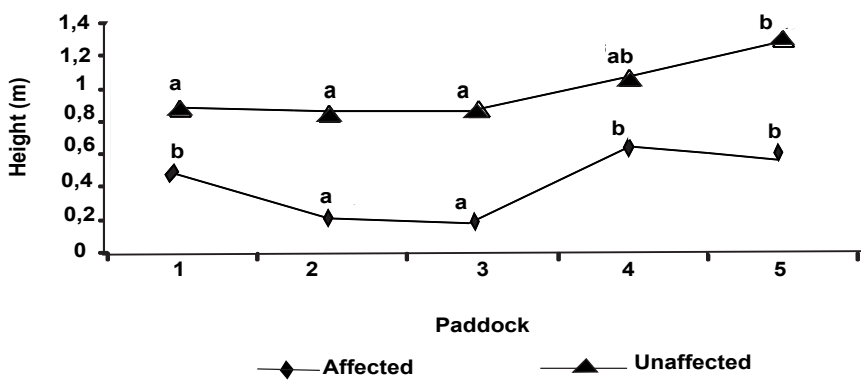
The constant weeding of the plantation, through hoeing around the plant, until it exceeded 60 cm of height (three months of age), stimulated its growth. During the evaluation the beneficial effect of this operation was perceived (fig. 3); the worst result was obtained in the plants that were surrounded by weeds, which differed significantly ($p < 0,001$) from the others.

When analyzing the effect of the damage caused by the animals (fig. 4), it was observed that the unaffected plants were taller and had increasing growth. There were significant differences ($p < 0,001$) in the growth of the damaged leucaena and the lowest height was obtained in paddocks 2 and 3, because they were the most damaged ones for being closer to the area through which the animals entered.

Mahecha *et al.* (2010) indicated that the affectation produced by the animals on tree species prolongs their establishment and, if that situation is not solved, it can cause the plant death. This occurs because during the initial months of establishment, plants are vulnerable to defoliation, and the introduction of the animals before they exceed 2 m

Different letters significantly differ at $p < 0,05$.

Figure 3. Effect of weeding on the growth of *L. leucocephala*.



Different letters differs significantly at $p < 0,05$.

Figure 4. Affectation caused on the height by the animal compsumtion of *L. leucocephala*.

of height can cause consumption, even to the apex, and cause the plant death.

Figure 5 shows the dynamics of emission of primary and secondary branches at the end of the evaluation period (fifteenth month). The increase of the number of branches was in correspondence with the increase of the tree height. The values varied from nine primary branches and two secondary branches per plant, in paddock 1, to 14 primary branches and 6 secondary branches per plant in paddock 5, where the mean height of leucaena was higher. The low emission of secondary branches could have been influenced by the consumption of the leaves ad green parts of the plant by the animals.

In general, the tallest plants coincided with the ones that showed a higher number of branches, which is in correspondence with the report by Wencomo, Hernández and Seguí (2001). Similar results were obtained by Dávila and Urbano (1996) in 13 *L. leucocephala* cultivars, in which the lowest values of plant height coincided with the lowest branch emission.

On the other hand, Espinosa *et al*. (1996) found that the number of branches of leucaena is found between 10 and 13 primary branches per plant; according to Zárate (1987), leucaena develops many thin branches when it grows isolated.

Regarding the floristic composition of the pastureland (fig. 6), the species that prevailed in the system was *Dichanthium caricosum* (L.) A. Camus

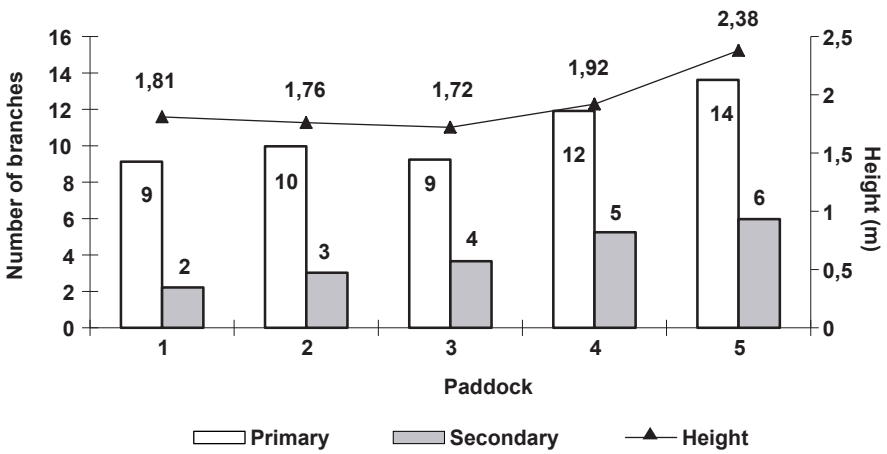


Figure 5. Emission of primary and secondary branches at 15 months of age.

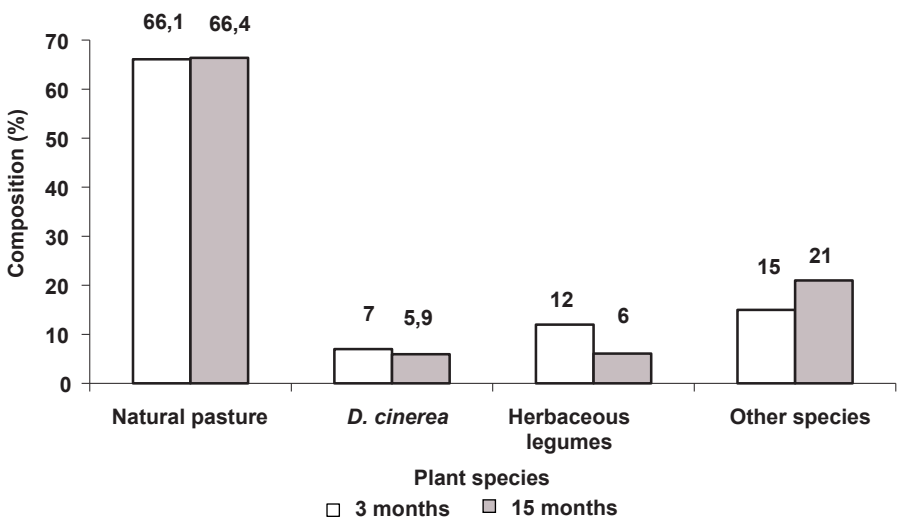


Figure 6. Floristic composition.

(jiribilla), which occupied more than 60 % of the covered area in all the paddocks. At the beginning of the evaluation *Dichrostachys cinerea* (L.) Wight & Arn. (marabú), the herbaceous legumes *Neonotonia wightii* (Wight & Arn.) J.A. Lackey, *Teramnus labialis* (L. f.) Spreng. and *Macroptilium atropurpureum* (DC.) Urb., as well as other non-leguminous species, represented 7, 12 and 15 %, respectively, of the floristic composition of the selected paddocks.

The presence of the above-mentioned herbaceous legumes was reduced during establishment, because they were substituted by natural pastures (*D. caricosum* y *Dichanthium annulatum* (Forssk.) Stapf); this coincides with the report by Machado, Miranda and Álvarez (2010). The existence of *D. cinerea* in the paddocks did not reach important values, because manual hoeing was performed and its population tended to decrease.

The presence of other non-legume species such as: *Sorghum halepense* (L.) Pers. (Johnson grass), *Hyparrhenia rufa* (Nees) Stapf. (jaragua), *Bidens alba* (L.) DC. (Spanish needles) and *Panicum maximum* Jacq. (Guinea grass) reached moderate values. This last species tolerates the shade projected by the trees, which reflects its associative ability with leucaena and constitutes a positive aspect which should be considered in the establishment. In addition, its high nutritional value and its more advantageous structure if compared with other tropical pastures should be taken into consideration, because it has other 80 % of leaves, which allows the cows to better show their selective ability (Sánchez *et al*., 2007).

However, this area had been previously managed in a continuous way, under grazing conditions with cows and sheep, with very little resting time; this could have influenced the decrease or disappearance of the better-nutritional-value plants, which coincides with the report by Milera (2006).

It is concluded that the weeding operations positively influenced the growth and establishment of *L. leucocephala* cv. Cunningham, because when the plant surroundings were hoed, the plant reached more height (1,09 m), contrary to those on which this operation was not practiced (0,73 m). On the other hand, the fortuitous consumption of the plant by the animals prolonged the establishment period, because, with a continuous defoliation, the photosynthetic capacity decreased. Nevertheless, the establishment of tree legumes in livestock production systems is considered to be a viable alternative for the low-resource farmers to increase the quality of the diet of animals and the productivity of their farm.

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