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Agronomic evaluation of the inclusion of short cycle crops in the establishment of *Leucaena leucocephala* cv. Perú

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Abstract

This work was carried out at the experimental area of the CEDEPA (Center of Study for the Development of Animal Production) of the Faculty of Livestock Sciences (University of Camagüey, Cuba), with the objective of describing the performance of height and yield of *Leucaena leucocephala* cv. Perú, as well as the incidence of weeds, pests and diseases when including short cycle crops between rows during its establishment. A randomized block design with four replications was used for each treatment: 1) Leucaena plus *Sesamum indicum*; 2) Leucaena plus *Sorghum vulgare* cv. INIA Dorado; 3) Leucaena plus *Vigna sinensis*; and a control (leucaena). The effects of the presence of pests, diseases and weeds; height and yield of leucaena in the establishment (2 m high) and grain production of the intercropped species were evaluated. The best results regarding control of pests and diseases, as well as the incidence of weeds, were found in the treatments with crops, and particularly in the case of *S. indicum*; in the three cases with crops the establishment period was reduced and the values of height and DM yield of leucaena were increased. The expenses and incomes relationship favored significantly the treatments with crops and the leucaena plus *S. indicum* association stood out.

Key words: Plant establishment, *Leucaena leucocephala*

Introduction

In tropical and subtropical regions the use of trees as forage in feeding is a common practice, combined with the adequate management as base of any exploitation system. *Leucaena leucocephala* is one of the most studied species because of its capacity to tolerate different management techniques and its adaptability to adverse conditions (Hernández, cited by Francisco, Simón and Soca, 1998).

However, the establishment of silvopastoral systems (in all the area or part of it) or protein banks implies an important number of expenses for the producer, independently from the volume of the area destined to this objective and the period of time spent. This, together with other factors such as the resources and the time the land remains without being utilized, many times brings about certain rejection by the producers, because in many cases, due to the specialization of production, their mentality is mostly monoproductive.

One of the most acute problems for the correct utilization of tropical legumes is the need to achieve the successful establishment of the commercial areas with these species, and the Leucaena genus is not an exception, for which much has been the effort of researchers, producers and extension workers to defeat the agrotechnical difficulties and of adaptation of this species to the soil, nutrition, light and pests factors. (Mullen and Soller, 1998; Shelton, 2001).

In this sense, one of the most difficult problems in Cuba to establish leucaena has been, as indicated by Simón (2000), the difficulty in the weeding of the areas in order to avoid the negative competition of weeds for nutrients and energy, which has propitiated the presence and damage of pests, specifically chrysomelids and the leucaena aphid (*Heteropsylla cubana*), which is very damaging for this species (Shelton, 2001).

An important way to counteract the above-mentioned negative aspects may be the intercropping of short cycle crops, which contribute other benefits for men such as grains and forages, in addition to providing income that may help to cover the expenses (many times high) of the legume establishment, that is, a real possibility is to use short cycle crops that may motivate man to keep them clear, searching for their benefits as foodstuffs and forages and thus recovering the financial investment for sowing (Hughes, 1998; Guevara and Guevara, 2003).
The objective of this work was to determine the performance of the height and yield of *L. leucocephala*, as well as the incidence of weeds, pests and diseases when short cycle plants are integrated during its establishment.

**Materials and Methods**

In a randomized block design with four replications for every treatment, the establishment of *L. leucocephala* cv. Perú, accompanied by sesame (*Sesamum indicum*), grain sorghum cv. INIA Dorado (*Sorghum vulgare*) and *Vigna sinensis*, and a leucaena control, was evaluated. This experiment was carried out in a 1.2 ha area.

**Experimental procedure.** The soil preparation consisted in turning, harrowing and furrowing. The seeding was done by dibbling (average of five to six seeds/dibbling), with a distance of 1 m between plants and 5 m between furrows. 1,5 kg of seed from *L. leucocephala* cv. Perú (six months after being harvested, without scarification) were used per hectare. The covering was done manually.

The intercropped species were sown immediately after leucaena, by hand in the three central furrows between the rows of the tree, with a distance of 0.80 m between rows for each one and 0.20 m between plants (slight drilling), with a density of 1.0; 8.0 and 6.0 kg/ha for the sesame, sorghum and vigna, respectively.

The weeding of the area was performed with rotary cultivator as first operation, in two days of work, and the rest of the weed controls were manual, with hoe and machete. Three weedings were carried out in vigna and only one in sesame and sorghum.

**Neither fertilizers nor agrotoxics were used in any of the treatments.**

**Measurements done**

**Plant height.** It was measured at the moment of establishment in six plants of leucaena per treatment. The criterion to reach the establishment in each treatment was determined when the height was superior or equal to 2 m as average per replication (Ruiz and Febles, 1987). For that a ruler graduated in centimeters was used.

**Presence of pests and diseases.** In leucaena it was determined in the first, third and sixth month of evaluation and it was done likewise with pests. In the case of the companion crops these observations were carried out in the first and third month after sowing.

**Botanical composition (%).** It was carried out taking into consideration the aggregate area of the four replications, the first and third month considering the regrowths or appearance of new species after the weeding in each treatment. For that the Mannetje’t and Haydock’s method (1963) was used.

**Yield.** The GM yield in the area of leucaena was evaluated at the moment of establishment and 12 months later. Six plants of each treatment were cut per furrow, from which the ligneous parts with more than 6 mm of diameter, approximately, were eliminated; afterwards, the samples were weighed and dry matter was determined at the laboratory. The calculation of forage production on dry base per area was carried out. The grain yields for each species were determined, by means of the harvest in the whole area.

The establishment expenses of each treatment were calculated by the records of all the cropping operations, considering the salaries of 10.00 pesos/man/day, the price of Diesel fuel as 0.50 pesos/L and the price of seeds as 12.00 pesos/kg, as well as other minor expenses. The possible income because of the grain sale was taken into account, according to the yields obtained in the field, and it was deducted from the total expenses.

The statistical analysis was performed by means of a double variance analysis, for the moment of establishment, the height and yield of leucaena, using the SYSTAT 7.0 program for Windows (1997).

\[ Y_{ij} = \mu + t_i + B_j + e_{ij} \]

Where:

- \( Y_{ij} \): j eth replication in the i eth treatment with \( \mu = 0 \) and \( \delta = \delta^2 \)
- \( \mu \): general mean of the experiment
- \( t_i \): i eth treatment, where \( i = 1, \ldots, 4 \)
- \( B_j \): j eth block, where \( j = 1, \ldots, 4 \)
- \( e_{ij} \): experimental error
Results and Discussion

The height reached by leucaena (fig. 1) corresponded to the references in the literature regarding that this plant has a slow establishment in the first stage after germination (Funes, 1982; Ruiz and Febles, 1987).

(Fig. 1. Average height values (cm) of L. leucocephala.)

These results showed the resistance and adaptability of leucaena to the adverse factors reported by Paretas (1990) as a result of the regionalization in Cuba; however, the presence of pests and diseases and the competition of weeds conspire against the normal development of the crop as stated by Mullen and Soller (1998) and Shelton (2001). Other authors assert that these factors are one of the main difficulties for this and other legume species, mainly in the sowing and establishment stage, which is decisive for an adequate utilization of the area.

The pests and diseases that appeared in the experiment are shown in table 1.

(Table 1. Presence of pests and diseases in the first six months after sowing.)

Ants were found in all treatments, with a higher incidence in vigna and sesame until the third month after sowing, which may have caused mechanical damage to the plants in those treatments. Also, different authors (Hughes, 1998) have reported damage in the crops by the action of these insects.

In all cases foliar spots were detected, which is one of the characteristic symptoms of the infestation by leaf spot, very frequent in the initial stages of plant development (Skerman, Cameron and Riveros, 1991).

In all cases, except in the treatment with sesame, the presence of the aphid was also found from the sixth month, which was associated to important damage to the plant and the performance of leucaena was affected; this coincides with the reports by Mullen and Soller (1998) and Shelton (2001), who indicated a decrease in the yields of several ecotypes of L. leucocephala when there was incidence of Heteropsylla.

In the treatment of leucaena with sesame an effect may have occurred of not preference or repellence between the pest and the crop, which is reported in the literature as highly resistant to this pest, probably because sesame has not been intensely improved by genetic means for productive characters which may affect its resistance to the action of pests (Altieri, 1996; ILRI, 2001).

Another factor that affected the establishment of leucaena was the presence of weeds (fig. 2). In this sense, it seems, the competition for nutrients, water, space and light, had influence on the best performance of the treatment with sesame, followed by sorghum and vigna, and the highest infestation percentages were shown by leucaena (control) in the two periods evaluated.

(Fig. 2. Degree of infestation by weeds according to the crops integrated to leucaena (%).)

The sesame crop shows a favorable architecture, has great ability for the extraction of nutrients and the competition for light and water, and affects the invading species because of lack of light by causing shade (ILRI, 2001). Sorghum is stated to be a very aggressive genus in its agronomic behavior (Paretas, 1990; CIAT, 2001), which competes avidly for water and light, all of which may have had influence, as in the case of sesame, on the higher adaptation to the system and the better association of these two species to leucaena; in both the need for weeding labors was reduced, which coincides with the reports by Huges (1998), Shelton (2001) and Guevara and Guevara (2003), who reported beneficial results when associating leucaena to short cycle crops. In a work carried out by Mahecha, Rosales, Molina and Molina (1999) in the establishment of a silvopastoral system, sorghum seed mixed with leucaena seed was used, with the objective of using the sorghum plants as row markers and thus facilitating the first weed controls.

The results of the establishment for the different variants analyzed (table 2) allow to appreciate that in those treatments in which the accompanying crop was used, the time for reaching the approximate height of 2 m as criterion for the establishment was reduced (Ruiz and Febles, 1987). On the other hand, the contribution made by the crops (sesame, sorghum and vigna) to reduce the time of establishment of leucaena, confirms what was stated by Padilla, Colom, Díaz, Cino and Curbelo (2001) regarding that intercropping does not affect the establishment of leucaena.

(Table 2. Time of establishment for the variants analyzed.)

Similar effects were reported by Simón (2000) for commercial fields of leucaena with vigna associated, in livestock farms in the western part of Cuba, with benefits for leucaena in its growth and in the economy of the agricultural system evaluated.

Grain production in sesame was similar to that reported by Ávila, Colmenarez, Marciano, Acevedo, Flores and Gutierrez (2003), who reported yields up to 973 kg/ha.
In the treatments of leucaena associated to sorghum and vigna there was a very similar performance in the establishment and they did not differ in their grain production, exceeding the control in all the indicators evaluated, which coincides with the reports by Reyes, Rodríguez, Simón, Lamela and Suárez (2000) for similar conditions.

With regards to total expenses (table 3) until the establishment, in the crops associated to leucaena they were lower than in the control. Undoubtedly, the weeding labors generated the highest expenses during the establishment, which coincides with the indications by Pool (1997) when he pointed out that pests, diseases and plants that grow spontaneously in the field increase the problems and expenses for production.

(Table 3. Sowing and establishment expenses of leucaena according to the companion crops and incomes from the grain sale ($)).

The treatment with sesame had a lower need of weeding labors and a lower presence of pests and diseases than the rest of the treatments, which represents an advantage.

Leucaena as a crop needed continuous weeding labors, which coincides with the reports by Ruiz and Febles (1987); Funes Zambrana and Yañez (1998); Ruiz, Monzote, Febles and Hernández (1998) and Ruiz and Febles (1999), regarding that the leucaena requires mechanical or manual weeding at least in the first 80 days of development, which makes the establishment expensive; it confirms the statements by Altieri (1996) that the costs of establishment of silvopastoral systems are factors that affect the producer.

In turn, the income provided by the grain productions of the intercropped species represents an important contribution to pay the expenses incurred in during the establishment of leucaena, which is an advantage as compared to the treatment of leucaena alone; this coincides with the reports by Simón, Francisco and Reyes (2001) regarding that the investment in the promotion and development of silvopastoral systems may be reduced if the tree sowing is accompanied by short cycle crops, in addition to achieving a profit margin.

The results in the establishment of leucaena with the three variants of short cycle crops, as well as the decrease of total expenses of this process with regards to the control, coincide with the statements by Ruiz, Febles, Díaz, Hernández and Pereiro (1997) and Padilla, Ruiz, Cino and Curbelo (1999), that the intercropping of temporary crops for grain production destined to human or animal consumption, constitutes an option to achieve a good survival and compensate, to a good extent, the expenses of soil preparation, sowing, weeding and the necessary period of immovability for the grazing of the area.

Conclusions

1. The use of short cycle crops such as *S. indicum*, *S. vulgare* and *V. sinensis* constitutes an economically sustainable alternative in the establishment of *L. leucocephala* cv. Perú.

2. The species analyzed do not affect the development and yield of *L. leucocephala* cv. Perú, when used as companion crops.

3. With the use of these crops, and particularly sesame, a more efficient control of infestation by weeds and pests is achieved and the time for the establishment of leucaena is reduced.